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The Effects of Environmental Education on Children's Knowledge of Elephant Conservation in Rural and Urban Thailand

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Abstract

Human-elephant conflict (HEC) occurs in Thailand due largely to human population growth and a decline in suitable habitation for elephants, which can result in both human and elephant deaths. Think Elephants International (TEI), a non-profit charity, designed an educational program to peak an interest in research, educate students on issues surrounding elephant conservation, and inspire them to develop novel ways to mitigate human-elephant conflict. One open-ended response question from surveys taken before and after participation in the program was analyzed to determine students' knowledge of elephants pre- to post-test, as well as whether there was a difference in pre-test knowledge between rural and urban students. The results show that, overall, the educational program did have an impact on knowledge levels. Furthermore, urban students referenced information relevant to HEC in Thailand and the role elephants play in the conflicts more after participation in the program, while rural students talked more about the role elephants play as keystone species in their ecosystem after participation. These findings indicate a need for further analyses of other open-ended response questions that were included in TEI's survey as well as additional lessons and activities in the TEI curriculum about elephant conservation to make knowledge about HEC and conservation more prevalent in student's minds.

Keywords: Asian elephant, conservation, environmental education, children, Think Elephants International, rural, urban, survey, Thailand

The Effects of Environmental Education on Children's Knowledge of Elephant Conservation in Rural and Urban Thailand

Environmental education (EE) is rooted in the necessity to protect nature and wildlife due to the rising human population leading to environmental degradation (Athman & Monroe, 2001; Fraser et al., 2014). This is particularly true regarding endangered species that will likely not survive without intervention strategies to prevent gradual extinction. EE programs that focus on species conservation often attempt to increase public awareness and knowledge about the issues at hand as well as inspire the public to act in more pro-environmental ways in order to prevent any further species population loss (Barney et al., 2005). In areas where wildlife and humans often come into contact, these programs are designed to educate individuals about the importance of the endangered species as well as foster positive attitudes towards the species while attempting to create conflict mitigation strategies (Engel et al., 2016; Breuer et al., 2017). An important step in this process is evaluating pre-existing attitudes and opinions regarding the species and assessing if and how the curriculum is effectively promoting more positive attitudes and actions towards wildlife. Think Elephants International (TEI), a non-profit charity founded and based in New York, designed one such educational program and collected surveys from students to help evaluate these questions regarding Asian elephants in Thailand. The current research study aims to assess attitudes (here defined as positive views) towards and knowledge of elephants in children from rural and urban areas of Thailand, both before and after participation in TEI's elephant conservation program.

Environmental Education

EE began as nature-study – the study of the outdoors – and was considered separate from science education; the goal of nature-study was to foster understanding and appreciation of the environment (Bailey, 1909; Comstock, 1911). Nature-study evolved into EE throughout the

1900s based on growing concerns about environmental degradation, due to negative issues such as pollution, and was no longer considered distinct from science education (Fraser et al., 2014). In its early form, the goal of EE was to provide awareness about the growing environmental issues and strategies for solving these problems (Stapp 1969). EE has continued to the present day, though there is some debate regarding what exactly characterizes EE or what the goal or outcome of EE should be, as it is a complex field drawing from a variety of disciplines (Lucas, 1972).

Multiple researchers and organizations have tried to define EE since its conception, in both what the intended goal or outcome of the education should be and what topics are included in the domain. Meadows (1989, p. 10) described the goal of EE as "learning to understand, appreciate, work with, and sustain environmental systems". Others expanded this definition to include action, with the notion that an increase in knowledge would lead to awareness about environmental issues, thus resulting in more pro-environmental behaviors (Hungerford & Volk, 1990). Sauve (1999) maintained the notion that EE should be defined as a problem-solving discipline set in place to encourage sustainable development, similar to the goal Athman and Monroe (2001) defined as fostering positive attitudes towards the environment while also ensuring individuals develop the skills to identify and solve environmental problems.

Beyond discourse as to what the goal of EE should be, researchers have also debated whether having a singular goal of EE actually helps or hinders the curriculums that are designed from it. Sanera (2008) believed that the way EE is defined is imperative for effectively teaching it due to the fact that educators will base their curriculum around the goal of the field, therefore shaping what students gain from the programs. In contrast, Hart and colleagues (1999) argued that having an overarching guideline as to how to plan lessons leads to a lack of engagement

from the educators due to a separation of "teaching" and "practicing"; they believed that having a set goal for EE inhibits educator's creativity in sculpting lessons based on their pupils' needs. Instead, Hart and colleagues thought educators should focus on evaluating their own educational strategies to ensure they are providing knowledge on the subject as well as encouraging their students to behave in pro-environmental ways without having to focus on a singular goal to teach students. Despite the competing thoughts about what the focus of EE should be or how it should be taught, some aspects remain consistent: highlighting concern for the environment and emphasis on the important role of education in promoting pro-environmental behavior (Sauve, 2005).

The Audience for Environmental Education

Many researchers believe that the multiple contrasting views and goals of EE make it stronger (Sauve, 1996; Hart et al., 1999; Krasny, 2009; Scott, 2009) because EE includes an array of disciplines that provide a flexible dynamic with the ability to withstand and accept change as well as introduce and encourage novel ideas. This flexibility allows educators to adapt their curriculum for whomever they choose as their target audience. Therefore, educators should not be overly concerned about what the overarching theme or specific goal of EE is, but instead develop programs focused on increasing concern for the environment and promoting pro-environmental behavior, based upon the needs of their pupils. Two of the most important aspects to keep in mind when designing EE programs for target audiences are age and location.

While EE should be continuous throughout the course of an individual's schooling so they can keep building on their knowledge and attitudes as well as hone their skills to shape more pro-environmental behavior (Vaughan et al., 2003), it is important to begin with and target youth since they are not likely to have fully formed opinions or attitudes about the environment

(Pellier et al., 2014). Pro-environmental attitudes are created mostly in childhood and are unlikely to change once formed (Asunta, 2003). Therefore, promoting pro-environmental behaviors from a young age can help foster positive attitudes and actions towards the environment later in life, which is essential for successful long-term conservation strategies (Meinhold & Malkus, 2005; Fernandez, et al., 2010 as cited in Franquesa-Soler & Serio-Silva, 2017).

Another reason why it is important to encourage children to develop a positive affinity for the environment is that this can impact more than just those children. Studies have found that children influence their parents' values, both in intentional and unintentional capacities (Knafo & Galansky, 2008). Intentional influence occurs when a child explicitly tries to change their parents' attitudes, such as discussing reasons why the parent should stop smoking leading to distaste for and a decrease in smoking from the parent. Unintentional influence occurs when children are not actively trying to alter their parents' attitudes but that the child's participation in a certain activity or program is enough to cause a change in the parent. For example, if a child participates in a college prep program, parents will emphasize achievement more than if their child did not participate (Knafo & Galansky, 2008). Researchers have found effects of these phenomena in relation to EE programs specifically. For instance, Rakotomamonjy and colleagues (2014) found that parents in rural areas of Madagascar whose children were enrolled in a 1-day program concerning local species of lemurs, which are threatened due to habitat loss and hunting, had higher levels of knowledge about lemurs a year after the program than did the parents of children who were not enrolled. While the researchers were unable to determine whether the knowledge transmission from child to parent was intentional or unintentional, the study demonstrates that even a short 1-day intervention can have longer-term effects on the

parents as well. Not only can enrolling children in EE programs increase knowledge gained about particular subjects, it can also have an effect on the actions of their family members; households with children going through a wetland conservation program, for instance, reported less water usage than did households where children were not involved in the program (Damerell et al., 2013). Results from these studies highlight the importance of targeting children, not simply for the sake of shaping pro-environmental behaviors in those individuals as they age, but also to help spread the positive effects of EE programs to their family members.

Location is another important aspect to consider in regards to designing EE programs. Again, in considering the needs of the pupil, it is essential to know what environmental issues are applicable to the community and how the people view those issues. This is especially important because EE is in part a social discipline, often shaped by cultural and community values (Bowers, 2002; Cole, 2007). An example relevant for our purposes here are locations exposed to human-wildlife conflict (HWC), which is defined as negative interactions between humans and wildlife species (Marchini, 2014). Areas experiencing HWC are particularly important to target because of the negative implications the conflict can have on certain species and their conservation. HWC is associated with several different species, including lions, jaguars, tigers, lemurs, and elephants (Kaltenborn et al., 2006; Treves et al., 2006; Dickman et al., 2013; Kansky & Knight, 2014). While conflict species such as the ones listed are usually viewed as charismatic, intelligent species in Western countries, they are frequently regarded as pests in areas where these species are native and HWC is abundant (Nyhus, 2000; Bandara & Tisdell, 2003; Fernando et al., 2005; Lucherini & Merino, 2008; Nsonsi et al., 2017). Local people often view the species as competition and will kill the animals to prevent or retaliate against the loss of livestock or crops (Zabel & Holm-Muller, 2008; Hazzah, 2009; Mabeluanga et al., 2016; Patil &

Patil, 2017). It is imperative to understand local attitudes towards the problem species in order to identify the main issues, design targeted education programs, and develop potential ways in which to resolve the conflict (Bandara & Tisdell, 2003, Conforti & Azevedo, 2003).

Why Elephants?

Elephants are just one species associated with HWC, but are particularly important because they are a keystone species – these animals affect their ecosystem on multiple levels, from seed dispersal and fertilization of plants and soil to creating openings in the forest and access to water sources (Kaltenborn et al., 2006; Sukumar, 2006; Kitamura et al., 2007; Choudhury et al., 2008). For this reason, if elephants were to become extinct it would have major catastrophic implications for all of the plants and animals in the ecosystems in which the elephants inhabit. Unfortunately, the fate of elephants hangs in the balance, as African elephants (*Loxodonta africana*) are currently listed as vulnerable by the IUCN (Blanc, 2008) and Asian elephants (*Elephas maximus*) are listed as endangered (Choudhury et al., 2008). Asian elephants have lost the majority of their historic range, and their existing range is fragmented (Leimgruber et al., 2003; Sukumar, 2006; Goswami et al., 2014). This habitat loss and fragmentation is caused by growth in the human population, which has resulted in the increased development of forest into agricultural land, and the expansion of infrastructure (Santiapillai & Ramono, 1993; Santiapillai, 1997; Sukumar, 2006; Baskaran, 2013). Elephants require large areas to live – Asian elephants need the largest area of natural habitat of any mammal in tropical Asia for survival – and they reside in unprotected habitats (Sukumar, 1989; Santiapillai, 1997; Gubbi, 2014). Leimgruber and colleagues (2003) sought to determine how much of the habitats in Asia are wildlands – large areas in which habitat fragmentation does not occur and ecosystem processes are relatively unaffected by humans – and discovered that only 51% of the elephant's range can

be defined as such. Due to the reduction of elephant habitat, Asian elephant populations are rapidly declining, and their distribution is decreasing as well (Campos-Arceiz & Blake, 2011; Fernando & Pastorini, 2011; Baskaran, 2013; Islam et al., 2011).

Increasing habitat loss is causing elephants to leave the forests and engage in interactions with human communities, therefore increasing human-elephant conflict (HEC) in those areas (Santiapillai, 1997; Bandara & Tisdell, 2003). HEC, like habitat loss, is a major problem for elephant survival (Santiapillai & Ramono, 1993; Santiapillai, 1997; Baskaran, 2013). HEC is largely caused by crop raiding – elephants roaming into nearby agricultural fields to feed on crops (Fernando et al., 2005; Sukumar, 2006; Nsonsi et al., 2017; Patil & Patil, 2017). Elephants consume a variety of plants in great quantities (Choudhury et al., 2008), and thus will feed on many agricultural crops, leading to major economic losses for the affected farmers (Santiapillai, 1997; Fernando et al., 2005; Gubbi, 2014). As a result, farmers will sometimes attack or kill elephants to eliminate the threat to their livelihood (Sukumar, 2006; MOEF, 2010; Gubbi, 2014). Likewise, elephants sometimes kill people: females with young calves will charge nearby humans, bulls will often charge humans entering the bush near them, and people attempting to scare off elephant herds from agricultural fields by using warning calls may make the elephants aggressive and more likely to attack people when they feel threatened (Thouless, 1994; O'Connell-Rodwell, 2000). Human fatalities caused by elephants only increases HEC due to the deceased's loved ones attempting to perform vengeance killings of perceived problem elephants (Santiapillai, 1997; MOEF, 2010; Fernando et al., 2005).

Due to the rise in HEC, affected farmers have tried to create their own strategies for mitigating these conflicts. Farmers often report using firecrackers, electric fences, shouting, flashlights, drums, fire, cars, or dogs to scare off invading elephants, with varying degrees of

effectiveness (Fernando et al., 2005; Mabeluanga et al., 2016; Ponnusamy et al., 2016; Patil & Patil, 2017; Van De Water & Matteson, 2018). Using such mitigation strategies is often risky and dangerous – chasing and scaring elephants put the two species in close proximity and can result in elephant or human injuries and fatalities (O'Connell-Rodwell, 2000; MOEF, 2010). These interactions frequently occur at night, making the situation even more dangerous due to the lack of light. Therefore, it is important for researchers to create efficient methods for deterring elephants from crop raiding that does not involve direct contact of farmers and the invading elephants. These strategies take time to develop and institute, and require cooperation from local farmers (Gubbi et al., 2014; Ponnusamy et al., 2016). However, the locals are not always receptive to initiating and participating in these strategies (Ponnusamy et al., 2016), so it is important to first determine what the existing perceptions are and whether people are willing to participate before determining what strategies might work best. Furthermore, EE programs aimed at influencing attitudes and opinions, as well as increasing knowledge about elephants, can play a crucial role in the long-term conservation of Asian elephants.

Think Elephants International

Think Elephants International (TEI) is a non-profit organization dedicated to promoting Asian elephant conservation due to their endangered status. Their mission is to encourage youth to think scientifically about elephant behavior and HEC through education programs designed to promote critical thinking skills. TEI's full-scale education program curriculum includes lessons that gradually introduce students to important topics surrounding elephant conservation. The lessons incorporate a multitude of activities meant to engage students and inspire discussions about the topics. Given the previously mentioned importance of targeting children for EE programs, TEI's education program focuses on children ages nine-14. They first piloted their

program in New York City in 2010 as an after-school program and then adapted it for students in Thailand, where elephants are native and HEC frequently occurs.

In 2008, the number of wild Asian elephants was estimated to be between 38,500 and 52,500 (Fernando & Pastorini, 2011), residing primarily in India, Myanmar, Thailand, Sri Lanka, Malaysia, and Indonesia (Sukumar, 2006). In Thailand today the wild population of elephants is just 3,000-3,500 (Saengpassa, 2018). The shrinking population combined with increased pressure from agriculture and infrastructure on ranges suitable for long-term elephant conservation (Leimgruber et al., 2003) makes conservation efforts in Thailand especially important if wild elephants are to survive. Due to the need for elephant conservation in Thailand, TEI educates children about elephant conservation and exposes them to research that can be applied to conservation, with the intention that education will influence how the students think about elephants and the elephant's perspective, peak an interest in research, and inspire students to develop novel ways to mitigate HEC in Thailand. Encouraging this scientific thought about potential solutions will create a generation of individuals that are willing to cooperate with and create effective mitigation strategies.

Perception of Wildlife and Location Effects

As previously stated, it is important to understand local attitudes and knowledge regarding wildlife, particularly in areas affected by HEC, when designing and implementing EE programs. There have been many studies assessing attitudes towards elephants in other parts of Asia, though almost exclusively with adults (Sri Lanka: Bandara & Tisdell, 2004; Fernando et al., 2005; Malaysia: Ponnusamy et al., 2016; India: Rohini et al., 2016; Patil & Patil, 2017). Research is lacking in Thailand as well as in children more generally. Studies have shown that being around nature as a child will help foster positive views toward wildlife (Meyer & Frantz,

2004; Cheng & Monroe, 2012; Rakotomamonjy et al., 2014). However, adults that experience increased conflict with wildlife, and associated economic losses, will have a decrease in tolerance towards those species (Parry & Campbell, 1992; Bagchi & Mishra, 2006; Kaltenborn et al., 2006; Fort et al., 2017). Given that children are prone to having similar attitudes to their family members regarding wildlife because of transmission of values to the children (Kals et al., 1999), it may be that children in areas with increased HEC may have negative views of elephants, though this has not yet been examined.

With respect to Asian elephants, though there are areas in Thailand that experience frequent HEC, these animals play an important national role in Thailand's history and culture. Historically, elephants have been used to help Thai people in warfare as vehicles for soldiers, as a way to pull logs from the forest (when logging was still legal), and as cultural icons, including serving as a symbol on the country's flag (Lin, 2012; Schliesinger, 2012). Elephants are revered as divine creatures and are closely tied to Buddhism, which is the predominant religion in Thailand (Keyes, 1971). This likely affects how individuals in Thailand view elephants, as studies have found that in areas in which problem species are also religious symbols, individuals tend to view them positively despite any conflict with the species (Ale, 1998; Bandara & Tisdell, 2003, 2004; Dickman et al., 2013; Patil & Patil, 2017). Furthermore, studies conducted on rural farmers throughout Asia have demonstrated that the majority of individuals have positive attitudes towards elephants and their conservation (Hill, 1998; Mabeluanga et al., 2016; Rohini et al., 2016; Nsonsi et al., 2017; Patil & Patil, 2017). Overall, it is important to assess what people already know and how they feel about particular wildlife species to determine how best to shape EE curriculum depending on the target audience. While individuals may have positive attitudes towards elephants in general, farmers may still threaten elephants that jeopardize their livelihood.

Therefore, positive attitudes alone are not enough to prevent elephant deaths. Researchers need to assess what other factors may play a role in helping mitigate HEC to prevent these killings.

Aside from assessing attitudes towards species associated with HWC, it is important to also determine what pre-existing factors may influence actions and receptivity to EE programs. Researchers have determined that the efficacy of educational programs is likely to differ between individuals with different backgrounds (Breuer et al., 2017). For example, education level effects what individuals are able to gain from a program; less educated individuals have the potential to gain more knowledge than more educated individuals (who may already have knowledge about the information the education program is conveying), but if the information is conveyed in complex ways, less educated individuals may gain very little from the program (due to the fact that they will not have the necessary background to understand the information) (Breuer et al., 2017). This notion can be applied to various backgrounds, from education level to cultural factors, once again indicating that designing EE programs with a target audience in mind is imperative for successful retention of knowledge and change in attitudes. However, there has been a lack of research assessing attitudes and knowledge of individuals in regards to HWC in rural versus urban areas, and the existing studies demonstrate a pressing need for further research on this topic. For example, Franquesa-Soler and Serio-Silva (2017) found a significant difference in knowledge about black howler monkeys between children in rural and urban areas in Mexico, a country where black howler monkeys are endemic: rural children showed more sophisticated knowledge while urban children had more misconceptions about the howler monkeys that did not reflect accurate knowledge about the appearance or habitat of howler monkeys. That study demonstrates the importance of surveying children's knowledge between contexts – rural children might inherently have more knowledge about certain species due to the fact that they

live in close proximity with them. Finding differences such as these can help shape future EE programs. For example, it might be best for EE programs to change or adapt their curriculum to give urban students more background on howler monkeys than rural students, thus creating the most effective curriculum for the target audience. The same can be applied to other areas where conflict species are present after first assessing current knowledge about the species between locations to determine if there is a similar difference in knowledge levels between rural and urban settings, as was witnessed by Franquesa-Soler and Serio-Silva (2017).

Due to the importance of understanding local attitudes and knowledge, TEI developed a survey to assess children's perceptions of elephants and determine what they think and know about elephants before and after participation in the program. The survey includes both Likert scale questions and several open-ended response questions, and is given to students both before and after participation in their education programs so TEI's researchers can track whether the program is fulfilling its goal – to shift student attitudes about elephants while also making them more knowledgeable about and interested in HEC and conservation issues.

Current Study

Between 2013 and 2015, TEI's education program was implemented in 15 classrooms across 11 different schools in Thailand. The locations of these schools were in both urban and rural areas of the country. Surveys were completed by the students in these programs, and in some cases, by students who did not participate in the program. The aim of the current study was to assess potential differences in responses between children in rural and urban areas, as well as before and after participation in the program.

The research questions we aimed to assess with this study were as follows:

1. Was there a difference between rural and urban children's attitudes towards elephants (defined here as positive views)?
2. Was there a difference in knowledge levels regarding elephants between children in rural and urban areas, particularly with respect to issues specific to Thailand?

Based on previous studies presented above, I predicted that children would have higher positive attitudes and lower negative attitudes towards elephants regardless of whether they reside in rural or urban environments given that elephants are imbedded in Thailand's cultural history. However, it is possible that rural students would have lower positive views than urban students given they live in areas affected by HEC and recent research has indicated that in adults living near forests in Thailand, positive attitudes towards elephants have declined (Wipatoyotin, 2018). Therefore, it is important to evaluate children's attitudes across locations and time points to determine if they are similar to what is seen in adults as children's attitudes have not been assessed before. If differences in attitudes are found between students in different settings, EE programs can modify their curriculum to specifically target and address this difference.

In addition to children's attitudes towards elephants, we also assessed knowledge about elephants. Based on previous findings (e.g. Franquesa-Soler and Serio-Silva, 2017), I predicted that children in rural areas will have more knowledge of elephants than children in urban areas before going through the education program, due to the fact that rural children have more exposure to elephants and thus will likely have more knowledge about the species than their urban counterparts. Furthermore, I predicted that, regardless of existing knowledge of elephants, all participants (both rural and urban) will have increased knowledge levels after participating in the program due to numerous studies that have demonstrated EE programs in general lead to an

increase in knowledge levels post-program (Brewer, 2002; Kruse & Card, 2004; Marchini & Macdonald, 2012; Rakotomamonjy et al., 2014; Mukhacheva et al., 2015; Breuer et al., 2017).

I was particularly interested in two specific areas of knowledge for this study: HEC and conservation. Both topics are important to assess in children to determine what they already know about these issues as well as track if and how that knowledge changes after participation in the program about elephant conservation. I expect to see an increase in statements about these topics post-test because conservation issues would be more prevalent in the students' minds after participating in the educational program. With respect to HEC, my interest was in examining knowledge related to certain aspects of HEC relevant to Thailand, such as crop-raiding (as opposed to poaching, which is not prevalent in Thailand) to determine whether students were more likely to mention HEC issues that are locally relevant or if they discuss the issue of HEC more broadly (e.g. poaching, ivory trade) across groups. It is important to know what HEC issues students are aware of because, while all forms of HEC are problematic to elephant conservation, unless children are aware of HEC relevant to Thailand specifically, they may not be able to think constructively about or contribute to possible conflict mitigation strategies. We assessed a subset of HEC knowledge demonstrated by students' responses about the role humans and elephants play in creating HEC; assessing whether students are placing the blame of HEC more on humans, elephants, or both will help researchers understand how the students think about the conflict, and therefore will help shape future EE programs designed to inform students about HEC based on existing knowledge levels about the issue. Determining differences in knowledge about HEC between contexts is also vital, as rural children may have more knowledge about relevant HEC issues since those are more prevalent in rural areas than urban areas. If this is the case, there may be a need for distinct program curriculums between the two groups of students.

As for the second area of knowledge, conservation, my interest was in examining specific knowledge about conservation issues at hand, such as reference to elephants being keystone species, as this knowledge is essential to understanding why it is especially important to conserve them. While I did not predict that students in one setting will have more knowledge about conservation than students in the other, it is important to assess what the students already know about conservation to help shape future EE programs. It is crucial for children to understand the current status of elephants, why they are so important to the ecosystem, how and why their numbers are dwindling, and potential intervention strategies set in place to conserve the elephants. Therefore, it is vital to evaluate whether these topics are mentioned by students as well as how in-depth their knowledge is about these topics.

This study will provide a general overview of how the children in Thailand perceive and think about elephants, which is an imperative first step to any EE program designed to instill a change in attitudes or knowledge. Furthermore this study will also provide insight into what children in Thailand know about elephants, whether there is an increase in knowledge after participating in TEI's EE program, and whether there are differences in types of knowledge between children in different settings. Currently there is a lack of research about potential knowledge differences in children in rural areas exposed to HWC and their urban counterparts. Results of this study will help bridge that gap by informing researchers about any initial differences in children living in different settings, as well as whether there is a difference in knowledge gained after participation in an EE program depending on the setting. Knowing this information can have implications for how EE programs should be designed and implemented. If results indicate significant differences between settings, this will help shape TEI's future educational programs to best suit the students the programs are aimed at teaching.

Methods

Participants

Participants were 696 (377 male and 319 female) students aged between nine and 13 (*M* = 10.97, *SD* = .72) years of age enrolled in one of 11 public or private schools in Thailand. Classes of students were enrolled as participants (taught the TEI curriculum) or as controls (not taught the TEI curriculum), designated by school administrators. Data from five students were discarded due to inability to determine if the students were participants or controls and data from two students were removed due to an inability to determine the time at which the data were collected. The final number of students was 689 (374 male and 315 female). There were 15 participant classes with 501 students and 3 control classes with 188 students.

Materials

The survey included two basic components: 30 Likert scale questions, and four yes/no questions that had an accompanying open-ended response question, and an individual open-ended response question ("list one to five things you know about elephants"). The survey was designed to evaluate the TEI education program via assessment of students' perceptions of elephants – including opinions of, interest in, knowledge of, and personal experience with elephants – and whether those perceptions shifted after participating in the program. Some questions were created by the researchers and several were included or adapted from prior research using surveys that assessed similar topics (Barney et al., 2005; Cheng & Monroe, 2012; Larson et al., 2009).

Likert scale statements, such as "hurting or killing elephants is wrong" and "learning about science is boring", were rated on a scale of one to five: strongly agree, slightly agree, neutral, slightly disagree, strongly disagree. Twelve of the items were reverse scored. Lower

scores were associated with answers demonstrating more positive opinions of elephants, more factual knowledge, and higher interest levels in elephants. Higher scores demonstrated the opposite – negative opinions, lack of knowledge, and disinterest in elephants. Questions were grouped into four categories to determine students' perceptions of elephants: opinion (n = 12), interest (n = 7), factual knowledge (n = 8), and experience (n = 3).

The four yes/no questions and their accompanying open-ended response questions – "Are you interested in elephants? Why or why not?", "Are elephants important to Thailand? Why or why not?", "Are elephants in trouble in Thailand? If so, how are they in trouble?", and "Should we help save elephants? How can we or others do it?" – as well as the single open-ended response question were used to assess students' attitudes towards and knowledge of elephants. The open-ended responses allowed for more in-depth analysis of student opinions and knowledge presented in the students' own words. All survey questions were presented in both English and Thai, allowing students to choose which language to use to answer. For the current study, we focused on data from the four yes/no questions and the single open-ended response question that asked students to list one to five things they knew about elephants.

Curriculum

There were five major topics covered in Think Elephants International's curriculum: animal behavior, elephant biology, conservation, HEC, and research methods. Some of the activities involved students assuming the role of a professional, such as an animal behavior researcher or veterinary assistant, where they were able to practice the same skills as the professionals. Animal behavior was a general introduction to descriptions vs. inferences in regards to observing animals as well as understanding that different species rely on different senses in their daily lives. Children were shown videos of different species' (e.g. dog, elephant)

behaviors, asked to describe what they observed, and then were tasked with differentiating between descriptions of the behavior and inferences about what the behavior meant. Students also played a sensory deprivation game to showcase what senses humans rely on the most and compared and contrasted humans to other species. The topic of elephant biology aimed to teach students about Asian elephants specifically, covering more in-depth topics such as elephant anatomy, social behavior, distribution, and communication. Students also performed a "vet check" based on video footage of how veterinarians assess elephant health.

After learning about elephants, students were taught about the importance of elephant conservation due to the fact that elephants are a keystone species, as well as ecosystem threats (e.g. deforestation in Asia, poaching in Africa). Activities such as creation of food webs and a game about deforestation caused by human population growth supplemented these lessons. Students were then taught about HEC – how and why it occurs and different mitigation strategies and attempts. Newspaper articles covering instances of HEC in Asia were used to demonstrate how those conflicts play out in real-life. They were guided to think about the different perspectives of all involved (farmers, conservationists, the elephants, etc.) and how their motives can cause disagreements about the best potential mitigation strategies. The final topic, research methods, served to teach children about forming research questions and using the scientific method, and how animal behavior research can contribute to conservation. Students were also provided a general overview of potential scientific career prospects.

Procedure

The education program ran for different lengths of time depending on time availability in the individual schools. Programs began in May or November and ran, on average, for nine weeks. The programs were taught once a week during normal school days and hours. Students in

schools with shorter program lengths still received the full curriculum, but in some cases two lessons would be condensed into one.

The 11 schools in which the education program was implemented were located in both rural and urban areas of Thailand. Running the program in contrasting geographic areas allowed us to assess whether living environments affected students' perceptions of and experiences with elephants. We used shorthand designations (BKK1, BKK2, Kan, and CS) to reflect where the schools were located in Thailand, with two areas in an urban setting (Bangkok) and two areas in a rural setting (Kanchanaburi and Chiang Saen). Five schools were located in Bangkok (BKK1, BKK2), an urban environment. The remaining six schools were located in rural areas: one school was located in Chiang Saen (CS) and five were located in Kanchanaburi (Kan). CS was near the TEI field research station and served as a pilot for running the program in Thai; there were only participants, no control classrooms, at this location. BKK1 was selected by the Institute for the Promotion of Teaching Science and Technology, a Thai governmental agency responsible for the development and oversight of national science and mathematics curricula, from which TEI originally sought advice; there were both participants and controls from this location. TEI instructors first met with school administrators to explain the education program and survey data collection and schools that granted permission were included in the study. Thus, BKK2 and Kan were selected based on school administration permission to run the program in their schools Students from the four schools in BKK2 were only participants (no controls came from these locations), while the five schools in Kan included both participants and controls. See Table 1 for summary information about the number of schools, classes, participants, and control students at each location. Parents were informed about the program and the survey, and could decline to have their child participate (all parents consented to having their children participate). There

were several instructors who taught the program: two TEI research assistants (BKK1), one TEI field assistant (CS), and three Mahidol University Conservation Biology students (BKK2 and Kan).

Table 1.
List of School Locations and Number of Participants and Controls

Location	Setting	Number of schools	# Participant Classes (# students)	# Control Classes (# students)
Kan	Rural	5	5 (204)	2 (150)
CS	Rural	1	1 (20)	0
BKK1	Urban	1	1 (35)	1 (38)
BKK2	Urban	4	8 (242)	0
Total		11	15 (501)	3 (188)

Data were collected via self-report surveys administered on the first and last day of the program (the same survey was given both times) while instructors were present. Participants received the survey on the first day after an initial introduction to TEI and what the students were going to focus on in the program. Students in the control (BKK1 and Kan) also completed the survey on two occasions, mirroring the first and last day of classes in which the program was implemented. The survey took approximately 45 minutes to complete, though students were allowed as much time as they needed to finish. At one school in Bangkok students were fluent in English (and the program was taught in English), therefore a large portion of the surveys were completed in English. Students at this school were also given the surveys via computers using SurveyMonkey. There was a power outage during the administration of the post-test survey, so the students were given the survey again a couple days later (only responses from the second, completed survey were used). All other schools administered a paper version of the survey (responses were in Thai) and instructors then transferred each response to SurveyMonkey. Only one school in Bangkok was able to use computers because it was the only school with enough computers for all students to complete the survey at the same time. Thai responses were

translated to English at a later date by a researcher fluent in both English and Thai. Study procedures were approved by the Mahidol University Central Institutional Review Board and the Cambridge University Psychology Research Ethics Committee.

Data analysis

Demographic information and Likert scale responses were exported from SurveyMonkey to Microsoft Excel to be checked and formatted before being analyzed. Analyses were conducted using Microsoft Excel and online calculators, depending on the particular analysis. Chi-squared tests were run with an online calculator (https://www.socscistatistics.com/tests/goodnessoffit/Default.aspx). McNemar tests were also run online (https://www.graphpad.com/quickcalcs/McNemar1.cfm). Paired and independent t-tests were run in Microsoft Excel. Mann Whitney and Wilcoxon signed-rank tests were conducted via a website (http://astatsa.com), as were the Holm corrections (https://alexandercoppock.com/statistical_comparisons.html). We used an alpha level of .05 for all statistical tests. General demographic information was assessed for gender and age: chi-squared tests were run to determine if there were any differences in the number of males and females in each group, and independent t-tests were used to assess differences in age between settings and groups. Given the difference in the number of participants versus controls in the urban setting, comparisons between the two groups were conducted only with data from the students in BKK1, which had relatively equal number of both participants and controls. In some cases, results are reported for all urban participants (referred to as ‘urban all’ and includes participants from both BKK1 and BKK2) as well as only the BKK1 participants so that comparisons can be made between BKK1 participants and controls.

The translated open-ended responses were transferred to Dedoose, a qualitative data analysis software, for analysis. We coded the open-ended response survey question of interest ("list one to five things you know about elephants") first using in vivo and subject codes – each idea was coded verbatim or summarizing the general idea of a student's statement. Once all in vivo and subject codes were created, researchers discussed and agreed upon several common themes present in the data, which we used to create theme codes. Theme codes such as 'keystone species' (responses stating how elephants help the ecosystem, e.g. "elephant dung is fertilizer") or 'human use' (responses involving ways elephants can benefit humans, e.g. "elephants are vehicles") allowed researchers to aggregate similar and related ideas across individuals into a general topic and served to narrow down the total number of codes. Twenty-one main theme codes were created (see Appendix A for the full list of theme codes and definitions).

There were two theme codes, 'questions about elephants' and 'program-specific knowledge' that always had at least one other relevant theme code applied to the same statement. The code 'questions about elephants' applied to responses where students listed questions about elephants instead of making a statement about them. Therefore, both the 'questions about elephants' code and another code indicating what the question was about were applied. For example, "Can elephants jump?" would have the themes 'questions about elephants' and 'abilities' applied. We applied the code 'program-specific knowledge' when a student's statement included information that was covered in the education program. For example, "What do elephants eat?" would have the codes 'questions about elephants', 'diet', and 'program-specific knowledge' applied because the statement was a question about elephants' diet, and the curriculum included dietary information. This code, 'program-specific knowledge', allowed researchers to determine what information in the curriculum the students already knew prior to

participation and what information they reported after participation. Furthermore, we could assess what information students were interested in that the curriculum did not cover by looking at statements that had the code ‘questions about elephants’ applied.

For some theme codes, there were qualifier codes that were added along with the theme code: true/false and general/specific. True/false codes served to distinguish correct or incorrect information about elephants provided by students. General/specific codes were necessary to include as some students answered questions more vaguely than others (e.g. “I know why elephants cover themselves in mud” versus “elephants cover themselves in mud to keep cool”). Only certain themes had these qualifiers attached to them, which were used every time a code was applied to a statement. For example, the theme code of ‘diet’ had qualifiers true/false and general/specific attached. There were a few exceptions in which qualifier codes were not applied: if there was not enough information to determine true/false or general/specific, if the student’s statement was too subjective for researchers to make a judgment, or if the theme code ‘questions about elephants’ was also applied to that code. We also created two other pairs of qualifier codes: broad/relevant and surface/deep. Broad/relevant were only applied to the theme code ‘HEC’ to distinguish between mentions of overall issues with HEC (e.g. “human-elephant conflict occurs”, ‘broad’) and mentions of HEC as it specifically occurs in Thailand (e.g. crop-raiding, ‘relevant’). Surface/deep were only applied to the theme code ‘conservation’ to reflect a general understanding of conservation (e.g. “elephants are conserved”, ‘surface’) or more in-depth knowledge about what is causing conservation issues or why they are important (e.g. “elephants are going extinct because people cut down trees”, ‘deep’)

Once researchers agreed upon a comprehensive list of theme codes (including main themes and qualifiers) and their definitions, we coded the open-ended responses again with the

theme and qualifier codes. There was no limit to the number of codes that could be applied to a statement. All responses had at least one theme code applied unless the statement was incomplete, uninterpretable, or the student's answer was "I don't know". The number of responses each student provided that had at least one code applied was analyzed to determine if there was a difference in the number of responses students generated from pre- to post-test (paired t-tests) or between groups or locations (independent samples t-tests).

We examined theme code prevalence in three ways: code presence, code application, and code co-occurrence. Code presence was used to determine the percentage of students in each group that referenced a theme code of interest at least once. While a student could have a single theme code applied to their response multiple times, code presence was either a 1 (the student had that theme code applied) or a 0 (the student did not have that theme code applied). Code presence made it possible to compare percentages of students across groups, as the number of students in each group was not the same (see Table 3). Code application was based on the frequency of a certain theme code being applied to each student. This made it possible to determine if the number of times a code was applied increased, decreased, or remained the same across time points or groups. Code co-occurrence reflected the number of times two particular codes were applied to the same statement, which made it possible to examine how students were referencing pairs of codes together.

Theme and qualifier data were analyzed through a series of comparisons, including comparing pre- to post-test responses for both the participant and control groups, responses between urban and rural settings at both pre- and post-test, and pre-test responses between participants and controls. The approach was similar regardless of what theme or qualifier codes were being examined. Mann Whitney tests were performed with Holm corrections to assess

whether there were any differences between participants and controls at pre-test and post-test on any of the categories as well as to assess whether there were differences between students living in different environments pre- and post-test (rural vs. urban). Wilcoxon signed-rank tests were performed with Holm corrections to assess differences within participants pre- to post-test, as well as controls pre- to post-test. For some theme codes, there were not enough data to run an analysis to test for significant differences. While analyses could not be performed, general observations about the data and possible differences or trends are noted.

Perceptions of elephants were measured via yes or no questions about elephants, such as "Are you interested in elephants?" and "Should we help save elephants?". McNemar tests were conducted to determine pre- to post-test differences in participants and controls. Chi-squared tests were run to determine potential differences between participants and controls as well as between rural and urban students. Attitudes towards elephants (defined here as "positive views") was measured via the two theme codes 'positive views' and 'negative views'. The theme codes of 'culture' and 'history' were also examined in conjunction with positive or negative views to evaluate how students were referencing elephants (in positive or negative ways) when they also mentioned the cultural and historical significance of elephants in Thailand. We assessed this by determining the number of students who mentioned culture or history while also referring to elephants in either a positive or negative way. This was reported as the percentage of students who had the theme codes of culture/history and 'positive views' applied, and the percentage that had culture/history and 'negative views' applied.

We generally assessed knowledge of elephants by examining true/false statement prevalence and general/specific responses regarding certain theme codes. While there were 21 theme codes and eight qualifiers, only six of the theme codes were analyzed along with the eight

qualifiers (see Table 2 for the list of codes, their definitions, and examples). The included theme codes were those that referenced knowledge related to conservation of elephants and related aspects (such as HEC), as that was the main focus of my research questions. These theme codes were not the most prevalent codes applied to students' responses, however I was interested in these themes specifically due to the fact that together they encompass knowledge about the importance of understanding why elephant conservation is necessary and how HEC is one factor driving elephants towards extinction. Furthermore, it was important to assess existing knowledge about these issues to determine what students already know about HEC and conservation issues. It was also important to assess how that knowledge was shaped by TEI's EE program to determine if the program was successful in increasing students' awareness of HEC and conservation issues.

Table 2.
Definitions and Examples of Relevant Theme and Qualifier Codes

Theme Code	*Definition*	*Examples*
Conservation	Status of elephants and/or protections over them	"eles are endangered" "eles are protected"
Ele Responsibility	What elephants should or should not do	"eles shouldn't eat crops"
Human Responsibility	What humans should or should not do	"we have to save ele" "humans should not kill eles"
HEC	Problems between humans and elephants	"humans kill eles" "eles eat peoples' crops"
Keystone Species	Elephants' importance to other living things, directly or indirectly	"ele dung is fertilizer" "eles help other animals survive"
Program-Specific Knowledge	Information specifically taught during TEI lessons	"eles are scared of bees" "eles don't like chili"

Qualifier Code	*Definition*	*Examples*
True	Information listed is correct/true	
False	Information listed is incorrect/false	
General	Listing information in a general (not specific) manner	"I know why eles cover themselves in mud"
Specific	Listing information in a specific (not general) manner	"Asian eles have four toes on their back legs and five on their front"
Broad	(Only applicable to HEC) HEC without any details as to what it is or how it occurs; HEC not relevant to Thailand	"eles are killed for their ivory" "human-elephant conflict"
Relevant	(Only applicable to HEC) HEC as it occurs in Thailand and is relevant to crop-raiding	"eles kill people" "eles eat farmer's crops"
Surface	(Only applicable to conservation) Mention of conservation without any information about it	"eles should be protected" "eles need help"
Deep	(Only applicable to conservation) What is causing conservation issues	"eles won't go extinct if people don't cut down trees" "eles don't have a place to live"

Note. "Ele" is shorthand for elephant.

Results

Demographics

Chi-squared tests were run to assess whether there were any differences in the number of males and females in each group (see Table 3 for full demographic information). The findings indicated that there were no significant gender differences between all rural and all urban

students ($\chi^2(1, N = 689) = .380$, $p = .538$) nor between participants and controls ($\chi^2(1, N = 689) = 2.362$, $p = .124$). With respect to age, there was not a significant difference in the ages of urban controls and participants ($t(55) = 2.00$, $p = 1.673$), nor in the ages of rural controls and participants ($t(321) = 1.97$, $p = .626$). There was, however, a significant difference between the ages of rural and urban participants ($t(457) = 1.97$, $p < .001$), with urban participants being slightly older than the participants from the rural setting.

Table 3.
Demographics by Setting and Group

Groups	N	Age in Years M (SD)	Male N	Female N
Rural Total	374	10.63 (.60)	199	175
Participant	224	10.68 (.62)	107	117
Control	150	10.59 (.58)	92	58
Urban Total	315	10.67 (.60)	175	140
Participant	277	11.22 (.69)	156	121
Control	38	10.11 (.50)	19	19
Total	689	10.85 (.72)	374	315

Perceptions and Attitudes

To first assess differences in how participants felt generally about and perceived elephants, we examined their response to four yes/no questions: “Are you interested in learning about elephants?”, “Are elephants important to Thailand?”, “Are elephants in trouble in Thailand?”, and “Should we help save elephants?”. Individual McNemar tests were conducted on both the urban and rural participants’ responses at pre- and post-test to each of these four questions. Overall, participants in both areas mostly reported interest in, importance of, troubled status of, and need to help elephants at both pre- and post-test. This was especially true for the rural participants, and as such, there were no significant changes between the two time points – participants reported “Yes” to these questions both at pre- and post-test (see Table 4). For the urban participants, however, the results indicated that there were two significant changes from

pre- to post-test. One change was in participants expressing an interest in elephants, with 10 participants first reporting they were not interested in elephants at pre-test, all of whom then reported they were interested after participation in the program. The second was with respect to whether we should help save elephants, with six students first reporting that we should not try to save elephants, and then all reporting that we should after participation in the program. McNemar tests were also conducted on control students in each location to determine if there was an effect of time on children's responses; results indicated there was no change in either group for any question (Table 5).

Table 4.
Results of McNemar Tests Examining Pre- Versus Post-Responses to Yes/No Questions in Participants

Setting	Interested in elephants	Elephants important to Thailand	Elephants in trouble in Thailand	Help save elephants
Rural participants	$\chi^2(1, N = 189) = .125$, $p = .724$	$\chi^2(1, N = 186) = .250$, $p = .617$	$\chi^2(1, N = 215) = 1.241$, $p = .265$	$\chi^2(1, N = 182) = 0$, $p = 1$
Urban participants	$\chi^2(1, N = 222) = 8.1$, $p = .004$	$\chi^2(1, N = 222) = 2.286$, $p = .131$	$\chi^2(1, N = 189) = 3.048$, $p = .081$	$\chi^2(1, N = 215) = 4.167$, $p = .041$

Table 5.
Results of McNemar Tests Examining Pre-Versus Post-Responses to Yes/No Questions in Controls

Setting	Interested in elephants	Elephants important to Thailand	Elephants in trouble in Thailand	Help save elephants
Rural Controls	$\chi^2(1, N = 117) = 0$, $p = 1$	$\chi^2(1, N = 116) = 0$, $p = 1$	$\chi^2(1, N = 170) = .083$, $p = .773$	$\chi^2(1, N = 117) = .250$, $p = .617$
Urban Controls	$\chi^2(1, N = 17) = 0$, $p = 1$	N/A	$\chi^2(1, N = 17) = .5$, $p = .480$	$\chi^2(1, N = 16) = 0$, $p = 1$

Note. N/A reflects an inability to conduct a McNemar test due to a lack of 'no' responses at pre- and post-test (no students reported 'no' at either time point).

How students felt about elephants – their attitude toward elephants – was assessed by examining two of the theme codes that were applied to students' reported list of things they know about elephants. These codes were 'positive views' and 'negative views'. Both the percentage of students who had the codes applied at least once (code presence) and the total number of times the codes were applied (code application) were examined. The prediction was that students, regardless of location or group, would report more positive views about elephants than negative views overall and that this would not change from pre- to post-test. To determine if there was a change in attitudes in participants, we examined code presence of each code in the participant groups at both pre- and post-test. The percentage of participants reporting positive views (Figure 1) and negative views (Figure 2) of elephants was similar in both groups, with a greater percentage of students reporting positive views than negative views at each location and time point. There was a slight decrease from pre-test to post-test in the percentage of participants in urban areas reporting positive views, though there were not enough data to determine whether this was a significant difference. However, with respect to the total number of 'positive view' statements that urban participants reported, a Wilcoxon signed-ranks test indicated that there was a significant decrease from pre-test ($Mdn = 0$, $M = .377$) to post-test ($Mdn = 0$, $M = .219$; $V = 2003$, $p = .003$) (Table 6). Positive and negative views were also assessed in controls at each location to determine whether the percentage of students or total number of statements regarding positive views was greater than negative views towards elephants (as was predicted). There seemed to be a slight increase in the percent of urban controls reporting positive views at post-test compared to pre-test (Figure 1), however there were not enough data to assess whether the increase in the number of students or in the total number of 'positive views' statements (Table 6) was significant. As to whether participants and controls had similar views toward elephants, both

the percentages of students reporting positive views (Figure 1) and the total number of statements referring to elephants in positive ways were similar at pre-test. The percentage of participants and controls reporting negative views of elephants was below 10% in each group at both pre- and post-test (Figure 2). There were not enough data to confirm whether there were significant differences in the total number of times that the code 'negative views' was applied to statements in any group.

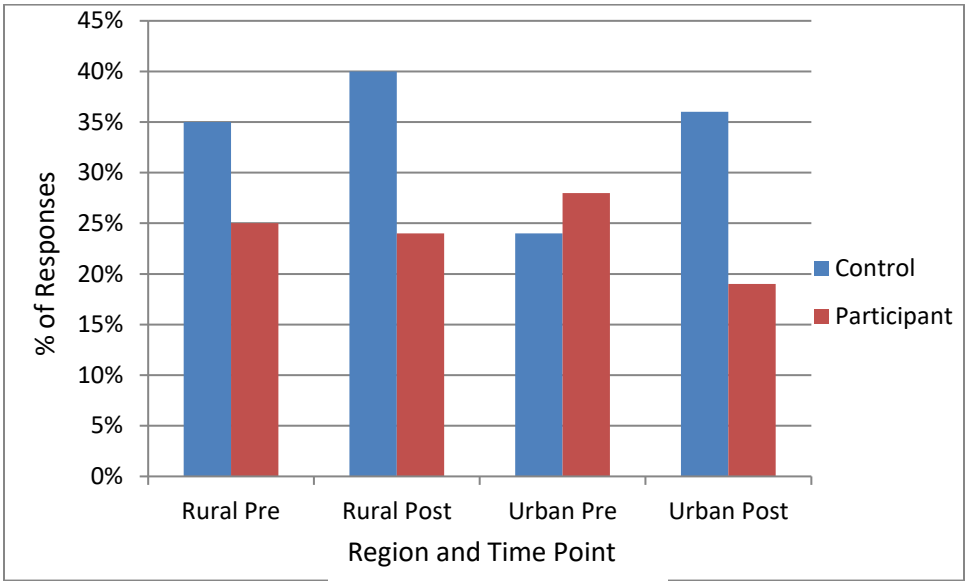

Figure 1. Percentage of students who reported 'positive views' toward elephants in each setting (rural and urban) at both time points (pre- and post-). Control students are in blue and participant students are in red.

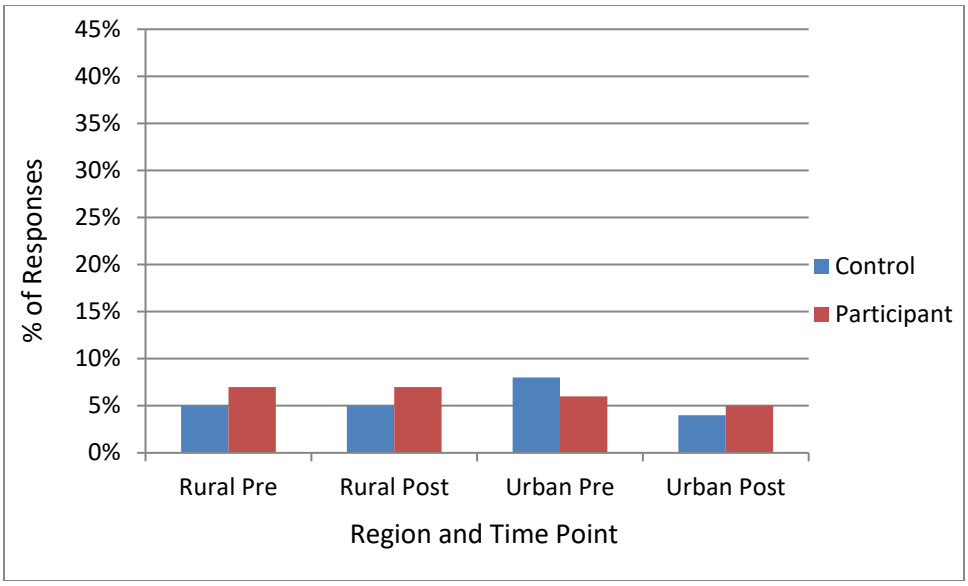

Figure 2. Percentage of students reporting 'negative views' towards elephants in each setting (rural and urban) at both time points (pre- and post-). Control students are in blue and participant students are in red.

Table 6.
Total Number of Positive and Negative Statements about Elephants

	Participant						Control			
	Rural		Urban (all)		Urban (BKK1)		Rural		Urban (BKK1)	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Positive Views	64	71	93	57	8	12	61	82	7	16
Negative Views	16	16	16	17	0	5	6	7	3	1

Due to the hypothesis that children in rural and urban areas would have overall positive views of elephants because of the cultural significance of elephants in Thailand, the theme codes 'culture' and 'history' were assessed in conjunction with 'positive views' and 'negative views'. The prediction was that children in both settings would have responses that made reference to elephants being important to Thai culture ('culture') or elephants' historical role in Thailand ('history') as well as positive statements about elephants ('positive views'), more frequently than

'culture' or 'history' would appear with negative statements about elephants ('negative views'). Code presence was used to determine the number of students reporting 'culture' in conjunction with either 'positive views' or 'negative views' as well as 'history' in conjunction with either 'positive views' or 'negative views'. Raw data indicated that positive views were reported more frequently than negative views in conjunction with 'culture' and 'history' among the children who mentioned those themes (Tables 7 and 8). This was consistent regardless of whether the students lived in a rural or urban setting. There were not enough data to assess whether there were significant differences within or between groups.

Table 7.
Percentages of Participants Reporting Culture and History with Positive and Negative Views

	Rural		Urban (all)		Urban (BKK1)	
	Pre	Post	Pre	Post	Pre	Post
Number of Culture	55	70	67	53	3	2
Culture & Positive Views	29%	26%	43%	43%	66%	60%
Culture & Negative Views	4%	7%	10%	2%	33%	0%
Number of History	17	14	35	20	0	0
History & Positive Views	29%	14%	23%	40%	0%	0%
History & Negative Views	18%	14%	3%	0%	0%	0%

Note. Percentages are of the number of students who referenced positive and negative views out of the number of students who referenced culture or history. Example: 29% of rural participants who mentioned culture also spoke positively about elephants at pre-test.

Table 8.
Percentages of Controls Reporting Culture and History with Positive and Negative Views

	Rural		Urban (BKK1)	
	Pre	Post	Pre	Post
Number of Culture	31	30	7	10
Culture & Positive Views	35%	53%	14%	50%
Culture & Negative Views	3%	1%	14%	0%
Number of History	7	3	3	2
History & Positive Views	57%	33%	33%	50%
History & Negative Views	14%	33%	33%	0%

Note. Example: 35% of rural control students who mentioned culture at pre also mentioned positive views towards elephants.

General Overview of All Themes

To get a sense of what participants most commonly listed regarding their knowledge about elephants, we looked at the total number of times each theme code was applied in both settings and time points to see which themes were most prevalent (Figure 3). The most prevalent theme codes participants referenced (excluding qualifiers) were ‘program-specific knowledge’, ‘physical qualities’, ‘behavior’, and ‘diet’. The theme codes of main interest – ‘HEC’, ‘conservation, and ‘keystone species’ were less frequently reported, with these codes being applied less than 100 times in the rural or urban group at either pre- or post-test. To assess which themes were mentioned more frequently at post-test than at pre-test in rural and urban participants, the top five positive difference scores for each location were compiled (Figures 4, 5). Difference scores were calculated by subtracting the total number of times a given code was applied at pre-test from the total number of times that code was applied at post-test. Positive scores indicate an increase at post-test. The difference scores show that for both rural and urban

participants, ‘program-specific knowledge’, ‘behavior’, and ‘keystone species’ had the greatest increases in responses post-test. Rural participants also more frequently mention ‘biology’ and ‘physical qualities’ post-test, while urban participants also mention ‘HEC’ and ‘elephant responsibility’ more frequently post-test.

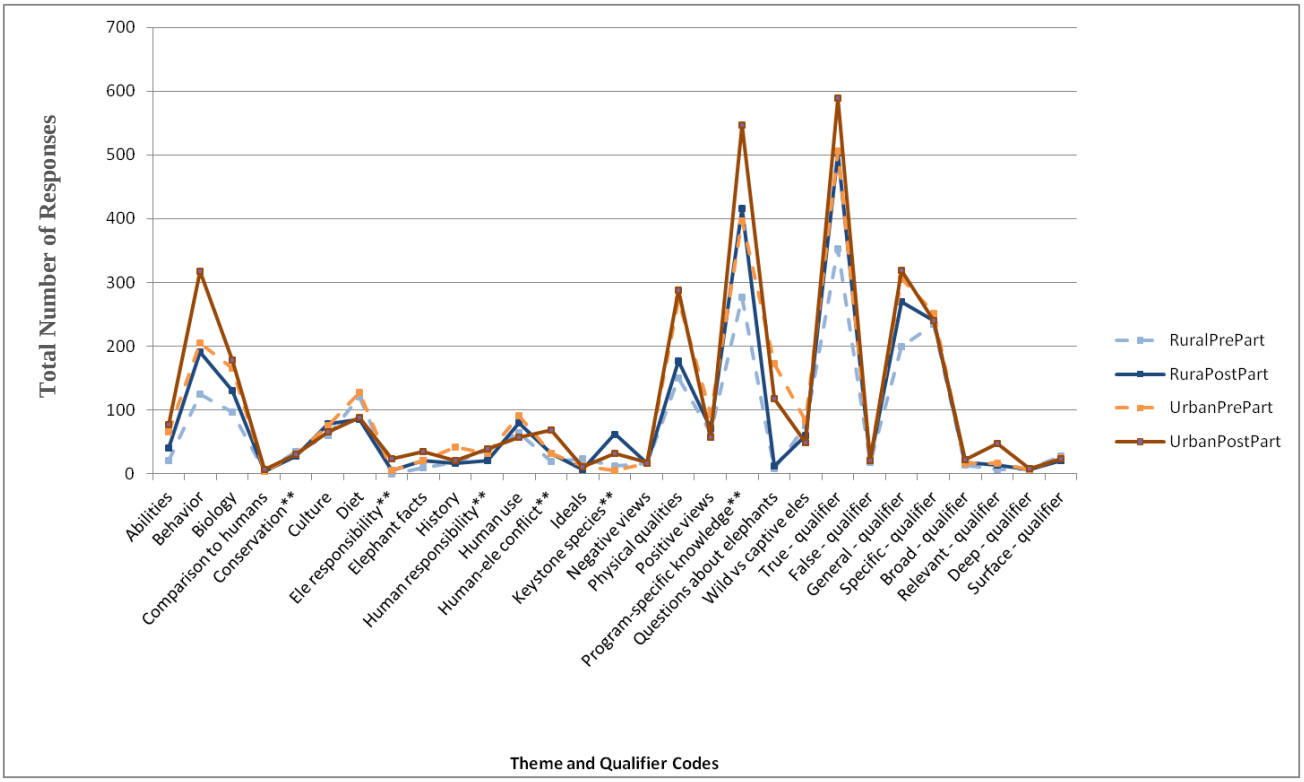

Figure 3. All theme and qualifier code applications in each pre- and post-test setting for participants. Lighter, dotted lines indicate pre-test, darker, solid lines indicate post-test. Rural participants are in blue and urban participants are in orange. ** indicate theme codes of interest.

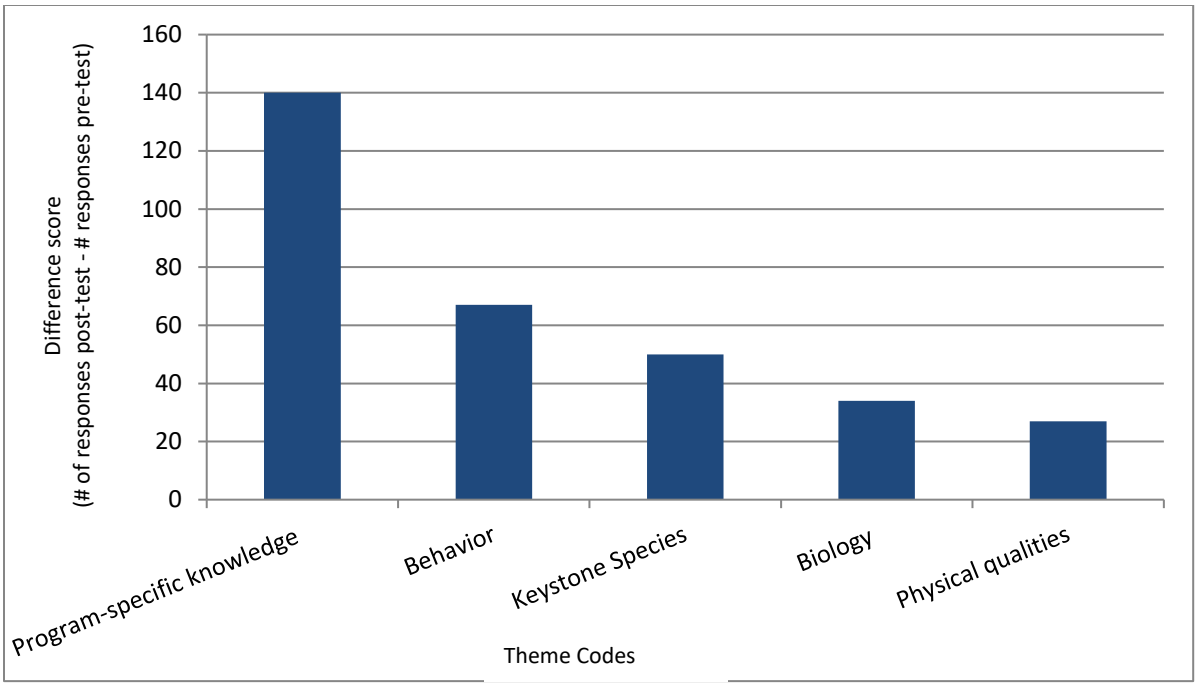

Figure 4. Five largest response increases from pre- to post-test in rural participants.

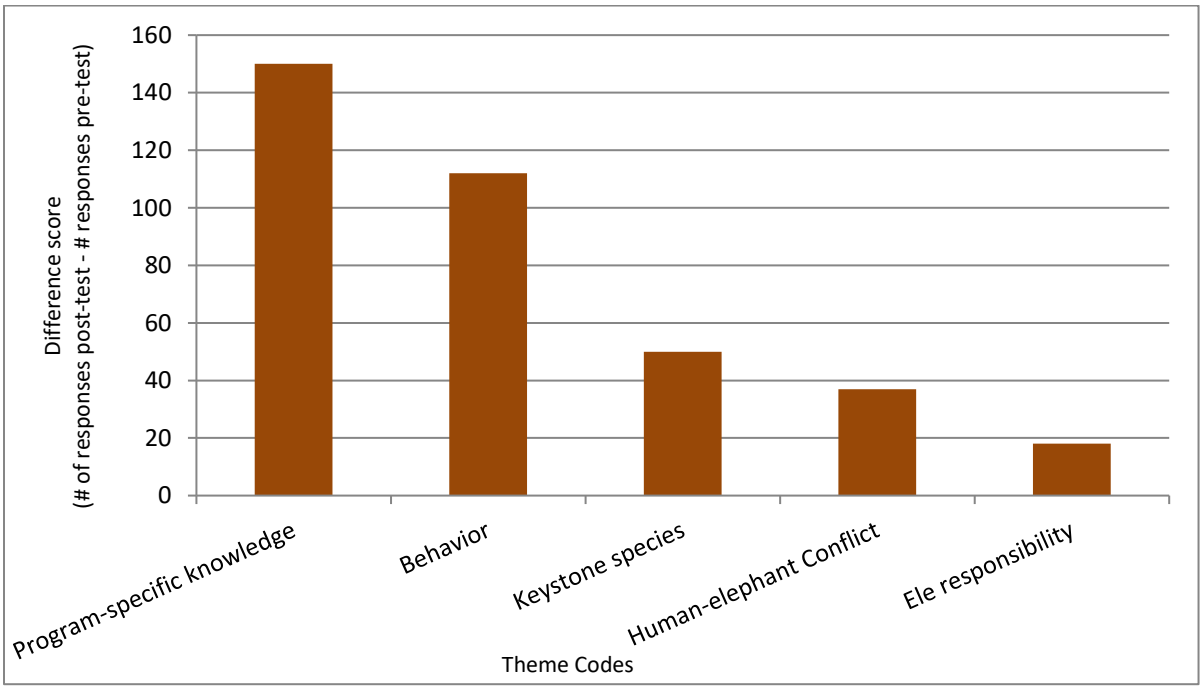

Figure 5. Five largest response increases from pre- to post-test in urban participants.

Knowledge

Knowledge of elephants was assessed based on a subset of the theme and qualifier codes applied to the responses that students provided regarding things that they know about elephants. The total number of responses a student submitted, as well as certain qualifier codes were both used as a proxy to reflect more or less knowledge. More knowledge was defined as students reporting more information in general (demonstrated by the total number of responses provided), and more statements that were coded as 'true' and 'specific'; less knowledge would indicate the opposite – fewer total responses provided, and greater 'false' and 'general' codes applied to statements about elephants. The prediction was that rural children would demonstrate more knowledge than urban children pre-test, and all participants would demonstrate more knowledge post-test regardless of their location.

Evaluating the total number of responses students provided indicated that there was no difference in the number of responses controls gave in either setting from pre- to post-test, nor was there a difference in pre-test participants versus controls (Table 9). There was, however, a significant difference in the number of pre-test responses all students (participants and controls) gave between locations; urban students at pre-test provided significantly more responses than did rural students at pre-test ($t(539) = 1.96$, $p < .001$). There was also a significant increase in the number of responses post-test participants reported in both locations (rural: $t(186) = 1.97$, $p < .001$; urban: $t(224) = 1.97$, $p = <.001$).

Table 9.
Average Number of Responses Provided by Students

	Rural			Urban		
	All	Participant	Control	All	Participant	Control
Pre	3.64	3.46	3.93	4.14	3.89	4.12
Post		4.49	3.88		4.60	4.47

True/false and general/specific qualifiers were assessed to get an overall sense of pre- versus post-test knowledge in rural and urban participants and controls. When considering the percentage of participants in each setting who made true/false or general/specific statements, we could not run statistical analyses on the code presence of qualifiers, but overall, there were similar percentages of students in each setting who reported true/false and general/specific statements (Figures 6). The same was true of control students as well (Figure 7). When assessing the total number of times that students reported information that corresponded to one of these four qualifiers (Table 10), there was a significant increase in the number of true statements from pre- (*Mdn* = 2, *M* = 1.69) to post-test (*Mdn* = 2, *M* = 2.49; *V* = 3025, $p < .001$, Wilcoxon signed-rank test with Holm correction), as well as an increase in the number of general statements (Pre: *Mdn* = 1, *M* = .984, Post: *Mdn* = 1, *M* = 1.33; *V* = 3105, $p < .001$), in rural participants. There was also a significant increase in the number of true statements urban participants provided at post-test (*Mdn* = 2, *M* = 2.32) compared to pre-test (*Mdn* = 2, *M* = 2.03; *V* = 5794 $p = .037$). Furthermore, a Mann Whitney test with a Holm correction revealed that post-test rural participants (*Mdn* = 1, *M* = 1.194) referred to specific information (more detailed information about elephants, e.g. “elephants cover themselves in mud to stay cool”) significantly more often than urban post-test participants (*Mdn* = 1, *M* = .952; *W* = 22372, $p = .008$). No other comparisons in the rural or urban participants were significant. It should be noted that overall, false statements were very low across pre- and post-test participants and controls. Code applications of true/false and general/specific qualifiers were also assessed in rural and urban controls – no significant differences were found (Table 11).

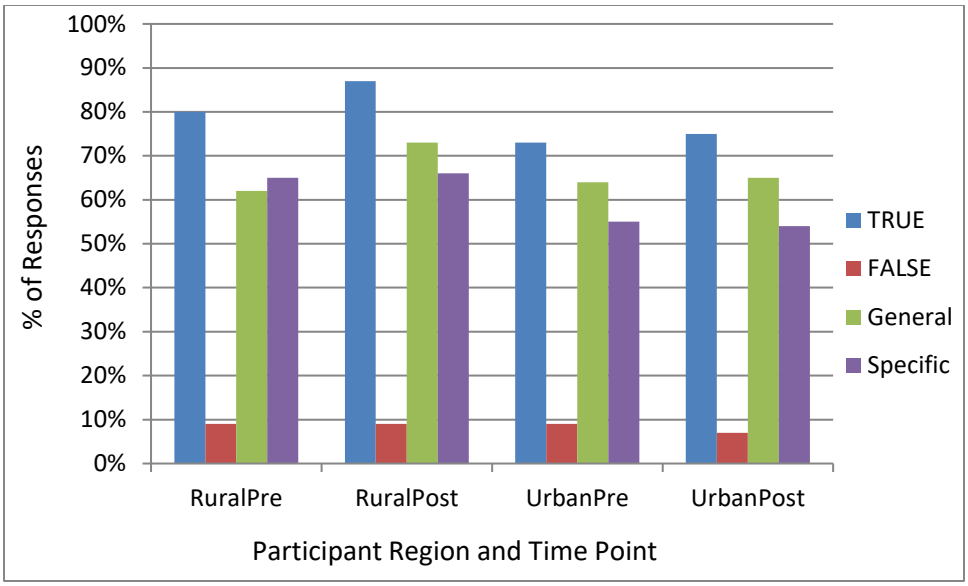

Figure 6. Percentage of participants in each location and time point who reported true/false and general/specific information.

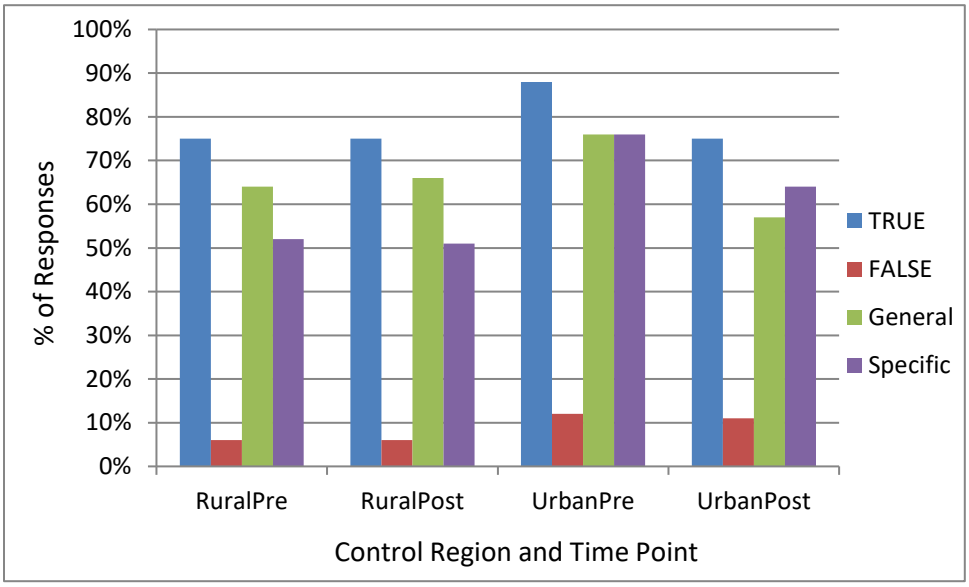

Figure 7. Percentage of control students in each location and time point who reported true/false and general/specific information.

Table 10.
Total Number of True/False and General/Specific Statements Reported by Rural and Urban Participants

	Rural		Urban	
Qualifier	Total Pre	Total Post	Total Pre	Total Post
True	353	503	506	589
False	18	21	22	21
General	199	270	306	319
Specific	234	240	252	240

Table 11.
Total Number of True/False and General/Specific Statements Reported by Rural and Urban Controls

	Rural (Kan)		Urban (BKK1)	
Qualifier	Total Pre	Total Post	Total Pre	Total Post
True	248	269	64	58
False	8	8	3	3
General	194	190	26	34
Specific	115	133	38	35

Information students reported that was covered in the education program, which was coded as 'program-specific knowledge', was also evaluated to assess a change in knowledge. I predicted that all rural and urban participants would have an increase in both the number of students who reported program-specific knowledge and the total number of times program-specific information was reported after participation in the program. The percentage of participants reporting program-specific knowledge was similar across both groups (Table 12). However, the total number of responses from participants regarding program-specific knowledge greatly increased from pre- to post-test in rural and urban areas (Table 13), and Wilcoxon signed-rank tests indicated that in both cases this difference was significant (rural pre: $Mdn = 1$, $M = 1.34$; rural post: $Mdn = 2$, $M = 2.05$; $V = 2384$, $p < .001$; urban pre: $Mdn = 1$, $M = 1.59$; urban post: $Mdn = 2$, $M = 2.17$; $V = 2384$, $p < .001$). With respect to the control students, rural students reported significantly more statements regarding program-specific knowledge at pre- ($Mdn = 1$, $M = 1.95$) than at post-test ($Mdn = 1$, $M = .906$; $V = 2384$, $p < .001$).

Table 12.
Percentages of Urban and Rural Participants Who Reported Program-Specific Information

Group	% Rural	% Urban
Pre	79	77
Post	80	81

Table 13.
Total Number of Statements Given by Participants that Referenced Program-Specific Information

	Rural		Urban		
	Participant	Control	Participant (All)	Participant (BKK1)	Control (BKK1)
Pre	276	152	397	30	37
Post	416	121	547	28	27

Theme Codes of Interest

We examined additional theme codes to assess potential differences in knowledge about specific issues related to the conservation of elephants, including the ways in which humans and elephants come into conflict with one another ('HEC'), the status of elephants ('conservation'), and the importance of elephants to the ecosystem ('keystone species'). More knowledge was defined as students reporting information that demonstrated deeper understanding of elephants and the issues surrounding their conservation, which would be reflected in higher frequencies of the theme codes 'HEC', 'conservation', and 'keystone species', and the qualifier codes 'relevant', and 'deep'; less knowledge in this case would be demonstrated through more 'broad' and 'surface' statements about these issues. I predicted that rural children would demonstrate more knowledge than urban children, and all participants would demonstrate more knowledge post-test regardless of their location. For each major theme code assessed (HEC, conservation, and keystone species), the percentage of students in each group and location that had the code applied to one of their responses is reported, as well as the total number of times within the group that theme code was mentioned. This allowed researchers to quickly assess how many

students in each group were referencing the theme code and how frequently the theme was brought up. Additionally, other codes that were commonly applied in conjunction with the main theme code are also reported.

Human-elephant conflict.

17 (9%) rural participants reported a total of 19 statements about HEC at pre-test. In 85 instances 'HEC' co-occurred with another code, the most frequent being: human responsibility (N=16, 19%) and program-specific knowledge (N=12, 14%). 28 (14%) rural participants reported a total of 32 statements about HEC at post-test. In 126 instances 'HEC' co-occurred with another code, the most frequent co-occurring codes being: program-specific knowledge (N=18, 14%), human responsibility (N=17, 13%), true (N=15, 12%), and human use (N=12, 10%). There were not enough data to reliably test if the increase in statements about HEC post-test was statistically significant.

As for the urban participants, 28 (11%) reported a total of 32 statements about HEC at pre-test. In 147 instances 'HEC' co-occurred with another code, the most frequent code co-occurring codes being: human responsibility (N=23, 16%), program-specific knowledge (N=19, 13%), and true (N=14, 10%). At post-test, 56 (22%) urban participants reported a total of 69 statements about HEC. In 258 instances 'HEC' co-occurred with another code, the most frequent co-occurring codes being: program-specific knowledge (N=44, 17%), true (N=31, 12%), and human responsibility (N=30, 12%). A Wilcoxon signed-rank test with a Holm correction confirmed that the increase in the total number of times urban participants made statements about HEC post-test ($Mdn = 0$, $M = .272$) was significant compared to pre-test ($Mdn = 0$, $M = .114$; $V = 407$, $p < .001$).

At pre-test, code application for HEC was higher in urban than in rural participants, however, there were not enough data to test whether this difference was significant (Table 14). A Mann Whitney test with a Holm correction indicated that at post-test, urban participants (*Mdn* = 0, *M* = .274) mentioned HEC more frequently than rural participants (*Mdn* = 0, *M* = .159; *W* = 28186, *p* = .017). In both rural and urban participants, 'human responsibility', 'program-specific knowledge', and 'true' were the most frequently co-occurring codes with 'HEC', indicating that participants (regardless of location) at both pre-test and post-test correctly reported the role humans play in HEC as well as information about the topic of HEC that was taught in TEI's educational program.

The code 'HEC' also had two qualifiers of its own: 'relevant' and 'broad'; knowledge about HEC as it occurs in Thailand (e.g. crop raiding) was coded with 'relevant', while more general information about HEC without reference to what it is or why it occurs (e.g. "humans and elephants conflict") was coded with 'broad'. A Mann Whitney test with a Holm correction indicated that at post-test, urban participants (*Mdn* = 0, *M* = .187) mentioned relevant topics about HEC more frequently than did rural participants (*Mdn* = 0, *M* = .070; *W* = 28216, *p* = .003). There did not appear to be much of a difference in the number of broad statements about HEC made by rural and urban participants, however, for relevant statements, it appeared that there was an increase from pre- to post-test in both rural and urban participants (Table 15). There were not enough data to test this for significance. Control students, both rural and urban, had very few broad and relevant statements overall (<10) at either time point (Table 16).

Table 14.
Total Number of Statements about HEC

	Rural		Urban		
	Participant	Control	Participant (All)	Participant (BKK1)	Control (BKK1)
Pre	19	12	32	6	9
Post	32	8	69	5	4

Table 15.
Total Number of Broad and Relevant Theme Codes for Participants

	Rural		Urban			
	Broad	Relevant	Broad		Relevant	
			All	BKK1	All	BKK1
Pre	13	6	16	3	16	3
Post	17	14	22	1	47	4

Table 16.
Total Number of Broad and Relevant Theme Codes for Controls

	Rural		Urban	
	Broad	Relevant	Broad	Relevant
Pre	5	7	5	4
Post	3	5	3	2

Conservation.

27 (14%) rural participants reported a total of 34 statements about conservation at pre-test. In 107 instances ‘conservation’ co-occurred with another code, the most frequent being: program-specific knowledge (N=19, 18%) and human responsibility (N=17, 16%). At post-test, 26 (13%) rural participants reported a total of 28 statements about conservation. In 83 instances ‘conservation’ co-occurred with another code, the most frequent co-occurring codes being: program-specific knowledge (N=23, 28%), and true (N=18, 22%).

29 (12%) urban participants reported a total of 31 statements about conservation at pre-test. In 103 instances ‘conservation’ co-occurred with another code, the most frequent co-occurring codes being: program-specific knowledge (N=24, 23%) and true (N=16, 16%). At post-test, 27 (11%) urban participants reported a total of 31 statements about conservation. In 116 instances ‘conservation’ co-occurred with another code, the most frequent being: program-specific knowledge (N=27, 23%) and true (N=23, 20%).

Both rural and urban participants at pre-test and post-test made conservation statements a similar number of times (Table 17), and in both settings, participants made these statements in conjunction with ‘program-specific knowledge’ and ‘true’ more than any other theme codes. Therefore, at pre-test and post-test, rural and urban participants correctly reported information about conservation of elephants and referenced knowledge specifically taught about this topic in TEI’s educational program.

‘Conservation’ was examined further through two additional qualifiers: ‘surface’ and ‘deep’; ‘surface’ was applied to general knowledge about conservation (e.g. “elephants are preserved”), while ‘deep’ was applied to responses demonstrating knowledge about what is causing elephant populations to dwindle (e.g. “people invade elephant habitats, therefore elephants don’t have a place to live”). There was no difference in rural or urban pre- to post-test mentions of more in-depth or surface knowledge regarding elephant conservation, nor was there a difference between pre- and post-test rural and urban participants (Table 18). Rural and urban participants mentioned deep information about the same number of times as rural and urban controls at pre-test. Rural participants, however, mentioned surface information about conservation more than control students at pre- and post-test, but there were not enough data to test if this was significant. Few statements that were considered surface or deep were made by

control students in either setting (Table 19), and in general, conservation was rarely mentioned by students in the control group. Due to these codes (conservation, surface, deep) being reported relatively infrequently by all students, tests for statistical significance could not be conducted.

Table 17.
Total Number of Statements about Conservation in Each Group

	Rural		Urban		
	Participant	Control	Participant (All)	Participant (BKK1)	Control (BKK1)
Pre	34	17	31	2	5
Post	28	5	31	0	3

Table 18.
Total Number of Surface and Deep Theme Codes for Participants

	Rural		Urban			
	Surface	Deep	Surface		Deep	
			All	BKK1	All	BKK1
Pre	27	8	25	0	8	2
Post	20	7	23	0	7	0

Table 19.
Total Number of Surface and Deep Theme Codes for Controls

	Rural		Urban	
	Surface	Deep	Surface	Deep
Pre	15	2	4	1
Post	4	1	2	1

Keystone species.

At pre-test, 9 (5%) rural participants reported a total of 12 statements about keystone species. In 32 instances ‘keystone species’ co-occurred with another code, the most frequent being: general (N=10, 31%), program-specific knowledge (N=9, 28%), and true (N=9, 28%). At post-test, 52 (26%) rural participants reported a total of 62 statements about keystone species. In

199 instances ‘keystone species’ co-occurred with another code, the most frequent co-occurring codes being: program-specific knowledge (N=60, 30%), true (N=56, 28%), general (N=42, 21%), and specific (N=20, 10%). A Wilcoxon signed-rank test with a Holm correction found that the increase in post-test (*Mdn* = 0, *M* = .311) statements compared to pre-test (*Mdn* = 0, *M* = .063) about elephants’ role as keystone species was significant ($V = 246$, $p < .001$) (Table 20).

5 (2%) urban participants reported a total of 5 statements about keystone species at pre-test. In 15 instances ‘keystone species’ co-occurred with another code, the most frequent being program-specific knowledge (N=4, 27%). 28 (11%) urban participants reported a total of 32 statements about keystone species at post. In 85 instances ‘keystone species’ co-occurred with another code, the most frequent co-occurring codes being: program-specific knowledge (N=27, 32%), general (N=25, 29%), and true (N=22, 26%). Therefore, the number of times urban participants reported knowledge about elephants being keystone species also increased from pre- to post-test (Table 20), though there were not enough data to confirm if this difference was significant.

A Mann Whitney test with a Holm correction indicated that rural participants referenced keystone species significantly more than urban participants at post-test (rural *Mdn* = 0, *M* = .309, urban *Mdn* = 0, *M* = .127; $W = 19861$, $p < .001$). In both rural and urban participants, the most commonly associated themes with ‘keystone species’ were ‘program-specific knowledge’, ‘general’, and ‘true’. Therefore, all participants typically reported general, truthful knowledge about elephants’ role as keystone species. These responses also touched upon themes taught in the TEI curriculum. As for the control students, there was no mention of elephants being a keystone species in either setting or time point (Table 20).

Table 20.
Total Number of Statements about Keystone Species

	Rural		Urban		
	Participant	Control	Participant (All)	Participant (BKK1)	Control (BKK1)
Pre	12	0	5	0	0
Post	62	0	32	5	0

Responsibility.

Other theme codes that fit with the topics of HEC and elephant conservation were also assessed to provide a greater understanding of how students were talking about these topics. The codes ‘elephant responsibility’ and ‘human responsibility’ were applied to indicate how students were referring to HEC – whether it was more focused on what elephants need to do or what humans need to do. At pre-test, very few statements were made about elephant responsibility in general, by any group (Table 21), and this was also the case at post-test for the rural students. The urban participants, however, made more statements at post-test about elephant responsibility, though this could not be confirmed statistically. There tended to be more statements about human responsibility than elephant responsibility overall, and participants in both settings had a similar number of human responsibility statements at both pre- and post-test. It appeared that rural participants mentioned human responsibility more often than did control students, though there were not enough data to confirm this statistically.

There were no pre-test rural participants who mentioned elephant responsibility. 5 (2%) post-test rural participants reported a total of 5 statements about elephant responsibility. In 18 instances ‘elephant responsibility’ co-occurred with another code, the most frequent being: relevant (N=5, 28%) and HEC (N=5, 28%).

As for urban participants, 5 (2%) reported a total of 5 statements about elephant responsibility at pre-test. In 22 instances ‘elephant responsibility’ co-occurred with another code, the most frequent being: HEC (N=4, 18%), relevant (N=4, 18%), and behavior (N=4, 18%). At post-test, 21 (8%) urban participants made 23 statements about elephant responsibility. In 109 instances ‘elephant responsibility’ co-occurred with another code, the most frequent co-occurring codes being: relevant (N=23, 21%), HEC (N=23, 21%), and program-specific knowledge (N=15, 14%).

A Mann Whitney test with a Holm correction indicated that the difference in the number of times rural (*Mdn* = 0, *M* = 0) and urban participants (*Mdn* = 0, *M* = .020) mentioned ‘elephant responsibility’ at pre-test was significant (*W* = 26600, *p* = .042). Furthermore, it appeared as though participants in both locations referenced ‘elephant responsibility’ more often after participation in the program, though there were not enough data to test if this was significant. There was, however, a significant difference in mentions of elephant responsibility at post-test between rural and urban participants: a Mann Whitney test with a Holm correction indicated that urban participants (*Mdn* = 0, *M* = .091) mentioned ‘elephant responsibility’ significantly more than rural participants (*Mdn* = 0, *M* = .025; *W* = 27458, *p* = .007). All participants who referred to elephant responsibility also mentioned HEC, specifically conflict relevant to Thailand, more often than any other codes. In both pre- and post-test control groups there was little mention of either ‘elephant responsibility’ or ‘human responsibility’, though there appeared to be more respondents reporting information about human than elephant responsibility, there were not enough data to test for significance.

Table 21.
Total Number of Statements Regarding Elephant/Human Responsibility

	Rural		Urban		
	Participant	Control	Participant (All)	Participant (BKK1)	Control (BKK1)
Elephant Responsibility					
Pre	0	4	5	0	0
Post	5	2	23	2	0
Human Responsibility					
Pre	37	13	32	5	8
Post	21	7	39	2	4

Discussion

EE programs must be designed with their target audience in mind to maximize knowledge retention and attitude change, especially regarding species associated with HWC. However, the first step in this process is to determine the pre-existing perceptions and knowledge levels about the species in question. TEI designed an educational program for Thai students focused on elephant conservation due to the endangered status of Asian elephants, increasing HEC because of expanding human populations, and lack of suitable elephant habitat (Leimgruber et al., 2003; Choudhury et al., 2008; Baskaran, 2013). The education program included a survey that was given to students before and after participation in the program to assess the efficacy of their education program. In the current study, the survey was used to assess perceptions of and attitudes toward elephants before and after participation to determine whether these perceptions and attitudes changed after involvement in the program. The survey was also used to assess whether living in a rural or urban setting influenced the students' responses. Specifically, we were interested in determining whether there were initial differences in the type

of knowledge the students in these settings had about elephants before participation as well as if the setting influenced what knowledge the students gained from participation in the program.

Perceptions and Attitudes

To examine the students' perceptions of elephants, the responses to four yes/no questions were analyzed to determine if there were any differences in response from pre- to post-test. As predicted based on previous studies that have shown local positive views towards HWC species despite the conflict (e.g. Bandara & Tisdell, 2003, 2004; Dickman et al., 2003; Patil & Patil, 2017), all students in the rural setting and control students in the urban setting overall had positive views of elephants that did not change over time. However, for two of these questions ("Are you interested in elephants?" and "Should we help save elephants?"), there was a significant increase in the number of urban participants who had initially said no, but then changed to yes after involvement in the program. These results indicate that TEI's educational program did in fact positively impact students' interest in and motivation to help elephants. This indicates that in some cases there is still an opportunity to positively influence students' attitudes toward elephants, even in settings where they generally already have positive views of the species. Interestingly, the total number of times that the 'positive views' code was applied to this group was significantly lower at post-test than how many were applied at pre-test. This difference, however, may not be representative of the attitudes urban participants have towards elephants, which is evidenced by the low numbers of participants reporting negative views towards elephants in the open ended response between pre- and post-test. If these children's attitudes towards elephants were shifting to more negative views, we would expect to see an increase in the number of children reporting 'negative views', and/or the number of 'negative views' codes applied to that group post-test, which was not the case. Therefore, urban

participants may have been reporting fewer positive statements about elephants at post-test not due to an actual attitude change, but rather, they were reporting other information about elephants more frequently instead. As for rural participants, the percentage of students who reported ‘positive views’ and the total number of times the theme code ‘positive views’ was applied remained about the same from pre- to post-test, suggesting that rural participants’ attitudes towards elephants did not change due to enrollment in TEI’s EE program; rural participants had more positive views than negative views towards elephants that remained higher than negative views after participation in the program.

Overall students more frequently made positive statements about elephants than negative statements. Based on previous research indicating that locals will have positive attitudes towards species associate with HWC if those species also have cultural significance (e.g. Ale, 1998; Bandara & Tisdell, 2003, 2004; Dickman et al., 2003; Patil & Patil, 2017), it is interesting to evaluate whether two theme codes, ‘culture’ and ‘history’ were referenced in conjunction with positive or negative views. Being that elephants are a prevalent species in Thailand’s culture and history (Lin, 2012; Schliesinger, 2012), we calculated how often students referred to elephants in terms of their cultural or historic role in the country as well as mentioned either positive or negative statements about elephants. In doing so, of the students who referred to the cultural significance of elephants and had either negative or positive views towards them, more students mentioned positive views than negative views, though we could not test this for significance. This was consistent for all students, regardless of where they lived, or whether they participated in the program or not, with one exception: urban pre-test controls reported the same percentage of positive and negative views in conjunction with ‘culture’. It should be noted however, that there were only seven (out of 38 total) urban control students whose responses were coded as

'culture'. In the case of students who mentioned the historical role of elephants and either positive or negative views toward them, students tended to mention positive views more often than negative views, but again, there were not enough data to test this. In general, though, the number of students who mentioned the historical role of elephants was relatively low overall, especially compared to the number that mentioned the cultural importance of elephants. Therefore, as predicted, it seems as though the cultural status of elephants does impact how students perceive them, evidenced by the high percentages of students who mentioned 'culture' as well as 'positive views'; of the students who mentioned 'culture', the majority also referred to elephants in positive ways rather than negative ways, though we were unable to test this data for significance.

Knowledge

Controls.

Control students served as a reference to determine if there were any existing differences in rural and urban students as well as to assess whether time was a factor in responses that changed pre- to post-test in participants.. Examination of pre-test controls versus participants indicated that there were no significant differences in urban or rural students initially. To ensure there were no time effects, responses provided by control students were analyzed from pre- to post-test in each setting. There was one significant difference: rural controls reported significantly more program-specific responses at pre- than at post-test. Further inspection of the types of responses indicated that the program-specific information provided was very general and did not include information about the theme codes of interest for the purposes of this study; most of these responses were in regards to elephants' diet, such as "elephants eat plants" and "elephants like to eat fruit". There were no other significant differences in controls from pre- to

post-test in either setting for any other code assessed, and therefore changes found in the participant group from pre- to post-test are due to their participation in the education program. Given there were no other significant differences in the control students, only data from participants were examined further.

Pre-test.

On average, urban participants were half a year older than rural participants. Given that students enrolled in the program were chosen based on which schools agreed to participate, this age difference could not be controlled for. While this difference in age may have had an effect on knowledge levels prior to program enrollment in general, results from the theme codes of interest and their related qualifiers did not indicate significant pre-test differences in knowledge about elephant conservation or related issues between rural and urban children.

The number of responses that children provided about elephants was used as an indicator of knowledge – the more responses children provided could indicate more knowledge about elephants. While it was predicted that before participation in the program rural students would have more knowledge about elephants due to their closer proximity to elephants, urban participants actually provided significantly more responses than did the rural participants. That said, the number of responses students provide may not necessarily be a good measure of knowledge, as there is no way to know the content and quality of those responses. Therefore, further information about what themes the rural and urban pre-test students were reporting was necessary to examine before concluding that urban children come into the program having more knowledge about elephants than rural children.

Qualifier codes (‘true’, ‘false’, ‘general’, and ‘specific’) were used as a general assessment of knowledge – “more knowledge” meaning more ‘true’ and ‘specific’ responses,

and “less knowledge” meaning more ‘false’ and ‘general’ responses. The prediction was that rural children at pre-test would have more true and specific knowledge about elephants than urban children at pre-test, but this prediction was not supported; there were no significant differences between rural and urban participants in the true, false, specific, or general responses they provided.

Similarly, the code ‘program-specific knowledge’ was used to determine what information students reported that was specifically taught in the program. There were no significant differences in the total number of statements coded ‘program-specific knowledge’ that rural versus urban participants reported at pre-test. Interestingly, there were large percentages of rural and urban participants who reported program-specific knowledge at pre-test. However, upon further inspection of the type of statements provided, it appeared that these responses may have stemmed from a general understanding of topics that would be covered more in-depth in TEI’s EE program. For example, a few pre-test statements that were coded ‘program-specific knowledge’ stated information such as “there are two kinds of elephants” and “elephants eat fruits”. Both statements were coded as ‘program-specific knowledge’ because the educational program did teach students about the different species of elephant as well as their diet. However, these statements do not reflect the depth or detail of the type of information that was taught in the program, and therefore do not necessarily indicate that pre-test participants were reporting the same level of knowledge as post-test participants were.

There were no significant differences between rural and urban pre-test participants in regards to the theme codes of interest. So while urban participants provided significantly more responses about elephants, there was no evidence to conclude that the age difference between

children in the two settings played a role in their pre-test knowledge levels of conservation, HEC, and related issues, which were the main focus of this study.

Pre-test to post-test.

To determine if the program had an effect on knowledge levels of participants, we first compared the number of post-test responses students provided to the number of pre-test responses they provided. In both settings, participants provided significantly more responses at post-test than at pre-test. This demonstrates that participants in both locations, as predicted, gained knowledge from enrollment in TEI's educational program. However, as mentioned previously, it was necessary to also examine the content of those responses.

We assessed qualifier information to test the prediction that all rural and urban participants would have an increase in knowledge post-test. Results indicated that in both settings, as predicted, the total number of true statements participants reported significantly increased from pre- to post-test. Examples of this can be seen in individual students reporting specific information about elephants at post-test, such as "elephants in the wild live in a herd and the leader is called a matriarch", "elephants in musth are dangerous to people" and "elephants can cooperate with each other". Rural participants also reported significantly more general information post-test than at pre-test, opposite of my prediction that participants would report more specific information about elephants post-test. However, the fact that rural participants reported more general information post-test does not indicate that participants were not reporting specific knowledge as well. In fact, the total number of specific statements at both pre- and post-test was high and quite similar to the number of general statements. Therefore, while there was a significant increase in the amount of general information being reported in rural participants post-test, the number of specific statements was already relatively high in pre-test, and remained

high post-test. Urban participants did not have any significant changes in number of times 'general' or 'specific' codes were applied from pre- to post-test.

With respect to any changes in pre- to post-test reports of 'program-specific information', findings indicated that, while there were about the same percentage of participants from pre- to post-test in both settings who reported this knowledge, the number of times each group reported program-specific knowledge significantly increased in both locations at post-test. Therefore, TEI's EE program was successful in teaching rural and urban participants information about elephants. Furthermore, upon examination of the types of post-test responses regarding program-specific knowledge, it is clear that post-test responses oftentimes reflected more details from the program, for instance "male elephants have bigger tusks than female elephants" and "elephants cannot eat chilies because their trunks are very sensitive". So, while many students reported 'program-specific knowledge' even before participation in the program, it seems that participants gained additional knowledge about elephants, which is reflected in the significant increase in total number of program-specific knowledge codes and in the details participants provided at post-test.

Certain theme codes were assessed to determine how participants referenced issues related to elephant conservation after the program (e.g. HEC in Thailand, importance of elephants to the ecosystem, and factors driving the endangered status of Asian elephants). Two significant differences were found in relation to these themes: urban participants reported significantly more statements regarding HEC post-test and participants in the rural setting referred to elephants' role as keystone species significantly more at post-test than at pre-test.

These results indicate that TEI's educational program was successful in increasing knowledge about elephants in both settings, but in different ways. Urban participants gained

more knowledge about HEC. Example statements from pre- and post-test demonstrate the level of detail urban participants were able to gain from the program. Pre-test statements were more general, such as “elephants should not be killed” and “elephant tusks can be sold”, while post-test statements reflected the knowledge obtained from the program, such as “HEC is caused by elephants invade into people’s vegetable farm” and “elephants hurt people to protect themselves”. The most frequently applied codes to the same statements that mentioned ‘elephant responsibility’ were ‘HEC’ and ‘relevant’ in both settings, which demonstrates that participants were talking about elephants’ role in HEC in ways particularly relevant to crop raiding in Thailand after participating in the program.

Knowledge gain from rural participants indicated they knew more about elephants’ role as a keystone species in their ecosystem after participation in the program. We can see evidence of this in the ways in which post-test participants referenced elephants’ role as keystone species, such as “elephants break tree branches to let small plants get the light” and “elephants eat fruit and leave them as food for other animals”. The amount of detail in some of these individuals’ responses demonstrates not only an increase in knowledge, but a very detailed recollection of why exactly elephants are so important to the environment in which they live. The same level of knowledge was not demonstrated in pre-test responses, which included statements such as “elephants are useful to the wild”, “elephants help plants survive”, and “elephants help other animals”.

Statements about conservation were generally mentioned the same, relatively low, number of times from pre- to post-test in both settings. These statements revealed that participants overall had a very general sense of knowledge about the status of elephants (witnessed by the majority of statements about conservation also having the code ‘surface’

applied). Some example statements were: “elephants in Asia almost became extinct”, “elephants are preserved”, and “conservation will help prevent the extinction of elephants”. These responses, though overall infrequent, were provided at both pre- and post-test, which demonstrates that participants knew about the present status of Asian elephants before TEI’s educational program, though overall participants retained a surface understanding of this status even after the EE program (reporting information about conservation in general terms without providing information about why it is necessary or how it occurs, for instance, “elephants should be conserved”).

Post-test.

Analyses of qualifier codes revealed that a greater portion of rural participants mentioned specific information than did urban participants at post-test. While the two groups overall had the same total number of specific responses, these responses were generated by more students in the rural group while in the urban group, the same number of responses were given by a smaller portion of students (i.e. individual students were providing several specific statements).

Upon examining difference scores, results indicated that the largest increase in post-test statements were of ‘program-specific knowledge’, ‘behavior’, and ‘keystone species’ in both settings. Therefore, as predicted participants from both settings gained knowledge from the program. Rural participants also reported more statements about ‘biology’ and ‘physical qualities’ post-test, while urban participants reported more statements regarding ‘HEC’ and ‘elephant responsibility’ post-test. These differences in the types of theme codes being reported demonstrates that urban participants had a greater post-test increase in the number of statements provided about the theme codes of interest than did rural participants. The difference scores do not indicate which themes were referenced most frequently overall; they only indicated which

themes had the largest increases in pre- to post-test responses (see Figure 1 for the most frequently mentioned theme codes).

In addition to difference scores, theme codes of interest examined for this study indicated that after participation in the EE program, urban participants spoke significantly more about HEC in general as well as in ways relevant to Thailand and the role elephants play in these conflicts, while rural students spoke significantly more about the role elephants play as a keystone species in their ecosystem. These differences in the main themes that were mentioned by the two groups may be due to the fact that urban participants were, on average, a grade older than rural participants. Therefore, rural children may have been reporting more knowledge about physical and biological characteristics of elephants (evidenced by these themes being two of the top five increases in post-test responses in the difference scores) because those themes likely corresponded to and reinforced what the rural participants were learning in their current school curriculum. Urban participants, on the other hand, may have already had the background knowledge about elephant's physical and biological characteristics and therefore were able to focus more on new information about themes such as HEC in their post-test reports. This is not to say that urban participants did not also mention physical and biological characteristics of elephants, as there were a high number of statements made about these themes at both pre- and post-test, just that this information did not increase after participation. So, while age may not have played a role at pre-test given that there were no differences in what urban and rural students reported, age, and the grade at school that students were in, may have played a role in the type of knowledge children were able to gain from participation. This finding supports previous research indicating that individuals' backgrounds (e.g. education level) play a role in how effective EE programs can be (Breuer et al., 2017). However, despite the age difference,

rural participants reported significantly more information about the role elephants' play as a keystone species than did urban post-test participants. If the difference in post-test knowledge about HEC and related issues was in fact due to urban participants being slightly older than rural participants, it may be the case that rural participants retained more information about the importance of elephants to their ecosystem due to the fact that this knowledge is more applicable to what rural children see, since they are exposed to elephants in their natural habitats.

General Discussion

Overall, the prediction that rural children would have more knowledge about elephants than urban children before any educational intervention was not supported, contrary to previous findings that rural children had more sophisticated knowledge regarding endemic species than urban children (Franquesa-Soler & Serio-Silva, 2017). However, this may be the result of the open-ended question we examined in this study, in that the question was not specifically designed to elicit detailed information about elephants from students as the previous study did. The educational program was successful, however, in increasing the knowledge about elephants students had after participation, which is evidenced by the overall increase in the number of responses, true responses, responses related to program-specific knowledge, and information about elephants' role as keystone species.

While several topics of interest (e.g. HEC, conservation) could not be analyzed due to low responses overall, the increase in the number of times participants in both rural and urban areas referenced topics such as HEC, keystone species, and elephant responsibility suggests that there was some knowledge gain about the theme codes of interest after enrollment in TEI's education program. In general, the question of "list one to five things you know about elephants" did not tend to elicit responses about the status of elephants and issues surrounding their

conservation. Having the ability to freely respond probably resulted in students listing the first things that came to their minds about elephants, which was information about elephants' physical and biological characteristics. In fact, physical and biological characteristics were two of the top five increases in pre- to post-test responses in rural participants. Urban participants did not show the same increase in reference to biological or physical characteristics, however, this was most likely due to the fact that overall pre-test mentions of these characteristics were high and remained high post-test. These topics might have especially been readily on the children's minds due to relevant information being taught to them in their current school curriculum – these themes, already prevalent in their minds, would have been emphasized by some of the lesson plans participants in TEI's educational program received about elephant biology. In fact, some of the students relayed very specific information about elephant biology almost verbatim from what the program's curriculum taught.

While the prediction was that the participants in this EE program would be thinking more about elephant conservation and relevant issues (such as HEC) after enrollment in the program, the results reported here demonstrate a need for further research into this issue. The very nature of an open-ended response question is to allow students to answer in terms of what information is most prevalent in their minds. While some increase in reference to the theme codes of interest in this study were seen, there were not always enough data to statistically test these differences. One such example is from an urban student who did not mention anything about HEC pre-test, but gave a very detailed example of HEC relevant to Thailand post-test – "elephants learn fast, for example, when farmers put up electric fences the elephants will not get close to the fences [on the] first day. However, they will learn fast and use the trees to damage the fences". While this is just one example from a single student, it demonstrates the level of knowledge gain that

this program has the potential to provide for students. For the students that did not demonstrate this level of detail in their responses, however, these results do not necessarily reflect a lack of knowledge about these issues, but rather students may have more readily recalled information related to other topics that the current study was not assessing. The fact that there are students who retained such detailed information about issues surrounding conservation highlights the need for more educational programs about Asian elephants and their conservation in the future to ensure that students continue learning about HEC, the importance of elephants to their ecosystem, and relevant conservation issues and possible mitigation strategies. This continued education over time will likely result in these issues being more prevalent in students' minds as they age, thus resulting in a generation of children that will be more aware of conservation issues that will create (or be more willing to cooperate with) mitigation strategies to help reduce HEC in Thailand.

Future Directions

This study provided information about what children knew about elephants before and after enrollment in TEI's educational program, though there are certain changes that could be made to provide more insight into how children are thinking about elephants and what they know about issues related to conservation. The pre-test survey could be given to participants before introducing them to the topics that the program will cover to reduce any potential biasing of the responses based upon the mere knowledge about what the program entails.

We only assessed a few of the 21 theme codes created to understand how students were reporting knowledge about conservation issues for the purposes of this study, but the other theme codes can be examined to provide a greater sense of what information students were gaining from participation in TEI's EE program. For instance, in both settings there is an increase in the

number of post-test statements made about the ways in which elephants behave. Examining these additional codes would provide a more holistic understanding of what information students gained from participation in the program in general, not just in relation to conservation issues.

In addition, future analyses on the other open-ended response questions that the children answered (such as “Are you interested in elephants, why or why not?” and “Should we help save elephants in Thailand, why or why not”) will give a more holistic view of pre-existing knowledge children have about elephants and how that knowledge changes after participation in the program. As stated previously the open-ended response question “list one to five things you know about elephants” would evoke more general knowledge about elephants from children rather than knowledge specifically related to the theme codes of interest for this study. Because students were reporting information most prevalent in their minds to answer the question, we see more statements about physical and biological characteristics of elephants than statements related to conservation issues. Therefore, coding the additional open-ended response questions in a similar manner to what was done for this study would likely result in more information referencing the theme codes of interest, as those questions are designed to elicit responses more focused on students’ knowledge related to conservation issues. Analyzing the responses from the other open-ended questions would provide more information about potential attitude change or knowledge gain, as well as any inherent differences in knowledge levels of rural versus urban children.

Conclusion

In summary, the analysis of one question from the TEI survey showed promising results for the educational program implemented in Thailand. The results indicated that the educational program was successful in increasing knowledge levels regarding HEC and the role elephants

play as a keystone species in their ecosystem. The open-ended response question of "list one to five things you know about elephants" was not designed to elicit information regarding conservation issues specifically, so the fact that responses regarding these themes significantly increased indicates that TEI's EE program is beneficial for raising awareness of these conservation issues in children. The post-test results indicated a significant difference in knowledge levels about conservation issues between children in either setting; urban children reported more knowledge about these theme codes of interest than did rural students. This effect, however, may be due to the age difference between participants in either setting, so it is necessary to assess potential location effects in children of the same age.

These results have implications for future research and educational programs run in Thailand. Additional research conducted on children of the same age would indicate whether there are inherent differences in the information rural versus urban students retain from participation, which would affect potential EE curriculums designed for students in either setting. Furthermore, due to the fact that all students regardless of setting had an increase in knowledge about elephants after participation in the program, it is important to continue these educational programs to encourage students to think more scientifically about HEC and related conservation issues, as well as to create a generation of individuals that are willing to create and implement conflict mitigation strategies in the future to help prevent Asian elephant extinction.

Appendix A

Descriptions and Examples of All Theme Codes and Qualifiers

Theme Code or Qualifier	*Definition*	*Examples*
Abilities	What elephants can or cannot do	“eles can’t jump” “eles can swim”
Behavior	How elephants behave or react	“eles are scared of human weapons” “eles put mud on themselves”
Biology	Physiology of elephants	“eles are mammals” “eles are viviparous”
Broad (qualifier)	(Only applicable to ‘HEC’) HEC without any details as to what it is or how it occurs; HEC not relevant to crop-raiding	“eles are killed for their ivory” “human-elephant conflict”
Comparison to Humans	Elephants’ similarities to or differences from humans	“eles are more patient than humans” “eles hear better than humans”
Conservation	Status of elephants and/or protections over them	“eles are endangered” “eles are protected”
Culture	Elephants’ importance to Thailand; historical role of elephants	“eles are Thai culture” “eles are Thai national animals”
Deep (qualifier)	(Only applicable to ‘conservation’) What is causing conservation issues	“eles won’t go extinct if people don’t cut down trees” “eles don’t have a place to live”
Diet	What elephants eat or do not eat	“eles eat sugarcane” “eles don’t like chillies”
Ele Responsibility	What elephants should or should not do	“eles shouldn’t eat crops”
Ele Facts	Misc. information about elephants; Thai names for elephants	“female ele is matriarch” “wild eles are called dtua”
False (qualifier)	Information listed is incorrect/false	
General (qualifier)	Listing information in a general (not specific) manner	“I know why eles cover themselves in mud”
History	Historical role of elephants	“eles fought for Thailand”
Human Responsibility	What humans should or should not do	“we have to save ele” “humans should not kill eles”
Human Use	Ways in which elephants can be useful to humans	“eles can carry heavy things” “eles are used in the show”
HEC	Problems between humans and elephants	“humans kill eles” “eles eat peoples’ crops”
Ideals	Statements about what students think should or would like to happen	“would like elephants to not hurt people” “would like eles to live with humans”
Keystone	Elephants’ importance to other living	“ele dung is fertilizer” “eles help

Species	things, directly or indirectly	other animals survive”
Negative Views	Speaking of elephants negatively	“eles are aggressive” “eles are angry”
Physical Qualities	Descriptions about elephants’ appearance; differences between physical qualities of Asian and African elephants or male and female elephants	“eles are grey” “Asian eles are smaller than African eles” “female eles don’t have tusks”
Positive Views	Speaking of elephants in a positive way	“eles are cute” “eles are smart
Program-Specific Knowledge	Information specifically taught during TEI lessons	“eles are scared of bees”, “eles don’t like chili”
Question about Eles	Asking questions instead of listing knowledge	“what do eles think?” “what is eles’ favorite food?”
Relevant (qualifier)	(Only applicable to ‘HEC’) HEC as it occurs in Thailand and is relevant to crop-raiding	“eles kill people” “eles eat farmer’s crops”
Surface (qualifier)	(Only applicable to ‘conservation’) Mention of conservation without any information about it	“eles should be protected” “eles need help”
Specific (qualifier)	Listing information in a specific (not general) manner	“Asian eles have four toes on their back legs and five on their front”
True (qualifier)	Information listed is correct/true	
Wild vs. Captive Eles	Mention of where elephants live and any differences between the two	“eles live in the wild” “eles in ele camps have better lives than eles in the wild”

Note. “Ele” is shorthand for elephants.

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