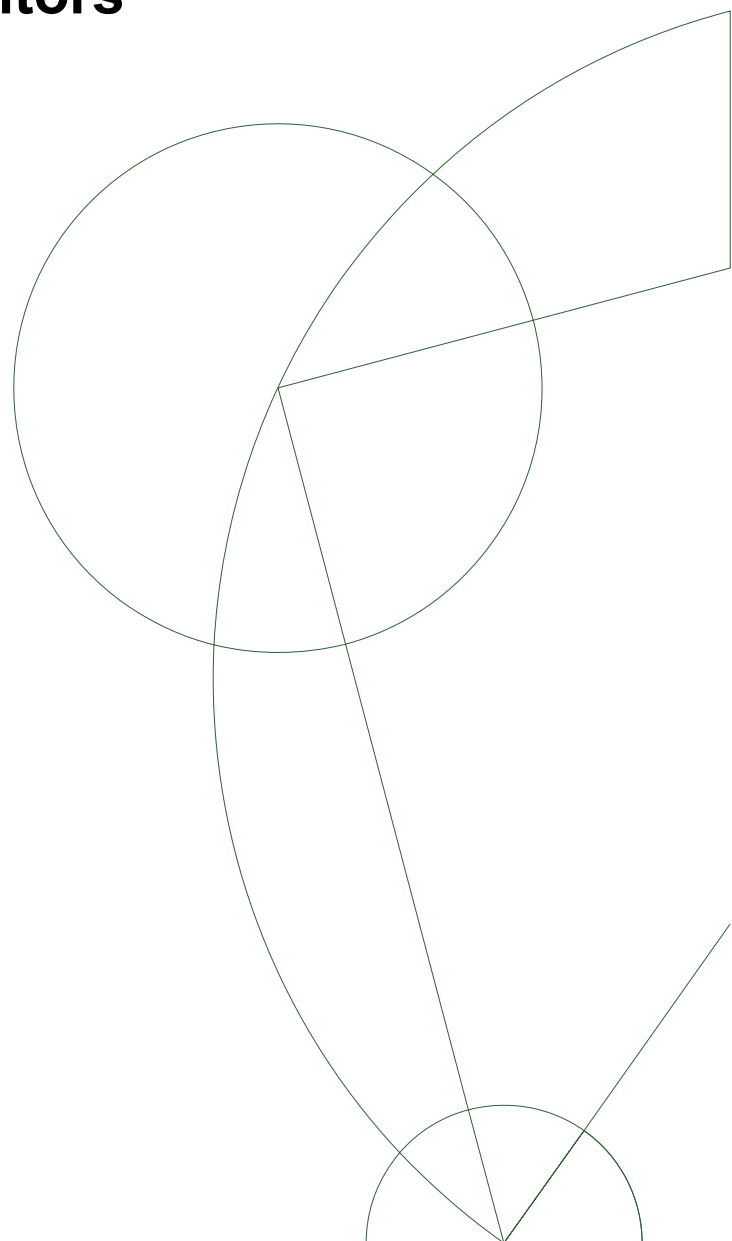




Using touch-tables and inquiry methods to attract and engage visitors

Sarah Elisabeth Klein

Kandidatspeciale



February 2011

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A new exhibit using a touch-table was designed to attract and engage zoo visitors to become a more interactive part in their learning process. The focus was on family groups and their learning ability in a social context. The touch-table was independent of a zoo educator being present for explanations, thereby making it less costly. Furthermore, visitors were more active participants, as they had to use more of their senses. The headlines of the information signs were questions without answer choices available to motivate and drive inquiry learning. □ Answers could only be found by reading the text and/or looking at the pictures in combination with using the relevant objects, thereby encouraging learning through inquiry and investigation.

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Using touch-tables and inquiry methods to
attract and engage visitors

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Using touch-tables and inquiry methods to attract and engage visitors

Abstract

A new exhibit using a touch-table was designed to attract and engage zoo visitors to become a more interactive part in their learning process. The focus was on family groups and their learning ability in a social context. The touch-table was independent of a zoo educator being present for explanations, thereby making it less costly. Furthermore, visitors were more active participants, as they had to use more of their senses. The headlines of the information signs were questions without answer choices available to motivate and drive inquiry learning. Answers could only be found by reading the text and/or looking at the pictures in combination with using the relevant objects, thereby encouraging learning through inquiry and investigation. Related tables with information signs only were designed and likewise tested in order to measure the effect of touch-table use. An audio recorder applied in both scenarios was used to record families' interactions and evaluate the different effects of using touch-tables. Two hundred fifty family interactions and interviews at two zoos were analyzed to examine the effects using touch-tables. It was found that more visitors stopped, time spent and learning behaviors were greater at the touch-tables compared to tables with information signs only.

Keywords: *Touch-tables, learning in social contexts, inquiry learning, family interactions.*

Introduction & Background

One responsibility of zoos is their commitment and contribution to education by providing visitors with relevant information. An educational strength of zoos is that they have the ability to communicate science using living and concrete examples (Falk, 1997). The question is, are zoos' enormous educational potential used to the maximum or can it be optimized?

More than 700 million people a year visit one of the zoos or aquariums united in the WAZA network (WAZA: Zoos and Aquariums of the World). A visit to the zoo is often in relation with a school field trip or a family excursion. When school classes visit zoos they often have an agenda for the day and assignments to fulfill whereas families often visit zoos for enjoyment and as an occasion to spend time together. Informal science settings are rich learning environments that nurture curiosity, motivation and attitudes toward science and engage visitors through participation, social interaction and generate excitement all contributing to learning and understanding (Barriault & Pearson, 2010). Families visit zoos in their leisure time with an agenda that is partly social and partly educational (Borun & Dritsas, 1997). Adults visit zoos to satisfy their intellectual curiosity and with their children because they think the experience is worthwhile and furthermore an opportunity to learn science in the process (Falk, Storcksdieck & Dierking, 2007). There is evidence supporting that most of what the general public knows about science is learned outside schools in their leisure time visiting informal settings and through Websites, reading magazine, articles or watching nature or science specials on television ("Learning in the wild", 2010).

Learning is the most complex of human activities (Barriault & Pearson, 2010). However, the complexities of the processes of learning during visits to free-choice settings are still not fully understood (Falk & Storcksdieck, 2005). One reason is the heterogeneity of visitors of all

ages, experiences and backgrounds, each of which influences how and what they learn (Falk & Adelman, 2003) making them more complicated to study. However, they are a very important group to consider, as they constitute the most frequent visitors in zoos.

Signage

The most general way of providing zoo visitors with relevant information is using informative signs (signage) close to the enclosures. The basics of signage are often very similar as it provides visitors with background information about the animal as it often contains basic animal identification about the species e.g. its common and scientific names, range, habitat, longevity, gestation period, diet and endangered status (Serrell, 1988). These forms of signage assume that the readers are as interested in the animal as the creators of the signage. However, signage does not always take into consideration that visitors are varied regarding their prior knowledge and interests. Visitors rarely visit free-choice learning settings with a desire to become experts in that subject (Falk & Adelman, 2003) but they want to be informed in a pleasant and entertaining way during their leisure times. It can be difficult fulfilling visitors' curiosity when only using non-manipulative items like signage (Lindemann-Matthies & Kamer, 2005).

Family learning

Families make up more than half of all visitors and they come to informal settings to play, talk and learn from each other (Ash, 2003). Much of what children learn about their world they learn in the context of parent-child interaction (Atkins et al., 2008). Family conversations in informal settings are critical mechanisms for learning and these

conversations include both non-learning talk e.g. orientation and learning talk, asking questions, answering questions, explanations and focusing (Eberbach & Crowley, 2005). Children's conversations and interactions with their parents play an important role in the learning process. Parents have prior knowledge, which is valuable in giving explanations and explaining concepts to their children that otherwise would be difficult for them to understand (Patterson, 2007) showing that parents take the role as explainer (Crowley et al., 2000). Research has shown that visitors to informal science education settings expect to learn during their visit. They also view learning and entertainment as complimentary goals. The strength of these settings is that visitors are driven by interest and they choose and control what they want to attend to (Falk & Storkdieck, 2010).

When improving or making new exhibits is it important to take into consideration that families represent the majority of visitors so zoos should facilitate group learning. Further considerations when designing exhibits are that families are complex yet unique learning groups of mixed ages and backgrounds (Ellenbogen et al., 2004) making the goal of the exhibit to attract and engage all age groups.

Touch-tables

Touch-tables are small exhibits that consist of a moveable cart on which objects are placed and made available for visitors to touch and investigate. One of the advantages is that they involve hands-on activities and objects, which are helpful tools in supporting learning (Lindemann-Matthies & Kamer, 2005). In creating social environments within exhibits; designs should facilitate social interaction, stimulate exploratory behavior by asking open-ended questions and present real objects. Furthermore, it has been found that questioning and explaining occurred more frequently in exhibits that provided opportunities for touching.

Questioning is an important component of family learning (Borun & Dritsas, 1997). Earlier studies have shown that the learning outcome was greatest at small, interactive and easily understood exhibits (Barriault & Pearson, 2010).

The touch-table allows for dialogue inquiry as parents interact with their children, each other and with objects. Families use inquiry skills such as observing, interpreting, questioning, hypothesizing and explaining (Ash, 2003). They encourage inquiry learning through investigation of objects (Borun & Dritsas, 1997). It is important to encourage children to express their curiosity about topics and to engage with their environment to find answers to their questions (Patterson, 2007).

Research has shown that interactive exhibits attract and holds visitors attention for longer than non-interactive exhibits (Sandifer, 2003). Furthermore, interactive exhibits increase visitors' knowledge and understanding of science and provide memorable learning experiences ("The Impact of Science and Discovery centers", 2008). Objects are helpful in making the exhibit more concrete and allow visitors to learn differently, as more senses are involved. In another study it was found that one of the benefits of objects was that they create an investigation and it lead parents to explain to their children more often than without objects (Aktins et al., 2008). Objects are important in their role of supporting conversations and learning (Eberbach & Crowley, 2005). Hands-on exhibits support collaborative learning and parent-child interaction.

Lindemann-Matthies and Kamer (2005) found that zoo visitors who used the touch-table compared to information signs knew more about biology, conservation and ecology of the concerned animal. Their recommendations for further studies were to develop and test an unmanned touch-table without a zoo educator being present to answer any questions.

The goal of this study is to develop a new and unique exhibit to attract and engage zoo visitors to be an active part in their own learning and further encourage active family learning. Furthermore, it takes into consideration that zoo visitors often are families and that learning often is a group experience (Borun et al., 1997).

The aim is to investigate if family learning is optimized by using touch-tables without a zoo educator present. The following questions are addressed in this study; do families stop more frequently at touch-tables compared to tables with information signs only? Do families even want to engage in the touch-table activities in their leisure time? Are the touch-tables effective tools to help increase family learning?

Method

Using convenience sampling, this study was conducted at two zoos, one in Honolulu Zoo (HZ), Hawaii, USA and the other part in Copenhagen Zoo (CZ), Denmark. Consequently, it is more international and tests the model in two different cultures.

The goal of this study is to develop a family friendly interactive touch-table to attract and encourage zoo visitors to participate and learn without having a zoo educator available to explain but still being able to understand the intended messages.

Touch-tables are small exhibits placed on a cart or table with objects to touch allowing hands-on activities and use a variety of senses to inspect them (Lindemann-Matthies & Kamer, 2005).

The exhibit

During a three months long study in Honolulu Zoo, four set-ups related to Black Rhinoceroses (*Diceros bicornis*) were developed. The first concerned the endangerment due to trade in their horns, the second dealt with their smelling behavior in which they smell each others' dung to identify one another. The third related to their prehensile lip and how they eat, and the last addressed why rhinoceroses wallow in mud. At the start of this project, they were all tested concurrently to find the appropriate combination of objects to have on a cart. When all four set-ups were tested at the same time, visitors reported that there was too much to do, to read and too many messages to understand, and furthermore, it was a bit overwhelming, crowded and maybe intimidating because of having to decide where to start and once started, knowing whether they would have to try everything and how long it would take. This showed that it is likely that "less is more" for families (Borun & Dritsas, 1997).

The second phase divided the four sets of objects into two with two separate touch-tables; one with real rhinoceros objects, which were the rhinoceros' horn and dung and the other with artificial artifacts with mud and a plastic grabber resembling the rhinoceroses' lip.

The horn and dung touch-table (see Figure 1) included two A3 sized information signs with the headlines: *Why do you think rhinos smell each other's poop?* and *Why do you think rhinos are endangered?* There were three pictures on each information sign. The information signs were standing in holders at an angle making it possible for both children and parents to read them. Beneath one of the information signs there was a digital audio recorder not visible to the visitors, which record timed their conversations. In the set-up, there was a jar on the touch-table with rhinoceros dung, a rhinoceroses' horn and a little plastic bag with white powder to resemble ground rhinoceros horn used in traditional Chinese medicine (TCM).

The horn and dung table with information signs only (see Figure 2) included the same two information signs and the hidden audio recorder. This control was made to measure the effect of touching and hands-on activity and so evaluate the touch-table.



Figure 1. Horn and dung touch-table with objects used in Honolulu Zoo, which was always placed in front of the black rhinoceroses' enclosure.



Figure 2. Horn and dung table with information signs only without objects to touch used in Honolulu Zoo placed in front of the black rhinoceroses' enclosure.

The mud and lip touch-table (see Figure 3) included two A3 sized information signs with the headlines: *Why do you think rhinos like to wallow in mud?* and *Why do you think it is an advantage to have a prehensile lip?* As part of this set-up there was a hidden audio recorder under one of the information signs. The set-up included a bowl of mud, stickers with bugs printed on them, plastic gloves, a bucket to throw the used ones in and wipes together with a short guideline of what to do. To clarify the advantage of having a prehensile lip there was a grabber and branches with leaves to show how rhinoceroses eat, as well as a short encouragement to try the grabber to understand how rhinoceros eat.



Figure 3. Mud and lip touch-table with artifacts and guidelines used in Honolulu Zoo, placed in front of the black rhinoceroses' enclosure.

The mud and lip table with information signs only (see Figure 4) involved the same two information signs and a hidden audio recorder. This table with information signs only was made to use as a comparison and to measure the differences between the mud and lip touch-

table and the mud and lip with information signs only and to measure the effect of using artifacts.



Figure 4. Mud and lip table with information signs only with no artifacts or guidelines used in Honolulu Zoo, placed in front of the black rhinoceros enclosure.

The horn and dung touch-table as well as the mud and lip touch-table both included two different activities where one of them was slightly more time consuming and challenging than the other. This division was intentionally made so it would fit different family groups and their time schedules.

In Copenhagen Zoo the information signs were similar to the ones used in Honolulu Zoo, however they were translated into Danish. The touch-tables were also identical except for small adjustments made to fit the White Rhinoceros (*Ceratotherium simum*) found in the Copenhagen Zoo.

Designing touch-tables

Philadelphia-Camden Informal Science Education (PISEC) has identified seven characteristics of exhibits in order to be successful family learning exhibits: multi-sided, multi-user, accessible, multi-outcome, multi-modal, readable and relevant (Borun & Dritsas, 1997; Borun et al., 1997). These characteristics are identified to attract and hold the attention of family groups. Bearing these criteria in mind the touch-tables for this study was developed. The aforementioned specific exhibit characteristics associated with family learning are seen in these touch-tables. It was multi-sided because several families can stand around the touch-table at the same time and it can be approached from three sides. It was multi-user since it allowed for several sets of hands to interact at the same time, as there are two different activities at the touch-table. Accessibility at the touch-table was easy since it was at a height so it could be used by parents, children and visitors with wheelchairs. However, the cart may have been a little too high for the youngest children to reach and try out for themselves. Nevertheless, toddlers are always accompanied by parents, who can lift them up. It was not a problem, but it could have been helpful having a stool there. Multi-outcome was addressed since the activities were diverse enough to hold visitors interests for longer periods and to engage a group in discussion as the topics are relevant in other contexts as well e.g. rhinoceroses are threatened like most other animals and marking territory is a behavior one probably is familiar with from observing cats and dogs. Furthermore, it was easier to start a dialogue when beginning with something, which is already known. The touch-tables were multi-modal in that they appealed to different learning styles, levels of knowledge and involved several senses. They were readable since the text was short, easy to understand and the typeface was large. The touch-tables were relevant since they were in front of the rhinoceroses' exhibit making a connection with it since it provided cognitive links to visitor's existing knowledge.

The touch-tables were tested over a longer period by gradually modifying more effective components could be developed before significant funds were found. Trial testing is one of the most important steps during exhibit designing (Bitgood, 1991) as it is possible to realize what is most effective in reaching the intended goal by testing the exhibit and designing.

Based on trials, some of the modifications made in to the touch-tables in this study were that the information signs were made larger to an A3 size. The text was shortened and made larger as were the pictures, since another study showed the importance of having text that is short, easy to read, and the typeface was enlarged for better readability (Serrell, 1988; Borun & Dritsas, 1997). Furthermore, an attempt was made to make an eye-catching headline to attract visitors' attention (Bitgood, 1991) as their initial attraction to an exhibit is based on curiosity (Sandifer, 2003). Additionally, a "think" was included in the headlines of all four information signs to clarify that it was a question. So for instance instead of "Why are rhinos endangered?", it was changed to "Why do you think rhinos are endangered?"

Initially, at the horn and dung touch-table, there was a picture on the information sign concerning territory marking of a rhinoceros smelling dung. However, some thought the rhinoceros was eating it, therefore the headline was changed from "Why is dung so important for rhinos?" to "Why do you think rhinos smell each other's poop?". Additionally, in the beginning, the word - "dung" was used, but several of the visitors did not know what dung was even though there was a picture of it on the information sign so "dung" was changed to "poop". This had a positive effect since it was a more common term with which everyone is familiar and provided better catches of their attention. The "poop" question was the one that caught visitors' attention most frequently because they thought it was an amusing question and probably not something they have thought about before. The same method was employed in the headlines and text by using "rhino" instead of "rhinoceros". This was to make it easier for visitors to read, and it is probably a term more widely used by the public.

As part of the horn and dung touch-table, there was a jar with rhinoceros dung inside. In the beginning, the lid was left on so visitors would have to take the lid off themselves and play a more pro-active part. None of the visitors did it, but it might also be that they did not know they were allowed to do so. It would have helped if there was a note explaining to take the lid off, and then it would have encouraged visitors to do so. When the lid was taken off, almost everybody smelled the dung. Many of the visitors tried it themselves and invited others to do because many of them said on the recorder “when has one ever had the opportunity to smell rhino dung before and one would probably never get that chance again”. The idea behind this method was to make connection so visitors smelt dung like rhinoceroses do.

To clarify that rhinoceroses smell others’ dung and urine to identify one another there was a very characteristic female and male perfume on the horn and dung touch-table to show the similarities to human nature and to clarify that even though we do not know which gender it belongs to we can tell by smelling it. However, they were removed after several of the visitors commented, “oh so perfumes are made from rhino dung”. The perfumes were consequently replaced by an ID-card with a photo of a rhinoceros and this was a great help in explaining that rhinoceroses use their dung as a calling card.

In the beginning of the study, many of the visitors tried to turn the information signs around to find the answers. It helped taping the information signs to the white boards, as it was then clearer that no answers were given and visitors stopped turning the information signs around. However, it was also helpful including a “think” in the headlines. It was a little more obvious that it was a question and there were no answers given. So the headline read e.g. “why do you think rhinos are endangered?”

Another reason why the headlines of each information sign started with – why do you think... was to show that it is a question and one has to come up with an answer on their own,

thereby encouraging visitors to take a more active part of their learning. In another study, it was discovered that visitors were more likely to read information signs if they started with a challenge in the form of a question (Borun & Dritsas, 1997). Open-ended questions on information signs increased the occurrence of learning behaviors (Barriault and Pearson, 2010). Another study showed that questions on information signs increased visitors' engagement, and after testing several different information signs, it was concluded that visitors preferred information signs with a combination of questions and suggestions. Furthermore, adding questions on information signs increased reading time and it was easier for visitors to recall the text at post-visits. In addition visitors reported that the questions were an encouragement and motivation for them to explore and think for themselves. The suggestions in this study were seen in the mud and lip touch-table in the guidance to help visitors know what to do and further help them get started but as there were no results, it was also an encouragement to think. Since visitors had to investigate to find the answers, it was helpful in encouraging inquiry learning. In general, information signs are important in informal settings since these are the ones that visitors encounter with first and the ones that will affect the initial engagement (Gutwill, 2006).

In order to analyze visitors' interactions at the touch-table, a hidden audio recorder was placed nearby. This ensured that visitors talked as they normally would. Otherwise, it could be expected that they could change their behavior and seem more interested or contrarily, be afraid of not answering correctly and therefore not stop at all if they knew the recorder was present. In another study, families who participated tended to spend more time at the exhibit because they knew they were being observed since they had been asked beforehand (Borun & Dritsas, 1997). The disadvantage of this method is the additional background noise in the recordings. However, this cannot be changed though the impact would be smaller if visitors were wearing a microphone. Nevertheless, the advantages of visitors being unaffected and

not knowing of the recorder are larger than a better sound quality. Furthermore, when setting up the touch-table, the audio recorder was very valuable in knowing and understanding what visitors talked about and gave insight into whether or not they understood the intended messages. To follow the process of learning it is necessary to get inside the learner's head and audio recordings are very useful for that (Rennie et al., 2003).

Procedure

The focus of this study was on family groups, which are defined as at least one child accompanied by either a parent or grandparent. Other groups were not included. Another requirement for being included was that the parent and child were together the whole time at the touch-table. If they walked away from the touch-table the recorded time paused and if they came back the recording time restarted. If only one of them left, and did not return time was stopped and they were not included. So the recorded time is only the time spent at the touch-table.

In order to secure diversity in zoo visitors and avoid bias, it was shifted between using touch-table and table with information signs only, so in the first part of the day the touch-table was tested and in the second part the table with information signs only was tested and this changed the next day until enough data was collected.

When collecting data, a researcher was sitting a few meters away from the touch-table, not too obviously, but still in a position where it was possible to observe visitors. When family groups stopped, they were considered to be engaged with the touch-table when they stayed there for at least five seconds either reading information signs, interacting and/or touching objects/artifacts. The use of a minimum five seconds of stopping is commonly used in time-

based behavioral studies (Sandifer, 2003). When a family group stopped at the touch-table, it was noted assumed ages of grand/parent(s) and child(ren) in a interval of five years, their relation (parent(s), grandparent(s), family gathering, friends) and the size of the family group. Furthermore, when the objects/artifacts were available, it was noted what items each family group touched. When they were leaving the touch-table, they were asked if they were willing to participate in an interview in order to help improving the rhinoceroses' area for visitors. If visitors declined to participate in the interview, their demographic characteristics were erased, however, only three families in total (1%) declined to participate due to time constraints.

In the interviews, participants were asked if they were members of the zoo and if so, how many times a year they visit, and if not members, then if they had been to the zoo before. Afterwards they were shown two pictures they had not been shown before. The pictures concerned the same topics as on the information signs. Participants in the interviews were asked to comment on the pictures and describe what the rhinoceroses were doing. All individuals who are part of the family group are encouraged to contribute with their suggestions and it was noted who and how many were answering. As a last question families were asked if hunting of rhinoceroses was illegal; here they could choose between the options yes, no, or I do not know.

The same pictures were used in the horn and dung touch-table and in horn and dung table with information signs only and a different set of pictures were used in mud and lip touch-table but the same as in mud and lip table with information signs only.

Another reason visitors were asked to participate in interviews was also to examine if learning outcome was different in touch-tables or table with information signs only.

In order to study learning outcome participants' answers were written down verbatim during their interview. In order to evaluate and categorize these answers each picture was given some 'buzzwords' defined as words that best described the pictures.

At dung and horn touch-table and dung and horn table with information signs only, four pictures were used. The pictures were connected two and two together. One picture showed a rhinoceros scraping a dung-site and the other one was a rhinoceros urinating while smelling dung. These behaviors are part of marking territory and related to the information sign "*Why do you think rhinos smell each other's poop?*". The other pictures showed a poached and killed rhinoceros with its horn removed by poachers and the other picture showed poachers who were handcuffed and arrested by rangers. These pictures were relating to the information sign "*Why do you think rhinos are endangered?*".

The most important 'buzzwords' to describe these pictures are: rhinoceros scraping a dung-site, peeing, smelling dung, leaving a scent behind. These behaviors are all part of marking territory. The buzzwords for the other pair of exhibits were rhinoceros killed, horn removed, TCM (Traditional Chinese Medicine), poachers, and poachers caught and handcuffed.

At the mud and lip touch-table and the mud and lip table with information signs only three pictures were shown to participants. Two of the pictures showed rhinoceroses in different situations connected to the information sign "*Why do you think rhinos like to wallow in mud?*". One picture showed two rhinoceroses where one of them was wallowing in mud and the other stayed on land with two oxpeckers birds sitting on its back eating bugs. The other picture was of a rhinoceros eating and it clearly showed its characteristic mouth. This picture was relating to the information sign "*Why do you think it is an advantage to have a prehensile lip?*".

The most significant words to explain these pictures were: Wallowing in mud to cool off, form a mud layer to protect against sun rays, to get bugs off, or use the mud to make it more difficult for bugs to bite and stay attached. Birds sitting on the rhinoceros' back eating bugs. Bugs penetrating/sitting on the skin. The other picture showed a rhinoceros eating leaves/grass, using its big mouth.

To show appreciation, participants were in Honolulu Zoo given a packet of coasters with animal illustrations and in Copenhagen Zoo were participants given a poster for participating in the interview.

In addition to the interviews, attraction power and holding time were measured. These criteria are often used in research studying visitors' attention. Attraction power is defined as the percentage of visitors stopping at the exhibit and holding time is defined as the time visitors spend at an exhibit (Sandifer, 2003; Shettel, 1997). These measures are helpful in evaluating an exhibit. When family groups passed the touch-table it was noted if they either made a full stop, partial stop or did not stop at all.

Full stop (FS) was defined as stopping completely for at least five seconds at the touch-table, as the time was measured it was also noted if it was a parent or a child who initiated the stop. Only family groups were studied and only if they were together the whole time as the focus was on learning in a social context. As a result if one walked away while the other person was still standing at the touch-table, time was stopped unless if at least an adult and a child from the same family group were still together at the touch-table.

Partial stopping (PS) was defined as reading the information signs while walking along. Again it was noted if it was an adult or child who looked first.

No stopping (NS) was defined as family groups who just walked by the touch-table without stopping.

All family groups passing by were recorded but if they passed several times only the first time was included in the measurement. These measurements were made in horn and dung touch-table and horn and dung touch-table with information signs only and mud and lip touch-table and mud and lip table with information signs only both in the Honolulu Zoo and Copenhagen Zoo giving eight measurements in total.

Results

Attracting power

Attracting power was defined as the percentage of family groups stopping at the touch-tables and table with information signs only. Attracting power can be used to evaluate how successful exhibits are because even though it might be a good exhibit, learning outcome can be limited if only few visitors stop.

Figures 5 and 6 show the number and percentage of visitors in the Honolulu Zoo (HZ) and Copenhagen Zoo (CZ) who either were classified as not stopping (NS), partial stopping (PS) or full stopping (FS). The figures show the differences in frequencies of stopping at the different touch-tables and tables with information signs only.

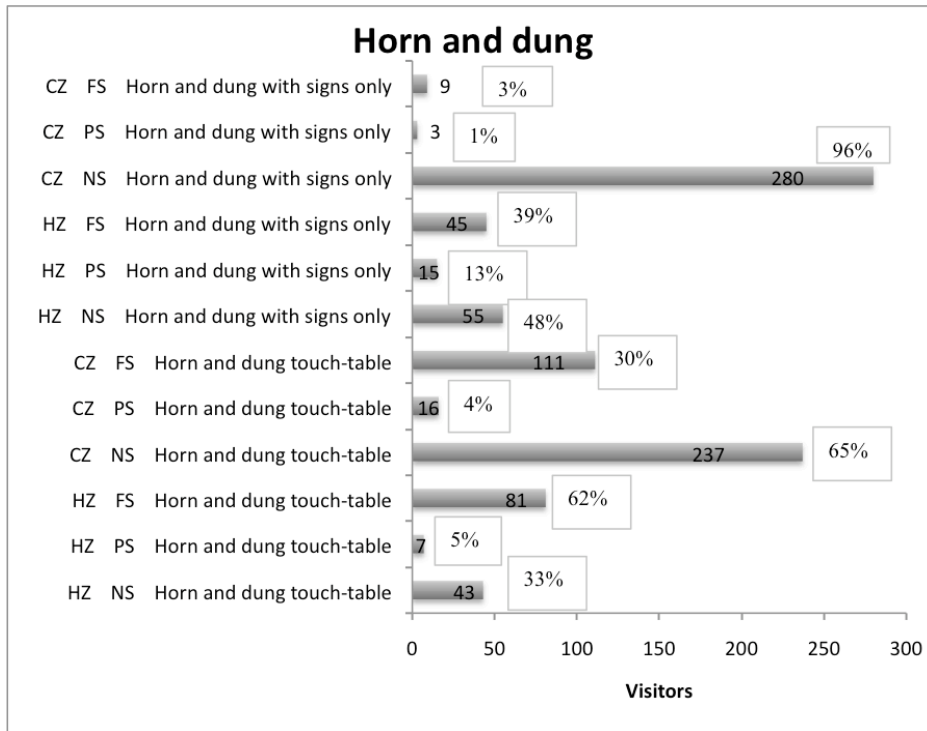


Figure 5. Number and percentages of visitors who either made a FS (family groups making a full stop), PS (family groups making a partial stop) NS (family groups not stopping) at the horn and dung table with information signs only and the horn and dung touch-table with objects to touch, carried out in Honolulu Zoo (HZ) and Copenhagen Zoo (CZ). Number of visitors at the horn and dung table with information signs only: $n_{HZ} = 115$, $n_{CZ} = 292$ and at the horn and dung touch-table; $n_{HZ} = 131$, $n_{CZ} = 364$.

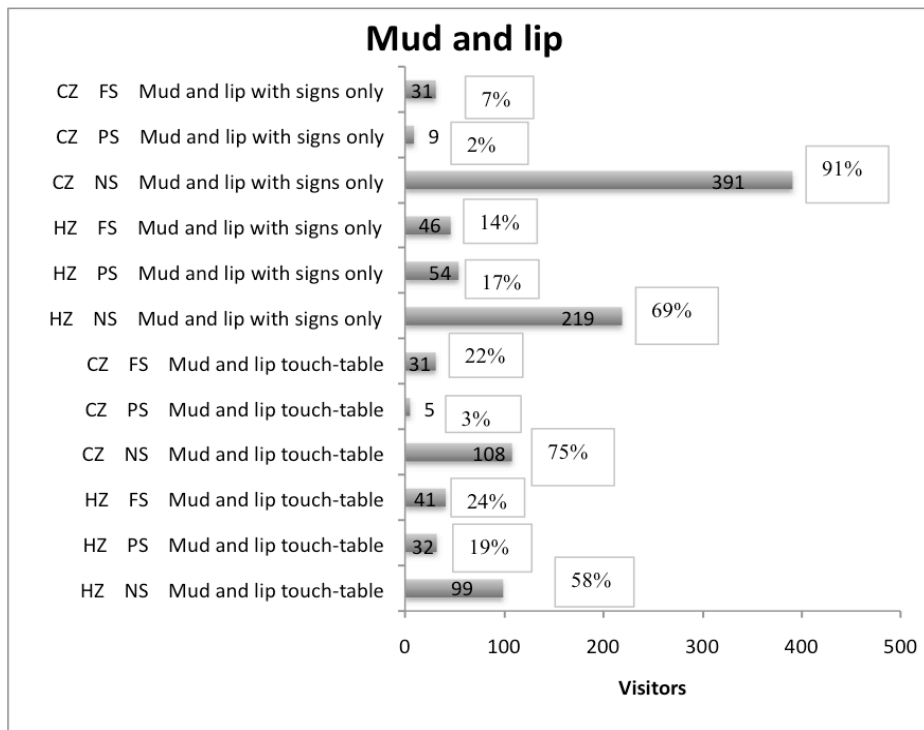


Figure 6. Number and percentages of visitors who either made a FS (family groups making a full stop), PS (family groups making a partial stop) NS (family groups not stopping) at the mud and lip table with information signs only or the mud and lip touch-table with objects to touch, carried out in Honolulu Zoo (HZ) and Copenhagen Zoo (CZ). Number of visitors at mud and lip table with information signs only: $n_{HZ} = 172$, $n_{CZ} = 144$ and at the mud and lip touch-table: $n_{HZ} = 319$, $n_{CZ} = 431$.

The percentages of visitors not stopping (NS) are higher in the Copenhagen Zoo compared to Honolulu Zoo. This might be influenced by the fact that the number of displays in general are fewer in the Honolulu Zoo compared to Copenhagen Zoo so visitors in Honolulu Zoo are more likely to stop. It is very challenging to know the reasons why a particular family does not stop to interact with the exhibit (Barriault & Pearson, 2010).

However, when comparing the percentages of visitors making a full stop (FS), it was higher in both zoos at the touch-tables compared to its tables with information signs only. The same conclusion can be drawn from another study where attracting power was greater in concrete exhibits with objects compared to abstract exhibits involving pictures and text only (Sandifer, 2003). The tendency that fewer visitors tended to stop at tables with information signs only is also comparable to another study where it was found that reading behavior was minimal or nonexistent (Borun and Dritsas, 1997) since visitors do not want to read a lot while in the zoo but rather want to be informed in an enjoyable and entertaining way.

Especially in the Copenhagen Zoo, the frequency of visitors not stopping was found to be very high in both the tables with information signs only, which might have been influenced by the weather. In general weather has a major impact on visitors in zoos and in all other informal outdoors settings. This was particularly true in the Copenhagen Zoo as the weather got colder and rainier during the three months period in which data was collected. Another impact from the weather in the Copenhagen Zoo was especially seen in relation to the horn and dung table with information signs only as it took a longer time to collect data as visitors in rainier and cold weather were hesitant to stop when only information signs were available.

The touch-tables appeared to have a larger attracting power on visitors in the Honolulu Zoo and Copenhagen Zoo as more stopped completely than in tables with information signs only. Similar to another study they found that the touch-table was helpful in attracting visitors'

attention (Lindemann-Matthies & Kamer, 2005). However, when comparing the frequency of full stop (FS) between the two zoos, it was generally larger in Honolulu Zoo undoubtedly influenced by the general better weather conditions for outdoor activities.

Stopping

The study showed that it was mostly parents who stopped initially and their children followed, however, this was expected as younger children follow the guidelines from parents, i.e. if parents stop children stop as well since the parents decide where and when to stop. In cases where the children were in strollers and the family group stopped, the parents were noted for stopping. In case it was clear that the children wished to stop the child was then recorded for stopping. The same applied if a child had been heard drawing the attention of a parent referring to the touch-table making the parent stop.

The frequency of adults and children stopping was the same at the touch-tables and at the tables with information signs only in both zoos. The adults were noted for initially stopping 64% of the time and the children first stopped 34% of the time both in the Honolulu Zoo and Copenhagen Zoo. It was expected that more children would stop at touch-tables as they were offered hands-on activities. Research has shown that interactive exhibits are more popular among children than adults (Bitgood, 1993). However, this was not seen, as there was no significant difference in stopping between touch-tables and tables with information signs only in both zoos. However, a few more adults were noted to stop in the touch-table compared to the tables with information signs only in both zoos, and this was likely due to the greater attraction power for the touch-tables.

Holding time

Holding time was defined as the actual time a family group spent at the touch-table. Time measurements are useful since they are an unobtrusive measure of visitors' attention. Whereas holding power is the ratio of the time spent at the exhibit versus the time required to interact, touch and read information signs (Shettel, 1997; Donald, 1991). However, holding power is more loose in definition and it can be expected that visitors require a different minimum of viewing time to study objects, read etc (Sandifer, 2003).

Holding time in this study was defined as the time visitors spent at the touch-table. Time registration was started when a family group arrived at the touch-table and stopped when they left. If the parent/child left before the other leaving the other one behind, time was stopped, as the focus is on learning in a social context. However, if only some left from the family group leaving at least one child and a parent behind the recording of time was continued. Figure 7 shows the average holding time (in seconds) families used at the touch-tables and tables with information signs only, in both the Honolulu and Copenhagen Zoos.

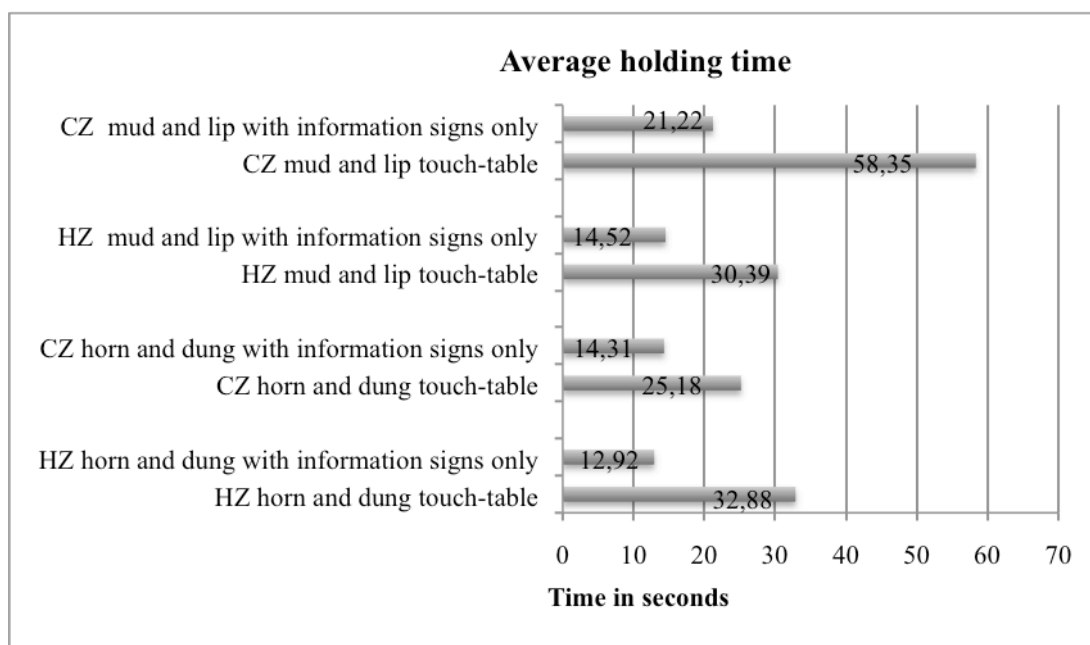


Figure 7. Average holding time in seconds that family groups spent at touch-tables and tables with information signs only in the Honolulu Zoo (HZ) and the Copenhagen Zoo (CZ).

Average holding time is defined as the average time families spent at the touch-tables and tables with information signs only in the Honolulu Zoo and Copenhagen Zoo. Figure 7 shows that visitors stayed longer at the touch-tables both in the Honolulu Zoo and the Copenhagen Zoo compared to the tables with information signs only. Research has shown that visitors generally spend more time on good exhibits (Borun et al., 1997). Families spend more time at exhibits that are participatory and allowed handling of objects (Borun et al. 1997). Further, interactivity as the touch-table offered is known to affect holding time (Sandifer, 2003). The assumptions in relation to holding power have been that visitors spend more time at the exhibits they find interesting than those they do not find as exciting. When visitors spend more time there are more chances to interact and engage with the exhibit and assumingly the learning outcome will be greater (Serrell, 1997). The correlation between increased time spent and learning seems to be consistent, however it is not that simple (Sanford, 2010). Some visitors require more time to read or to understand the topic than others thereby using more time at the exhibit without necessarily learning more compared to other family groups spending less time. The same tendency was seen in the study showing that some families spent a smaller amount of time although they understood the intended messages and had an adequate interaction at the touch-table. When they were furthered interviewed, they were able to answer correctly. This indicates that the prior knowledge visitors bring to the zoo is a crucial factor in learning. Prior knowledge will influence what visitors learn from their visit and how they interpret their experiences, as do their interest and motivation (Falk & Adelman, 2003; Ellenbogen et al., 2004).

Interaction

Visitors' interactions were recorded when stopping at the touch-tables or table with information signs only. These recordings are a way of getting to know what visitors were discussing and if the exhibit fulfilled its intended goals. Audio recordings provide insights that are not possible to obtain using only observational methods. It is important to examine, visitors' conversations since they are a critical mechanism for learning in informal settings (Eberbach & Crowley, 2005) because it is through conversations that learning takes place (Sanford, 2010). In a large study Borun et al. (1997) identified similar behaviors, which were found to be associated with family learning and that learning was taking place. Furthermore, a correlation was shown that that these behaviors increased with learning level (Borun & Dritsas, 1997). The characteristics associated with family learning were: **Comment on, or explain the touch-table**, which in this study could be that a visitor e.g. said, "oh the rhinos are endangered because of trade with their horns" and many expressions of sadness; **Asking a question** could be e.g. "what is that?"; **Answering a question** could be e.g. "yes that is a rhino horn" or **statements** could be e.g. "oh that is heavy" or "it looks like wood". Statements were mostly seen in relation to the horn and dung touch-table, as many of the statements were related to the horn. Almost all of the visitors in horn and dung touch-table touched the horn, knocked on it and investigated it to see if it was real or made of wood, and many were impressed that it was so heavy. For **Reading text aloud**, almost all visitors read the information signs out loud, which is more a form of interaction compared to reading silently. Furthermore, it was observed that parents encouraged their children to read the information signs out loud and further encouraged them to try to answer. Reading behavior was more greatly recognized at the mud and lip touch-table since besides information signs there were also directions to read.

The level of interaction is dependent on the age of the children. Younger children may not be capable of expressing themselves verbally and as a consequence their parents often encouraged them to touch the rhino horn or smell the “poop”. If the children were older parents often encouraged them to read the text out loud and try to answer. However, as the focus of this study was learning in families, all family groups no matter age were included. The free-choice environment encourages leaning in groups (Rennie et al., 2003).

Hands-on exhibits increase interaction between exhibits and family groups (Borun & Dritsas, 1997). This is also seen in the following example. This is an interaction between a mother, father and their two children a son aged ten and a five-year-old daughter recorded at the mud and lip touch-table in Honolulu Zoo.

Son: Is that a spider (pointing on the illustration of a tick)?

Father: No, why do you think rhinos like to wallow in mud?

Mother: Try this put on a glove to discover why rhinos like to wallow in mud.

Son: You try.

Mother: Oh here put on the gloves (guiding and helping the son to put them on).

Son: Is it disgusting?

Mother: They are supposed to like it. Ok then try to put on a sticker on your hand covered in mud and one on your other hand. What is the difference?

Son: Oh the sticker can't stay on the mud.

Father: That's why the bugs can't stay on the mud.

Mother: Oh I get it the bugs won't stick to them when they have mud on them.

Father: Yes it will not stick to the ones covered in mud.

Mother: That's how they keep the bugs off.

Daughter: What is this? I want to try.

Mother: It says why do you think it is an advantage to have a prehensile lip? Try it. See you can grab the leaves better. See that is there lip (pointing on the pictures). That is why they have this pointy lip. Interesting.

Son: That's so cool.

This example illustrates that parents engage and guide the conversation by explaining and interpreting (Ash, 2003). Further, it showed that interactions are interpreted by others from ones group and through their conversations, they construct meanings specific to the topic (Ellenbogen et al., 2004).

Audio recordings described the process of conversation and how learning progressed during their stops at the touch-tables or tables with information signs only. It provided insight into the learning process and into visitors' interaction with objects. Furthermore, it revealed learning about individuals' interactions and interactions with others from family groups (Rennie et al., 2003).

Table 1 is the result of a total of 250 analyzed recordings from horn and dung touch-tables, horn and dung tables with information signs only, mud and lip touch-tables and mud and lip tables with information signs only. Every family interaction recorded was transcribed and when analyzed, each behavior (comment on, or explain of the touch-table, asking a question, answering a question, statements or reading aloud) equaled one point, so if two questions are asked then it equaled two etc.

Table. 1 Number of learning behaviors found by analyzing recordings from the horn and dung touch-table, the horn and dung table with signs only, the mud and lip touch-table and the mud and lip table with signs only in the Honolulu Zoo and the Copenhagen Zoo. (*Twice as much time was spent to collect data in horn and dung table with information signs only as in the horn and dung touch-table, however this was still not sufficient enough).

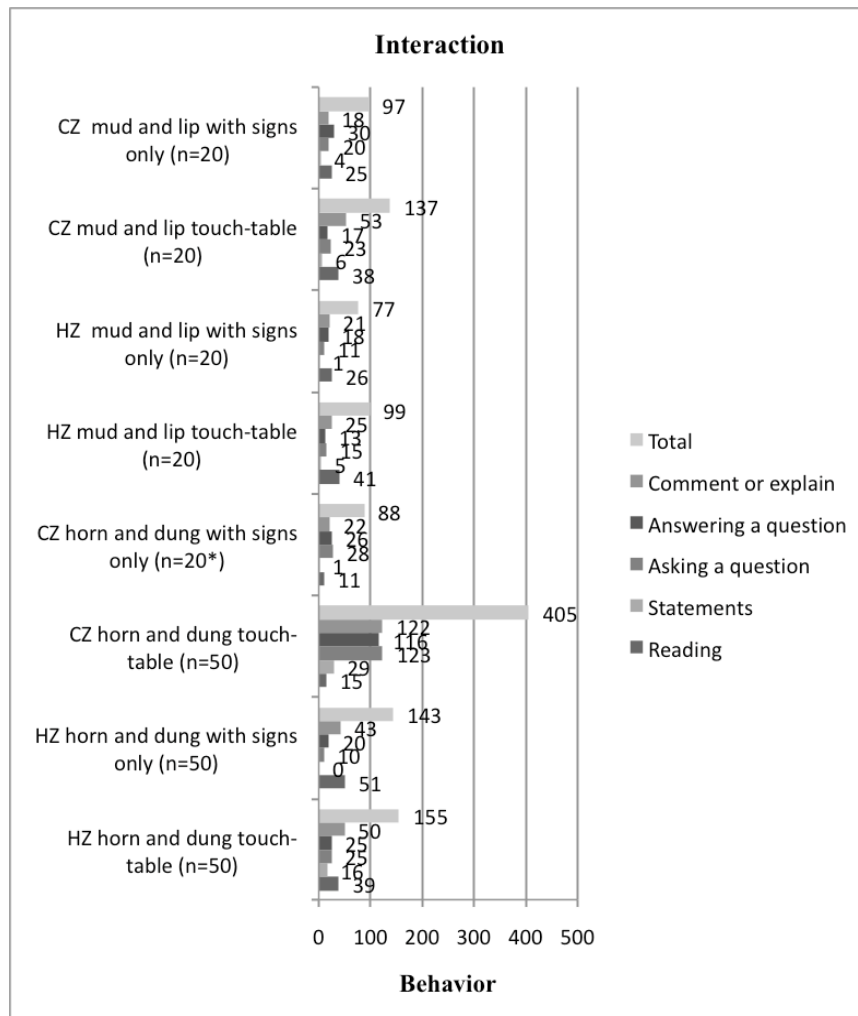


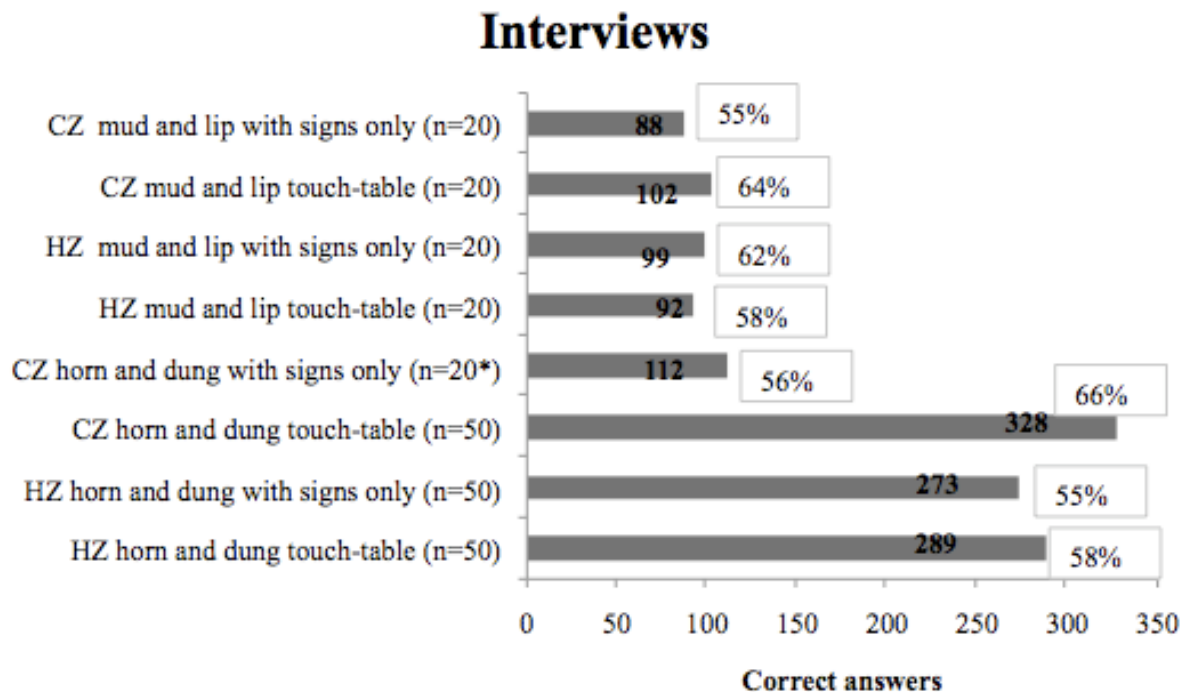
Table 1 reveals that learning behavior was greater in the touch-tables both in the Honolulu Zoo as well as Copenhagen Zoo compared to the table with information signs only. Borun et al. (1997) found that when visitors were engaged in these behaviors then learning was taking place, which then indicates that more learning is taking place in the touch-tables than tables with information signs only.

Knowledge gain

If family groups stopped at the touch-table or table with information signs only they were asked to participate in a face-to-face interview before leaving. As part of the interview they were shown two pictures they had not seen before but related to the same topics as on the touch-table. They were asked to comment on the pictures, describe them and the researcher prompted participants to elaborate further after each given answer. The researcher wrote down their responses verbatim. Open-ended questions were used since they allowed participants to describe their knowledge (Falk & Storksdieck, 2005). Also, open-ended questions allowed participants to explain unprompted and unclued as open and freely with their own words instead of using questionnaires where participants are bound to choose one of the given options. Interviews are still the main method of data collecting when observing family interaction (Rennie et al., 2003). Interviewing was a way to examine if they had understood the intended messages and the deeper they could describe the pictures the more they had understood the topics the touch-table was concerning. A reason that participants were shown pictures they had not seen before was to discover if they could transfer what they just experienced to another context so it was not situation-bound, thereby showing that learning had taken place. The end goal of education is only achieved if transfer occurs. When learning in one context impacts the performance in another related context then transfer of learning has occurred (Subedi, 2004).

Based on transcriptions of the interviews the answers were included in a scoreboard giving a score of one point for each correct answer whereas incorrect answers were not taken into account. The amount of correct answers from the horn and dung touch-table, the horn and dung table with information signs only, the mud and lip touch-table and the mud and lip table with information signs only in the Honolulu Zoo (HZ) and Copenhagen Zoo (CZ) are shown in Table 2.

Table 2. Amount of correct answers in interviews the boxes show the percentages in relation to the maximum total score, which was 10 in the horn and dung and 8 in mud and lip (*Fewer data was collected even though more time was spent observing).



The following is an example of a family group answering the researcher’s questions as they were interviewed after interacting with the horn and dung touch-table in the Honolulu Zoo. The family was comprised of five adults and their four younger children. The correct answers are shown in bold.

Researcher: Try to explain what you are seeing in this picture (showing them a picture of a rhinoceros peeing while smelling dung).

Family: Rhinoceros **urinating** while **smelling “poop”**.

Researcher: Why is it doing that?

Family: Part of **marking territory**.

Researcher: Ok and then what are you seeing on this picture (showing them a picture of a rhinoceros scraping a dung-site)?

Family: It is **scraping the ground after “pooping” to leave a scent** just like cats and dogs do.

Researcher: What can you tell me about this picture (showing them a picture of a poached rhinoceros where the horn is removed)?

Family: A **dead rhino** and its **horn has been removed**.

Researcher: Why?

Family: Because the horns are used in **Chinese medicine**.

Researcher: What are you seeing in this picture (showing them a picture of a ranger who has arrested and handcuffed poachers)?

Family: These men are **poachers** who been **arrested and handcuffed**.

Researcher: That was all. Thank you all for helping.

This interview gave a score of 10 out of 10 indicated by the bold words, which were some of the important buzz-words. Furthermore, the interview showed that the family had a good understanding of rhinoceros and they could make a connection to dogs and cats who mark territory.

Following is another transcribed interview from the horn and dung touch-table in the Honolulu Zoo. This family consisted of a father, mother and their three children.

Researcher: Try to describe what you see on the picture (showing them a picture of a rhinoceros peeing while smelling dung).

Family: It is on the bathroom.

Researcher: Anything else you see?

Family: No

Researcher: Ok try to describe what you see on this picture (showing them a picture of a rhinoceros scraping a dung-site).

Family: It is kicking up some dirt.

Researcher: Why is it doing that?

Family: Maybe because it is ready to charge.

Researcher: I will now show you a different picture what do you see on this (showing them a picture of a poached rhinoceros where the horn has been removed).

Family: A **rhinoceros killed** for its snout.

Researcher: For what reason?

Family: Don't know.

Researcher: What about this picture what are you seeing (showing them a picture of a ranger who have arrested and handcuffed poachers)?

Family: **Poachers.**

Researcher: Anything else?

Family: No

Researcher: That was all. Thank you all for helping.

This interview was an example of a much less detailed interview compared to the first one. This interview received a score 2 out of 10 indicated by the words in bold. However, these are two examples of the differences and diversity in interviews.

The results from all the interviews are shown in Table 2. The score was higher in the touch-tables compared to the table with information signs only meaning that participants who had been interacting with the touch-tables answered in more details. This indicated that supporting objects are helpful when learning new issues as these objects works as supportive information tools (Lindemann-Matthies & Kamer, 2005). However, there was an exception as the mud and lip table with information signs only scored higher in total than the mud and lip touch-table. This could imply that visitors' prior knowledge is an important factor in answering questions. Research has shown that visitors' prior knowledge is an important factor influencing how and what they learned from their experience (Falk & Adelman, 2003; Falk & Storkdieck, 2005).

Discussion

The touch-table had many positive effects as viewing time increased, visitors stayed longer the holding time was larger, attraction power was greater since more visitors stopped to have a look, and communication power better since the conversations visitors had were deeper and more advanced. These are all important goals when trying to improve exhibits (Borun & Dritsas, 1997). The best measure of exhibit success for families might be whether it contributes to learning (Sanford, 2010).

In general it took longer to collect data to the table with information signs only because fewer visitors stopped at the tables with information signs only (Figures 5 and 6). Thus much more time was spent to collect data in the horn and dung table with information signs only in the Copenhagen Zoo. Consequently, time did not allow for the same amount of observations as in the horn and dung touch-table carried out in Copenhagen Zoo even though twice as much time was spent. The probable reason may be that the visitors in Copenhagen Zoo are generally pampered with more relevant information material also including interactive activities, which is not the case in Honolulu Zoo.

Some of the surroundings and activities found in the Copenhagen Zoo can be a distracting factor especially for younger children who might focus on the more amusement park like activities offered in the Copenhagen zoo like e.g. pony riding, face painting and a playground. The space around exhibits affects visitors' attention and when there are other things to attend to it distracts both parents and children (Borun & Dritsas, 1997). In the Copenhagen Zoo there are several things to distract and compete for visitors' attention while observing the rhinoceroses. However these factors cannot solely explain why collecting data in horn and dung table with information signs only took so long when the same amount was collected in mud and lip table with information signs only but only half the time spent.

As shown in Table 1 the behaviors associated with learning were greater in all touch-tables compared to the tables with information signs only, which indicates that the learning outcome is larger with the use of touch-tables. If learning is greater at the touch-tables compared to tables with information signs only, which is more similar to the signage already known from zoos, there seems to be a need to develop more touch-tables.

The great advantage of the suggested touch-table is that it is not dependent on a zoo educator being there to inform visitors, which will often be prohibitive due to the costs involved. The touch-table only requires some maintaining once it has been developed and can then be accessible for visitors during opening hours. Furthermore, the presence of a zoo educator can sometimes actually limit family interaction and dialogue because it is expected that the educator will take the role as expert and the families as listeners.

Zoo visits are often part of a social event and recommendations for future use of touch-tables is to encourage visitors to take a more active part of the interaction and learning. It is recommended to use touch-tables considering that zoo visitors often come in groups with several children, which can make it possible to combine the children's curiosity and parents' ability to guide and explain and through a dialogue a greater understanding of zoo animals can be reached. Families operate as learning systems and by talking and interacting together they all reach a greater understanding (Sanford, 2010). Interactions with persons from one's group can strongly influence visitors' learning experiences (Lindemann-Matthies and Kamer, 2005).

This touch-table exhibit was built to answer and explain some important facts about rhinoceroses' biology but it could be constructed with different objects to fit and explain biology about any desired animal.

This form of teaching is different, as it required zoo visitors to take an active part, think and through investigation and interaction reach the answers themselves. It required more engagement from visitors. The effects are to some extent measurable since visitors remembered it better when having touched the objects or at least realized the answers themselves so they felt like it was a successful experience. Figuring out answers to the questions unaided promotes a motivating sense of empowerment (“Learning in the wild”, 2010). Visitors’ engagement with physical experiences are seen as an important element in learning and visitors are more easily kept engaged when more senses are involved like smelling, touching and interacting. In this study, active involvement increased visitors’ curiosity and interest in contrast to information signs, which are non-manipulative objects and only sight can be used (Lindemann-Matthies and Kamer, 2005).

However, touch-tables might require some adaptations as many zoo visitors are used to the more traditional way to learn where they read a question and get the answer by lifting the lid or turning it around since this does not require thinking or the drawing of conclusions. This was seen in this study especially in the Honolulu Zoo where many of the visitors tried to turn the information signs around to see if the answers were given on the backside. On the recorder it was very often heard that visitors read the questions out loud and then replied “okay and where are the answers?”, “but there are no answers”, and “so what are the answers?”.

It can be frustrating not just to be given the answers but it can also result in visitors becoming curious enough to find the answers themselves by studying the information signs and trying to find the answers or discussing possible answers with other family members. Visitors working things out unaided resulted in a sense of satisfaction. Visitors were forced to be a more active part of the learning.

Sometimes the study showed that families only read the headlines and turned to the researcher who was collecting data and said, “ok, so what are the answers?” When they were asked to try to look at the information signs, read the text and look at the pictures again they could often figure out the reasons and correct answers. This resulted in a successful experience for them, which could be detected in the audio transcripts.

Several times it was seen that one person from one family started explaining it to other families so the touch-table can also be helpful in creating dialogues between groups. This could be because they are part of something to which they are both trying to find answers.

The study also showed that parents’ engagement affects their children both positively and negatively. Visitors’ engagement is an important factor in the learning process (Barriault & Pearson, 2010). It was very positive when parents encouraged their children to try or read the information signs out loud and the children were encouraged to come up with possible answers, which indicated that parents often take on the role of teachers as other studies have found (Ellenbogen et al., 2004). It was negative when the children were curious and wanted to get in a dialogue but were neglected by their parents. Parents affect a child’s level of active participation by responding to the child’s dialogic turns or by ignoring them (Ash, 2003). It might be that parents have an agenda for the day in order to do all the things they have to do while in the zoo. This agenda does not only affect the visit but also influences the whole zoo experience (Bitgood, 1993).

The frequency with which visitors stopped was very much dependent on the visibility of the rhinoceroses. If it was not possible to see them immediately visitors tended just to glance while walking without stopping for a few seconds to see if they were hidden behind some rocks.

The activity level of the rhinoceroses also influenced viewing time. In the instances when they were sleeping visitors only stopped briefly whereas if they were running or fighting viewing time increased greatly. This was comparable to another study concluding that active animals were associated with twice as much viewing time as inactive animals (Bitgood et al., 1988). Experiences from the Honolulu Zoo showed that rhinoceroses can also draw too much attention, since they are a mating pair some visitors may not want to stop at all.

This study also showed mistakes in many answers even though it said rhino horn on the information sign some of the visitors still called them tusks both when discussing at the touch-table and when being interviewed. The misunderstanding was probably based on confusion with elephant tusks.

Another thing to note was that several of the interviewed visitors could not answer the questions correctly or only to a certain degree but when listening to their recorded conversations showed they had understood the essence of the questions. This is likely because what they just learned has not consolidated into memory yet and was therefore unavailable to recall for participants (Falk & Storksdieck, 2005).

In a future study it could be interesting to examine the long-term effect of using touch-tables and see if the impressions visitors bring home are greater and longer lasting compared to more traditional zoo exhibits. Earlier studies have shown that many of the conservations that started in informal science settings continue once families are back in the home and some are integrated into their lives (Ellenbogen et al., 2004).

Touch-tables can definitely be recommended to zoos, as they are good improvements and an alternative to signage. Another positive reason to recommend touch-tables is that they are not dependent on an available zoo educator. Furthermore, a touch-table can be designed to fit any desired animal and it takes in consideration that the major group of zoo visitors is families so

learning can take place through interactions between children and their relatives bearing in mind that learning is socio-culturally situated (Falk & Storksdieck, 2010).

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