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The Influence of Teacher Professional Development on the Knowledge and Attitudes of Early Elementary Students Following an Inquiry-Based Intervention

Abstract

Inquiry-based interventions have been shown to have significant influence on the scientific knowledge and attitudes of middle school students in urban environments, yet similar studies of early elementary students have not been done. The goal of this study was to measure the degree to which teacher professional development influences student gains in scientific knowledge and attitudes, with anticipated results being higher for those students of classroom teachers who participate in professional development. Students were administered pre- and post-test surveys surrounding their participation in the Connections to Africa pilot test program developed by Cleveland Metroparks Zoo. Significant knowledge gains were achieved by students in both the test and control groups while attitudinal gains were insignificant for both. In addition, knowledge gains achieved by African American boys allowed them to catch up to their peers when they were once lagging behind. This study did not comprehensively address the degree to which teacher professional development affects student gains, but it is clear that students benefit from having a teacher who embraces and fully utilizes inquiry in the classroom.

Introduction

Early elementary school programming at Cleveland Metroparks Zoo has for many years taken place within a Zoo classroom. Program content is well-received by classroom teachers, but save for the small animal contact provided to students, it doesn't adequately use the resources provided by the Zoo's animals and exhibits. Zoo docents conducting the programs fall into Haberman's "pedagogy of poverty" (Haberman, 1991), treating the students as empty vessels needing to be filled with science knowledge rather than allowing them to use higher level thinking to solve problems and draw their own conclusions concerning STEM (Science, Technology, Engineering and Math) concepts. With the opening of a major new elephant exhibit in 2011, it is time to retire the old programs and replace them with something new that will provide students with a rich learning experience and will allow them to use the best of what the Zoo has to offer.

Data from a number of studies across the country have shown that inquiry-based classroom interventions result in significant knowledge gains in science content, particularly for students from underserved, urban school districts (Thadani et. al., 2010; Geier et. al., 2008; Marx et. al., 2004). Interventions consisted not only of the inquiry-based classroom units but also on professional development to prepare the teachers for using inquiry methods with their students. These interventions help to close the achievement gap in science experienced by African American boys (Geier et. al., 2008) but also close the confidence gap in scientific ability experienced by Caucasian girls (Kahle & Damnjanovic, 1994). In order to participate in some of the major issues currently facing our society, such as global warming and sustainability in natural resource use, students will need to be proficient in STEM content areas (Duschl et. al., 2007). The majority of these referenced studies have been conducted with upper elementary and middle school students, yet Campbell (1991) indicated that deciding to pursue the sciences as a career is determined between 4th and 6th grades. Earlier intervention is thus needed to create a scientifically literate community and to encourage students to pursue careers in science.

The primary audience for Zoo programming falls well within the description of underserved and urban. The student population at Cleveland Metropolitan School District (CMSD) is 70% African American, 12% Hispanic and 100% are considered economically disadvantaged (Ohio Department of Education, 2009). The primary objective of Connections to Africa, the Zoo's new elementary school programming, is to immerse the students in the elephant exhibit, require them to make observations, gather data and share it with others. An on-grounds component is being developed along with supplemental materials that will be available for use in the school classroom. Large urban districts such as CMSD typically do not use inquiry in the classroom, so it is anticipated that this programming change will be significant to both teachers and students. The goal of this study is to measure the degree to which teacher professional development influences gains in student scientific knowledge and attitudes. In addition, data will be analyzed to see if some of the trends found in the middle school studies (e.g., closing the achievement gap experienced by African American boys, closing the confidence gap in Caucasian girls) can be identified within this early elementary school population. It is predicted that students of classroom teachers who participate in the professional development session related to inquiry will have higher knowledge and attitude gains than the students in the control group. Due to the shortened intervention time frame of this study as compared to the referenced studies, both in terms of professional development hours and length of inquiry unit, it is unclear if any additional identified trends will be statistically significant, but hopefully data analysis will indicate a clear direction for further studies.

<u>Methods</u>

The Connections to Africa pilot test program was open to teachers and their 1st to 3rd grade students. Teachers participating in the pilot test program self-selected the opportunity during the Zoo's online school year program registration period which began August 2, 2010. Although teachers did select this opportunity over other programs for the same grade level, the pilot testing weeks were restricted to October 25-29 and November 1-4, which may have limited the chance to participate to only those who could attend at that time. All teachers choosing this program had to agree to complete their own pre- and post-surveys, administer pre- and post tests with their students, utilize at least one of the classroom lessons provided in the pilot kit prior to their Zoo field trip and actively participate in the field trip. Those teachers pilot testing in November also had to agree to participate in a 1 ½ hour inquiry workshop for the purposes of a concurrent study regarding the influences of professional development on the adoption of inquiry practices in the classroom.

Survey and test materials were delivered to the classroom a minimum of 3 weeks prior to the field trip experience. Teachers were asked to complete them and return them to the Zoo within the week. Teachers participating in professional development attended the workshop either as part of the Zoo's annual Educator Open House or the Cleveland Regional Council of Science Teachers fall conference. Both events occurred 2-2 ½ weeks prior to their field trip. Connections to Africa kits were delivered to the classroom a minimum of 2 weeks prior to the field trip. Kits contained a lesson plan packet [Appendix 1], chaperone guide to the field trip activities [Appendix 2], and hands-on materials for use in the classroom. Teachers were asked to complete the post-survey and test within one week of their Zoo field trip.

Student pre- and post-tests [Appendix 3] were designed to measure both knowledge of science content correlated to the theme of the African Elephant Crossing exhibit and Ohio Academic Content Standards for grades 1-3 as well as attitudes about science interest and ease. The five knowledge questions were multiple choice questions with only one correct response per question. The five attitude questions were scaled response questions that required a response weighing either positively or negatively. To accommodate what could be a wide range of reading abilities, questions were written using both words and pictures and teachers were told that they could read test questions and answer choices to their students if need be.

Student surveys were examined using a simple t-test to compare for statistically significant differences between the pre-tests and the post-tests. Knowledge questions were scored on the number of correct responses out of 5 questions. Attitude questions were scored on a scale of 1-4, with 1 being negative and 4 being positive. Trends were examined for the entire student sample. In addition, based on demographic data collected on the students, trends were also broken down by race, gender, grade and whether or not their teacher participated in the professional development component.

Results

Key Findings

- Students in both the test and control groups (those whose teacher participated in inquiry-related professional development and those whose teachers did not) showed significant knowledge gains by the end of the Connections to Africa pilot test program.

- When fleshed out from the rest of their respective group, students whose teachers embraced the inquiry format of the Connections to Africa pilot test program were responsible for the statistical significance of the knowledge gains of their group.

- Participation in the Connections to Africa pilot test program closed the achievement gap between African American boys and Caucasian boys and girls that was identified in the study's pre-test.

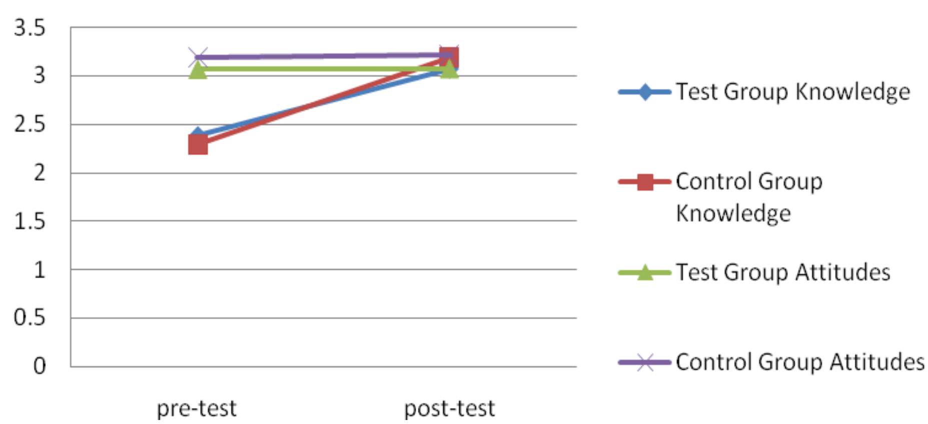
Pre-test, student demographics and post-test data were returned from 11 different schools that originally signed on to participate in the pilot testing of the Connections to Africa program. Nine of these schools are part of CMSD and two are parochial schools within the Cleveland city limits. Data for groups not returning all components were excluded from this study. Five of the 11 schools have teachers in the test group who have gone through a professional development component prior to the pilot testing with their students. The other six are in the control group and have had no such professional development. Demographic data is indicated in Table 1. Demographically, the test and control groups are not closely reflective of one another. The breakdown was initially determined by the self-selection of the teachers into the control or test group and then by their willingness to return test materials to the researchers.

TABLE 1: Student Demographics

	Test Group [Teacher professional development included in intervention]	Control Group [Teacher professional development not included in intervention]
Total Number of Students	136	177
Gender	52.21% male 47.79% female	47.46% male 52.54% female
Race	55.15 % African American 38.97 % Caucasian 0% Hispanic 5.88% other	67.78% African American 16.95% Caucasian 11.86% Hispanic 3.39% other
Grade Level	11.03% 1st grade 30.88% 2nd grade 58.09% 3rd grade	24.29% 1st grade 30.51% 2nd grade 45.20% 3rd grade
Special Needs	5.88%	7.34%

Mean and standard deviation were calculated for the number of correct responses to conservation knowledge questions and the scored responses to conservation attitude questions for both the test and control groups. Student pre-test data was compared with post-test data from the same group to determine the statistical significance of any knowledge and attitude gains as a function of the Connections to Africa program. Data was not compared across groups. Both test and control groups showed significant knowledge gains (p=0.0001 and p=0.0033 respectively) as a result of this study, which is illustrated in Figure 1. Full data details are found on Table 2 in Appendix 4.

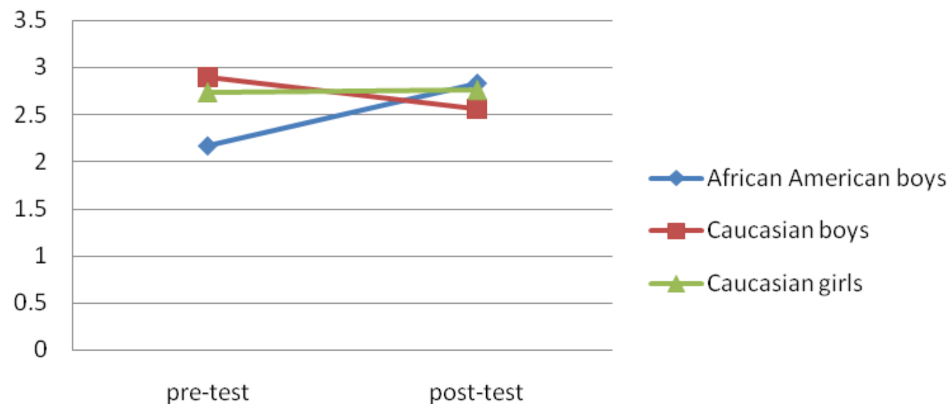
Figure 1: Student Pre/Post Test Comparisons



Conservation knowledge data was broken down by both gender and race for the entire study population to test for the achievement gap in African American boys as noted by Geier (2008). Table 3 in Appendix 4 shows complete data of African American boys in this study compared to all other demographic groups for differences in conservation knowledge. This group significantly underperformed in the pre-test when compared with Caucasian boys (p=0.0018) and girls (p=0.0129) but the trend did not hold true for the other demographic groups. Post-test data as illustrated in Figure

2 indicates that this inquiry-based intervention helped to close the achievement gap noticed between the African American boys and the Caucasian boys (p=0.2542) and girls (p=0.7569).

Figure 2: Inquiry and the Closure of the Achievement Gap



Conservation attitude data was broken down by both gender and race for the entire study population to test for the confidence gap in scientific ability as noted by Kahle & Damnjanovic (1994). Table 4 in Appendix 4 shows complete data of Caucasian girls in this study compared to all other demographic groups for differences in conservation attitudes. In this study, this group did not show any statistically significant attitudinal differences than any other demographic group in the study. Post-test data was not analyzed since the Caucasian girls in this study do not follow the confidence gap trends.

According to the companion study on the teacher's confidence and attitudes regarding this inquiry-based programming (Corr, 2010), 6 teachers provided written comments that indicated they embraced this format and liked the inquiry lessons they were provided. Three of these teachers were a part of the control group and 2 were a part of the test group. Based on this conversation, data for the students of these teachers was compared within their group to the students whose teachers did not indicate positive comments towards the lessons. Table 5 in Appendix 4 shows complete data for the students of positive teachers compared to the other students within their group. This unanticipated data analysis indicates that it was the students of these teachers that showed significant knowledge gains (p=0.0013 for the test group and p=0.0143 for the control group) while the others made gains that were not quite statistically significant (p=0.0845 for the test group and p=0.0549 for the control group).

Discussion

The Connections to Africa pilot test program provides evidence that even short-term inquiry-based interventions can lead to significant knowledge gains for early elementary students. Of particular interest for the urban audience is the closure of the achievement gap in science knowledge for African American boys. These findings indicate that inquiry intervention at an early age has positive benefits for all students and provides opportunities for those who traditionally fall behind to catch up to their peers.

Whether or not these findings are related to teacher professional development is unclear. Differences in levels of significance were identified in this study. The knowledge gains for those students whose teachers did not participate in professional development are considered very significant (p=0.0033) while the gains for those whose teachers did attend professional development are considered extremely significant (p=0.0001). A more comprehensive professional development program would need to be designed and tested to determine if professional development truly influences teachers to a degree that translates into more significant student knowledge gains than the use of inquiry materials alone.

In addition, information coming from the companion study of these particular teachers indicates that several teachers from both the test and control groups embraced the inquiry format more than their peers. The determining factor as to why certain teachers embraced the program format while others did not is thought to be related to how many years a teacher has been in the classroom, but this cannot be comprehensively analyzed with the data collected in the companion study. What is clear is that the students benefit from having a teacher who embraces and fully utilizes inquiry in the classroom. Part of a more fully developed professional development program should include additional teacher demographics in an attempt to gain insight into what influences a teacher to embrace inquiry as part of their teaching style.

Although there were no significant changes in student attitudes related to science, this finding may be due to the short-term nature of this study. Beliefs and attitudes are formed over a course of time and involve the influences of families, teachers and the larger community. Showing attitudinal gains may take a longer course of intervention before results become significant.

Conclusions

The goal of this study was to measure the degree to which teacher professional development influences gains in student scientific knowledge and attitudes. To that end, this study provided inconclusive results. Attitudinal gains were insignificant for both students in the test and control group while knowledge gains were quite significant for both groups. Although the knowledge gains in both groups are exciting to see in such a short-term inquiry intervention, additional studies would need to be done to determine if the difference in the degree of significance is significant.

A challenge to the study format was the way in which teachers self-selected to participate in the pilot test program. Although this method was designed to allow for randomization, it did not necessarily provide for comparable demographics between the test and control groups. While all the teachers who registered for the program agreed to complete all components of the pilot test, obtaining these materials from the teachers was difficult and, in some cases, groups were ultimately excluded from the study because materials were not completed as required. Although a more time-consuming option, future studies should consider having researchers in the classroom to collect some of the data components rather than fully relying on the teachers.

An additional challenge that will have future implications is that the teachers in this pilot test study showed interest in the program content and/or format based on their decision to sign up for the study. Although 16 teachers showed this initial interest, only 6 of these embraced the lessons and the inquiry format as indicated by their written comments. How this will translate to the interests of the educational community in the greater Cleveland area remains to be seen. Finding a way to engage the teachers and encourage them to embrace the inquiry format will be critical to the success of the program.

It is hoped that the results of this and companion study will encourage area teachers and the larger educational community to embrace inquiry and the success it can bring the students. Results of these studies will be shared with grant funders that provided materials for this program. These foundations are well-respected entities within the community and their support of the results coming from these studies will provide added respect for the work that was accomplished. Results of these studies will also be presented to key personnel within CMSD, to show what can be accomplished with their students by utilizing the Connections to Africa program provided by the Zoo. Hopefully CMSD administrators will show their support for the program and encourage principals and teachers at their elementary buildings to take advantage of the opportunity. As the program is rolled out for the 2011-2012 school year, participation in professional development on inquiry teaching methods and the use of the Connections to Africa classroom materials will be requested of all teachers signing up for the field trip portion of the program. Although this study did not conclusively show that teacher professional development led to higher student knowledge gains over use of the materials alone, it also did not show the effort to be detrimental. Utilizing these workshops to engage teachers and provide them encouragement as they use these lessons should translate into knowledge gains for elementary students in the great Cleveland area.

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Appendices

Appendix 1	Connections to Africa lesson plan packet	pages 9-29
Appendix 2	Connections to Africa chaperone guide	pages 30-33
Appendix 3	Student pre/post test	pages 34-37
Appendix 4	Student data tables	pages 38-39

CONNECTIONS TO AFRICA

CLEVELAND METROPARKS ZOO

Introduction

With newly revised Ohio Science Standards on the horizon and Cleveland Metroparks Zoo's newest exhibit, African Elephant Crossing, set to open, the education division is joining the excitement too with a new, inquiry-driven approach to teaching. *Inquiry Learning* is learning through discovery. Students develop critical thinking skills; they learn scientific concepts and begin to recognize themselves as scientists. Students discover their world through making observations, creating hypotheses and developing scientific tests. Inquiry can be *guided*, with the teacher providing general topics and activities, or it can be *open*, where students are free to create their own explorations based on personal observations. You will find both styles included in this kit. Inquiry is most successful when the students and teachers both recognize that they can be scientists and that discovery led by students is, indeed, *real* science. With that in mind, enjoy what this kit, and what your students, both have to offer.

Table of Contents

Standards-Based Science Instruction and Classroom Inquiry Pages 4-7

These pages are reproduced from the Ohio Department of Education website. The materials provided are not all inclusive, but are designed to give background on why the lessons in the kit are designed as they are. For a more comprehensive look at standards-based science instruction and classroom inquiry, go to www.ode.state.oh.us.

Materials in the Kit Page 8

We have provided many useful tools for your students to use as they work through these lessons and inquiries. You will find that specific materials are not listed on the individual lessons. This is done intentionally as the hope is that your students can explore the kit and all that it contains, determining for themselves what might be useful as they conduct experiments and investigations.

Lessons

Living Things Need Food Pages 9-10
Living Things Need Food Student Research Plan Sheet Page 11
Living Things Need Water Pages 12-13
Living Things Need Water Student Research Plan Sheet Page 14
Living Things Need Shelter Pages 15-16
Living Things Need Shelter Student Research Plan Sheet Page 17
Living Things Need Space Pages 18-19
Living Things Need Space Student Research Plan Sheet Page 20

Open Inquiry Page 21

The final element of this kit is an open inquiry for your students. One of the greatest parts of inquiry learning is that explorations almost always lead to the creation of further questions. It is when students are closely observing and questioning the world around them that they truly begin to discover their inner scientist. *Did your students come up with questions of their own or ideas that they would like to explore?* If so, use the included Research Plan sheet to guide you in your own inquiry.

Standards-Based Science Instruction and Classroom Inquiry

Learning Cycle

What key features distinguish science lessons with positive effects on learning and student achievement?

Instructional practices must be aligned to ensure positive student outcomes. Students learn best when instruction, assessment, and differentiation practices are woven together in a learning cycle to enhance teaching and learning. A recent study conducted by Horizon Research, Inc. concludes that the key factors that distinguish effective science lessons from ineffective lessons are opportunities for the lesson to:

1. Engage students with content by inviting purposeful student interaction with the dynamic body of scientific knowledge.
2. Create conducive environments for learning by providing respectful and rigorous opportunities for individual and group learning
3. Ensure access for all students by differentiating instruction to meet learning needs.
4. Use questioning to monitor and promote understanding by posing questions to encourage students reflection, planning, monitoring and self-evaluation.
5. Help students make sense of the content by facilitating students' intellectual work and conceptual connections among ideas, explorations and explanations.

From the standards-based science curriculum perspective, it is essential to differentiate processes, products and expectations to address learning needs throughout the learning cycle. Instructional and assessment practices employed throughout a learning cycle differe as students progress from engagement to exploration to explanation to expansion but always include ongoing collection of evidence of understanding and skills.

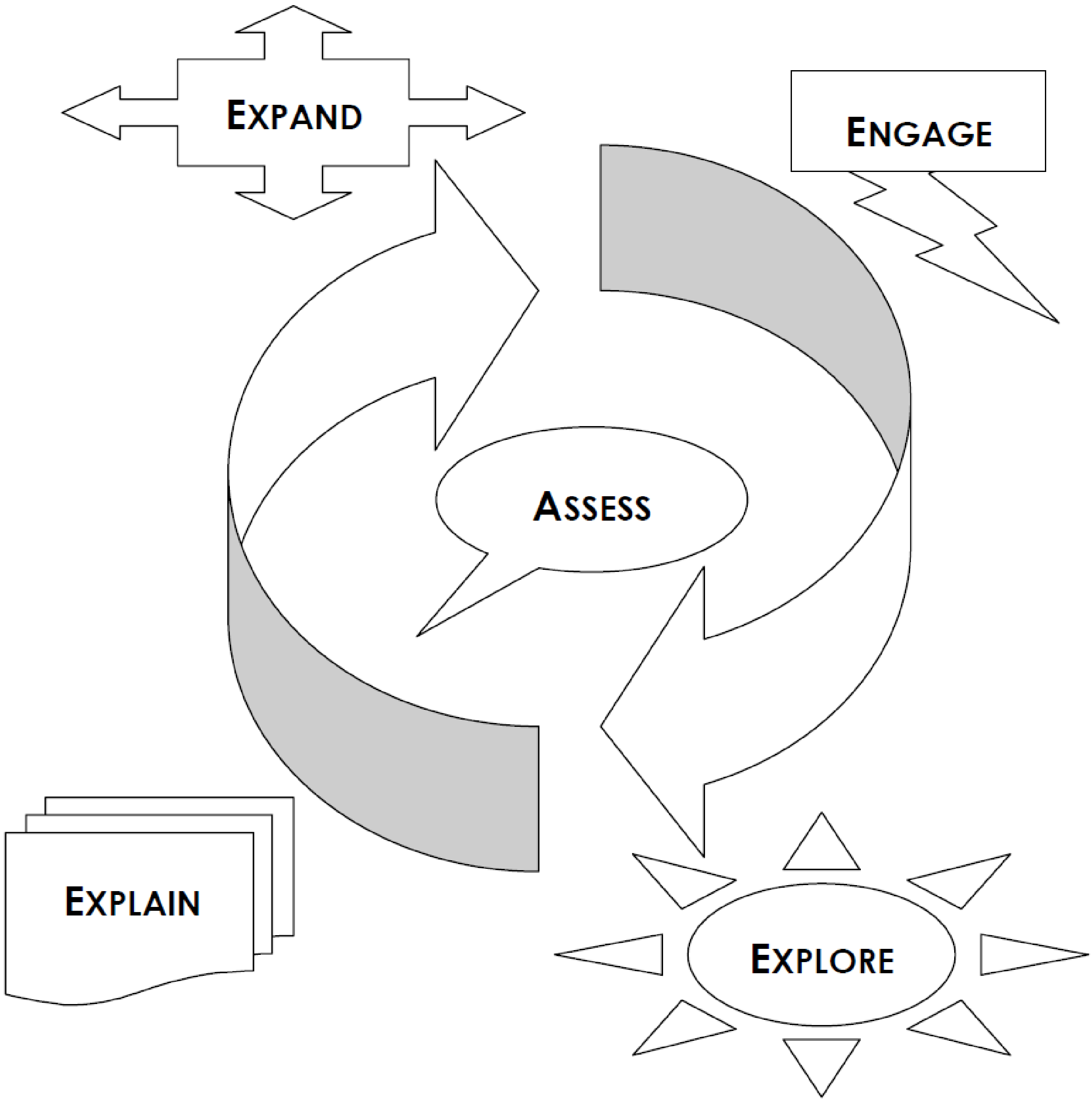
What do we know about effective instructional models for classroom inquiry and assessment that enhance science teaching and learning?

One standards-based instructional model for science is based on our understanding of how people learn and of learning cycles. The model includes engagement, exploration, explanation and expansion and revolves around assessment as an ongoing process. Effective planning uses this learning cycle model as a reference, not as a rigid template.

A learning cycle approach is an effective strategy for bringing explorations of the natural world and scientfic questioning into the classroom. A summary of research supports the conclusion that a learning cycle approach can result in greater achievement in science, better retention of concepts, improved attitudes toward science and science learning, improved reasoning ability, and superior process skills than would be the case with traditional instructional approaches (Abraham & Renner, 1986; Ivins, 1986; McComas III, 1992; Reghubir, 1979; Renner, Abraham & Birnie, 1985).

Standards-Based Instruction and Classroom Inquiry

Learning Cycle



Standards-Based Instruction and Classroom Inquiry

Learning Cycle

Engage: Set up motivating conditions to initiate and sustain students' engagement in inquiry. Use standards-based questions, demonstrations, discrepant events, and perplexing case-based or technological-design scenarios to strategically capture and channel student thinking. Help students access a learning cycle at multiple entry points. Select and design motivators to help students access the prescribed concepts, skills and cognitive demands described by the *Ohio Academic Content Standards, K-12 Science.*

Explore: Provide opportunities for students to explore and ask questions that can be tested scientifically through student-centered inquiry, including manipulating materials, making observations and keeping appropriate records. Align student-centered investigative activities with the standards, placing special emphasis on the standards *for Scientific Inquiry* and *Scientific Ways of Knowing.*

Explain: Use guided questioning based on teacher observation of students doing inquiry to help students focus on uncovering the standards-based concepts and skills of the lesson. This teacher-guided process is compatible with how people learn and helps students challenge misconceptions and develop preconceptions into more accurate conceptions, which students relate to prior experiences and learning.

Expand: Help students contextualize and deepen their understanding of the concepts and skills of the lesson. This will provide real opportunities for teachers to naturally address the Ohio science standards *for Scientific Ways of Knowing* and *Science and Technology*. Student questions often help expose new problems for inquiry and may be a springboard for new cycles of learning.

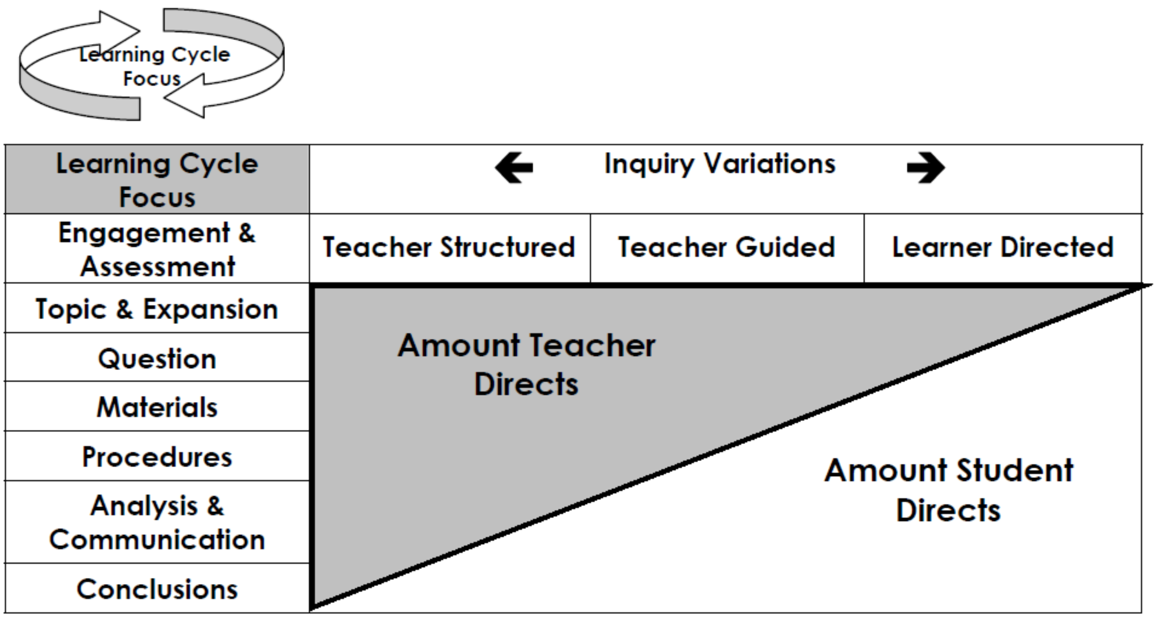
Assess: Assess for learning as students conduct classroom scientific inquiry. Assessment should reflect teacher expectations for substandtive intellectual student work and provide opportunities to collect evidence of what students know and are able to do. Use a variety of assessment strategies including journaling, concept maps, portfoios, authentic problem-solving and interviews. Provide timely feedback to help students self-monitor and clarify learning. An expected outcome of the standards-based science curriculum is student achievement of the prescribed science content.

Standards-Based Instruction and Classroom Inquiry

Inquiry Teaching and Learning

What do we know about the essential features of classroom inquiry that enhance science teaching and learning?

In classrooms, an effective working definition distinguishes inquiry in the general sense from inquiry as practiced by scientists. Effective patterns of instruction, differentiation and assessment may be viewed as falling along an inquiry continuum, based on how people learn and the identified learning needs.



- Teachers model inquiry and ramp up student responsibility for doing inquiry and monitoring their own learning. The assessment, content, processes and products of classroom inquiry range from “teacher structured” to “teacher guided” to “learner directed” at each juncture in a learning cycle depending on students’ needs.

- As a learning cycle moves from assessment and engagement, blending into exploration (e.g., questions and procedures), students’ needs guide whether more explorations are needed before moving on to explanation (e.g., analysis and communication). Explanation gives way to expansion which leads back to more inquiry questions and continuation of the cycle.

- At the learning directed level, the student is responsible for everything beyond the selection of the general topic, the content of the summative assessment and maybe a little teacher guidance with question development.

- It is a best practice to match the level of shared responsibility for classroom inquiry with the specific learning need, the environment and the readiness of teachers to provide instruction and for students to assume responsibility.

Materials in the Kit

Books

Face to Face with Elephants by Beverly & Dereck Joubert
Our Ecological Footprint: Reducing Human Impact on Earth by William E. Rees
Protecting Our Planet series by Angela Royston
- *Disappearing Forests*
- *Disappearing Wildlife*
- *Global Warming*
- *Oceans and Rivers in Danger*
- *Polluted Air*

Inquire Within: Implementing Inquiry-Based Science Standards by Douglas Llewellyn

DVDs

Echo and Other Elephants starring David Attenborough and Cynthia Moss
BBC Atlas of the Natural World: Wild Africa starring Fergal Keane

Scientific Equipment

Binoculars
100 foot measuring tape
pocket magnifiers
renewable energy kit

Biofacts

African elephant molar
elephant Poo Paper Journal & Papermaking Instructions

Living Things Need Food

Engage

This activity is designed to start your students in recognizing themselves as scientists and thinking critically about problem-solving. The goal is to teach concepts through discovery and to encourage using a scientific thought processes. As with all lessons provided, please feel free to adapt them according to your students' abilities. Some of your students may be early readers, in which case you may find it more successful to lead activities and discussions as a whole group rather than using individual Research Plan sheets. Certain scientific vocabulary may or may not be appropriate for your students' level of understanding. Take these ideas, make them your own and your students will have a greater chance at success.

Can I identify a situation where elephants and people might have to compete with each other for food?

1. Begin this lesson by telling students that they will be investigating one of the basic needs of all animals.
2. If your students are familiar with brainstorming and recording their ideas, break them into small groups. If your students need more guidance, work with them as a large group. Engage your students in a discussion of what they predict the answer to this question to be. More importantly, <u>why</u> do they think this?

Explore

3. Continue with the above discussion and encourage the group to come up with ways that they could investigate the question and test their predictions scientifically (all suggestions are welcomed). What tools might they need to carry out their suggested explorations? Are there materials that would help them find the answer? Should they be making observations? What kinds of records will they need to keep? What will they do with the information once they have it? And how will they know that they've successfully answered the question? Allow a wide variety of ideas and encourage conversation amongst the students to refine the details of their ideas.
4. Ideas should be recorded on the Research Plan sheets. Small groups can record their own answers or you can record ideas as a group.

Explain

7. Explain to the group that you have an activity that might help to give them some insight in to the situation.
8. Set up "food tokens" in two areas of the classroom. These will serve as natural areas where elephants are eating. Choose several of the students to represent elephants eating in this area.
9. In a third area of the classroom, set up an African village farm with "farm food tokens" representing the farmers crops. Choose a few of the students to be farmers and villagers in this area.
10. With the elephants standing in the first natural area, ask the students to predict what will happen if the elephants start eating here. Have the students representing the elephants act out this behavior.

11. When no food remains in this area, have the students discuss what the elephants should do next. Take all suggestions into account and let the group decide on the best choice. If at any point, they need assistance in this activity, feel free to help, but try to leave the decision making ultimately up to the students.
12. Have the "elephants" move to other areas to find more food. After they eat all the food in the other areas, ask them to discuss what the elephants should do next to find food.
13. When the elephants have reached the African village, ask the students to discuss what they think might happen here. Be sure to get input from all parties: the villager/farmers, the seated members of the class AND the elephants as to what they each think should happen next.

Expand

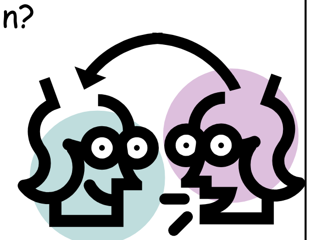
14. As the students think about the situations that they have just seen through the activity, have them reflect on what happened.
15. Discuss this situation further with the students. Why might this type of elephant vs. human situation be bad for the elephants? How might it be bad for the people?
16. Brainstorm ideas for possible solutions that they may have for this food issue.
17. Feel free to repeat the activity in any number of ways with any number of situations that your students can come up with.

Assess

18. Was the outcome the same as what they had predicted? Was the situation they found in which elephants and people compete for the same food a situation that they had thought of before the activity?
19. If the students are working in small groups, observe their work and review what they are writing on the Research Plan. If working as a whole group, fill in the Research Plan together.

Name:_______________________________

Research Plan – Living Things Need Food

1. What is my research question? Is it a good question? 	Can I identify a situation where elephants and people might have to compete with each other for food?
2. How can I get my information? 	
3. What will I do with this information? 	
4. How will I know I did my job well? 	

<u>Living Things Need Water</u>

Engage

This activity is designed to start your students in recognizing themselves as scientists and thinking critically about problem-solving. The goal is to teach concepts through discovery and to encourage using a scientific thought processes. As with all lessons provided, please feel free to adapt them according to your students' abilities. Some of your students may be early readers, in which case you may find it more successful to lead activities and discussions as a whole group rather than using individual Research Plan sheets. Certain scientific vocabulary may or may not be appropriate for your students' level of understanding. Take these ideas, make them your own and your students will have a greater chance at success.

How easy or difficult do I think it would be for people and elephants to share water?

1. Begin this lesson by telling students that they will be investigating one of the basic needs of all animals.
2. If your students are familiar with brainstorming and recording their ideas, break them into small groups. If your students need more guidance, work with them as a large group. Engage your students in a discussion of what they predict the answer to this question to be. More importantly, <u>why</u> do they think this?

Explore

3. Continue with the above discussion and encourage the group to come up with ways that they could investigate the question and test their predictions scientifically (all suggestions are welcomed). What tools might they need to carry out their suggested explorations? Are there materials that would help them find the answer? Should they be making observations? What kinds of records will they need to keep? What will they do with the information once they have it? And how will they know that they've successfully answered the question? Allow a wide variety of ideas and encourage conversation amongst the students to refine the details of their ideas.
4. Ideas should be recorded on the Research Plan sheets. Small groups can record their own answers or you can record ideas as a group.

Explain

5. Students will now participate in an activity that will help them understand what sharing water would be like.
6. The included "water droplets" represent the water available to your students. Place them all together at one spot in the classroom that is accessible to all students.
7. Each student is given a card which tells them who they are and what task they will need water to complete. Have the students read the cards so that they are familiar with what they will need to complete their task.
8. The order of students is completely dependent on the teacher's choosing. There is no proper order. The first student is told to come up to the water droplets and take as much as they will need to complete their task. Allow them to take whatever amount they believe they will need.

9. When one student returns to his or her seat, have the next student perform their task. Continue until all of the water droplets are gone. When the water is gone, no remaining tasks can be completed. This lack of water can simulate a drought or the end of the rainy season.
10. Ask the students basic questions about the game. How many of them were able to complete their task and how many were not? What do they think would happen to the students that were unable to complete their tasks?

Expand

11. Ask students to reflect on the results of the activity and review their ideas of how to get the information they would need to answer the original research question. How difficult was it for people and elephants to share water? Was there enough water for everyone? Are there some tasks they consider more important than others? Can you list the tasks that require more water and the tasks that require only a small amount?
12. Allow students time to discuss and plan how they could make the activity more successful. Do they need to gather any additional information before they can answer the question? Did they think of additional ways to gather information based on the activity they've just done?

Assess

13. Monitor your students as they continue to research and develop their method for communicating their results. Make sure to help them continue their discussion on the difficulty of people and elephants sharing water.
14. Once the students feel as though they've completed their research, have the students participate in the activity again.
15. Using what they have learned, see if they can come up with different ways to make the activity more successful. Were they able to complete more tasks? Were they able to get water to more of the people and elephants?
16. Conclude the lesson by looking back at the original research question. Did the students' answer to the question match their prediction? What would happen to either people or elephants if they were not able to figure out how to share a resource as important as water?

Name:______________________________

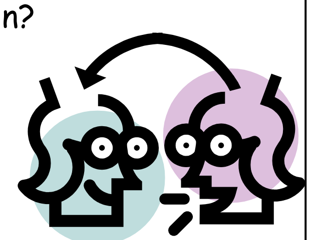
Research Plan – Living Things Need Water

1. What is my research question? Is it a good question?

How easy or difficult do I think it would be for people and elephants to share water?

2. How can I get my information?

3. What will I do with this information?



4. How will I know I did my job well?

Living Things Need Shelter

Engage

This activity is designed to start your students in recognizing themselves as scientists and thinking critically about problem-solving. The goal is to teach concepts through discovery and to encourage using a scientific thought processes. As with all lessons provided, please feel free to adapt them according to your students' abilities. Some of your students may be early readers, in which case you may find it more successful to lead activities and discussions as a whole group rather than using individual Research Plan sheets. Certain scientific vocabulary may or may not be appropriate for your students' level of understanding. Take these ideas, make them your own and your students will have a greater chance at success.

In what ways are African shelters the same or different than shelters found in the United States?

1. Begin this lesson by telling students that they will be investigating one of the basic needs of all animals.
2. If your students are familiar with brainstorming and recording their ideas, break them into small groups. If your students need more guidance, work with them as a large group. Engage your students in a discussion of what they predict the answer to this question to be. More importantly, <u>why</u> do they think this?

Explore

3. Continue with the above discussion and encourage the group to come up with ways that they could investigate the question and test their predictions scientifically (all suggestions are welcomed). What tools might they need to carry out their suggested explorations? Are there materials that would help them find the answer? Should they be making observations? What kinds of records will they need to keep? What will they do with the information once they have it? And how will they know that they've successfully answered the question? Allow a wide variety of ideas and encourage conversation amongst the students to refine the details of their ideas.
4. Ideas should be recorded on the Research Plan sheets. Small groups can record their own answers or you can record ideas as a group.

Explain

5. Explain to the students that they are going to use a method of scientific exploration to answer to this question.
6. Assign each student an animal or person that represents either Africa or the United States. The student is in charge of finding out everything that they can about the shelter used by their assigned individual. They can use whatever means necessary and whatever resources are available to discover this information.

Expand

7. After gathering information, have the students discuss as a group what they think they should do with this new information. Any suggestions and ideas should be encouraged and welcomed. The students should then choose what they would like to do with this new information.
8. Discuss these different shelters. Why do different individuals require different types of shelter? Are the reasons that individuals need shelter in Africa the same as the reasons that individuals

need shelter in the United States? What are other factors that may influence shelter structures and use?

Assess

9. Review the information that was collected and discuss if the group's predictions on shelter similarities and differences were a match to the ones that were actually observed.
10. If the students are working in small groups, observe their work and review what they are writing on the Research Plan. If working as a whole group, fill in the Research Plan together.

Name:_______________________________

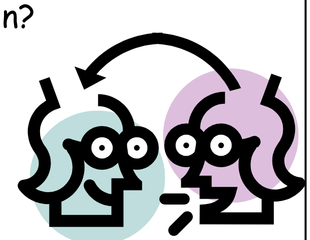
Research Plan – Living Things Need Shelter

1. What is my research question? Is it a good question?

In what ways are African shelters the same or different than shelters found in the United States?

2. How can I get my information?

3. What will I do with this information?



4. How will I know I did my job well?

Living Things Need Space

Engage

This activity is designed to start your students in recognizing themselves as scientists and thinking critically about problem-solving. The goal is to teach concepts through discovery and to encourage using a scientific thought processes. As with all lessons provided, please feel free to adapt them according to your students' abilities. Some of your students may be early readers, in which case you may find it more successful to lead activities and discussions as a whole group rather than using individual Research Plan sheets. Certain scientific vocabulary may or may not be appropriate for your students' level of understanding. Take these ideas, make them your own and your students will have a greater chance at success.

In how many ways is shrinking space alike or different for elephants and for humans?

1. Begin this lesson by telling students that they will be investigating one of the basic needs of all animals.
2. If your students are familiar with brainstorming and recording their ideas, break them into small groups. If your students need more guidance, work with them as a large group. Engage your students in a discussion of what they predict the answer to this question to be. More importantly, <u>why</u> do they think this?

Explore

3. Continue with the above discussion and encourage the group to come up with ways that they could investigate the question and test their predictions scientifically (all suggestions are welcomed). What tools might they need to carry out their suggested explorations? Are there materials that would help them find the answer? Should they be making observations? What kinds of records will they need to keep? What will they do with the information once they have it? And how will they know that they've successfully answered the question? Allow a wide variety of ideas and encourage conversation amongst the students to refine the details of their ideas.
4. Ideas should be recorded on the Research Plan sheets. Small groups can record their own answers or you can record ideas as a group.

Explain

5. Explain to the students that you have an activity that will help them imagine what it would be like to have to live in less space than they are used to.
6. Have the students measure your classroom. How they measure the space is up to you and your students abilities.
7. Now explain to the students that their space, or classroom habitat, is being cut in half. Calculate with your students what half the size of the classroom is and decide which half of the space is best to now live in. Have all the students move within the boundaries of this new space for the remainder of the activity.
8. Ask the students what it feels like to now be in their new habitat. Have them think about and create a list of all the things that happen in the classroom on a given day and how they will accomplish those things now that their space is smaller. Are things easier to do or harder to do? Are there some things that can no longer be done?

Expand

9. Ask students to reflect on the results of this activity and review their ideas of how to get the information as they begin to think about elephants. How do elephants go about their daily activities if their habitat is cut in half? Allow the students time to discuss and plan for the next steps of this research plan. Do they still need to gather additional information before they can answer this question? Did they think of additional ways to gather information based on the activity they've just done?

Assess

10. If students are working in small groups, monitor their work as they continue their research and developing their method for communicating their results. If you are working with the class as a whole, facilitate their work and discussion of how habitat loss is affecting elephants.
11. To conclude this lesson, did the students answer to this research question match their prediction? What happens if the basic needs of living things aren't met? How does this relate to habitat loss, or shrinking space.

Name:______________________________

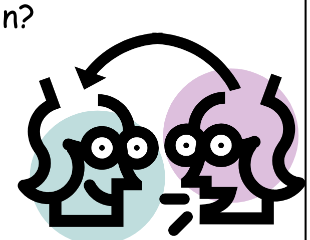
Research Plan – Living Things Need Space

1. What is my research question? Is it a good question?

In how many ways is shrinking space alike or different for elephants and for humans?

2. How can I get my information?

3. What will I do with this information?



4. How will I know I did my job well?

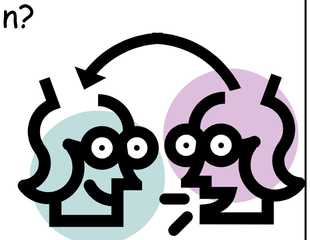
Name:________________________________

My Research Plan

1. What is my research question? Is it a good question?

2. How can I get my information?

3. What will I do with this information?



4. How will I know I did my job well?

Connections to Africa

Teacher and Chaperone Guide

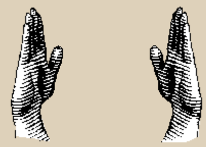
Getting Started…

- Use the tools inside this kit to explore and navigate the Giraffe exhibit and experience *Connections to Africa*.
- The notes and examples provided within this guide are for the use of the teachers and chaperones. Please allow the students to develop their own ideas and hypotheses.
- You can visit the stations in any order that your group chooses.

HAVE FUN!

Survival Need: **SPACE**

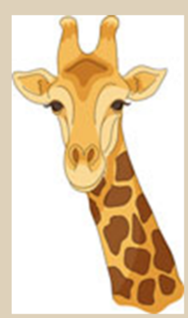
- Look at the amount of space that the giraffe have in this part of the exhibit.
- How **BIG** do you think this space is? How might you measure it?



- Try to estimate the size of this space using a measurement method of your choice.
  - Your group can be as creative as you like. Think of all the different measuring tools that you could use. Are there any other things that you could use to measure?

Animal Behavior

- Do you think that giraffe do the same behaviors when they are inside the building as they do when outside in the yard?
- What do **you** think?
  - Make a guess (This is called making a **hypothesis**). There are no wrong guesses.
- **Now help to find out the answer…**



Animal Behavior (continued)…

- Find the giraffe in the exhibit and go stand where you can easily observe them.
- Choose **ONE** giraffe to watch.
- For 3 minutes, watch that ONE giraffe and record the behaviors that you see it doing.
    - (eating, walking, drinking, head-bobbing, etc.).
- Use the information sheet on the clipboard found in the Inquiry Backpack to record the observations you see.

Reporting Your Data

- An important part of being a scientist at the Zoo is to be sure to add ***your*** findings to the findings of other scientists.

- Find the docent holding a computer. Report to them and enter into the computer the observations your group collected.
    - This is our Master Database, a place that we store ALL of the *Connections to Africa* data collected by scientists, just like you.

Get-Close Encounter

- Giraffe are not the only animals found throughout Africa. They share their habitat with many different types of animals.
- Find the docent holding an African animal.
- Go over to meet this docent and their animal. If you listen carefully and follow instructions, you might even be able to touch this animal!


Return Your Backpack…

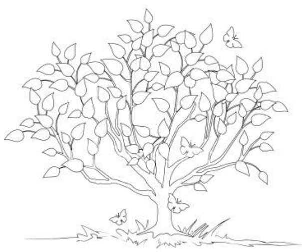
- Now that you have completed your exploration of the Giraffe exhibit, hopefully you and your class feel a *Connection to Africa*.

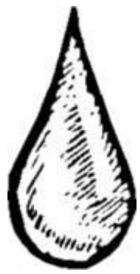
- Please remember to **return the entire backpack and all of its contents** to one of the docents.

Connections to Africa Student Survey

Student name: ______________________________

1. Which of these is a non-living thing that elephants need to live?





Trees   Water   Rocks   Grass

2. What types of animals would be found in this environment?

Rain forest animals   Pond animals

Grassland animals   Forest animals

3. To cut down on the use of resources is to:

recycle

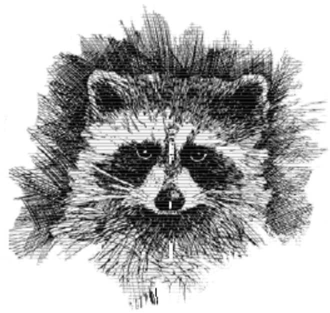
reinvent

retrace

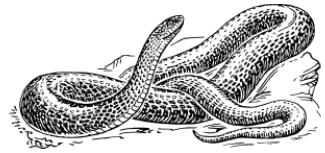
reduce

4. An elephant is an herbivore that lives in Africa. An herbivore that lives in Ohio is a:

Black bear



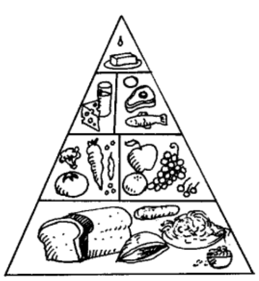
Raccoon



Rat snake

White-tailed deer

5. Which of these is not a basic need of animals?



Food to eat

Shelter from weather

A place to swim

Water to drink

1. I can be a scientist.

No! Probably not Maybe I can Yes!

2. I like to study animals.

No! Not really A little bit Yes!

3. I can help save wildlife.

No! Probably not Maybe I can Yes!

4. People and animals can share habitat.

No! | Probably not | Maybe | Yes!

5. Science is easy.

No! | Not really | A little bit | Yes!

TABLE 2: Student Pre/Post-Test Comparison Data

	Test Group [Teacher professional development included in intervention]	Control Group [Teacher professional development not included in intervention]
Total Number of Students	136	177
Pre-Test		
Correct Responses to Knowledge Questions	Mean 2.3780 Standard deviation 1.2441	Mean 2.2825 Standard deviation 1.1577
Scored Responses to Attitude Questions	Mean 3.0647 Standard deviation 0.4825	Mean 3.1853 Standard deviation 0.6263
Post-Test		
Correct Responses to Knowledge Questions	Mean 3.0735 Standard deviation 1.2210 **p=0.0001**	Mean 2.6610 Standard deviation 1.2470 **p=0.0033**
Scored Responses to Attitude Questions	Mean 3.0739 Standard deviation 0.6057 p=0.8899	Mean 3.2137 Standard deviation 0.6222 p=0.6689

Conservation knowledge questions were scored as follows: 0 = none correct, 5 = all correct
Conservation attitude questions were scored as follows: 1= no, 2 = probably not, 3 = maybe, 4 = yes

TABLE 3: Mean Number Correct Responses to Conservation Knowledge Questions – Pre-Test and *Post-Test*

	Male	Female
African-American	Mean 2.1683 Standard deviation 1.2655 Number 101 *Mean 2.8317* *Standard deviation 1.2967*	Mean 2.3191 Standard deviation 1.0596 Number 94 p=0.4641
Caucasian	Mean 2.9024 Standard deviation 1.2001 Number 41 **p= 0.0018** *Mean 2.5610* *Standard deviation 1.2257* *p=0.2542*	Mean 2.7381 Standard deviation 1.1489 Number 42 **p=0.0129** *Mean 2.7619* *Standard deviation 1.0314* *p=0.7569*
Other	Mean 2.3077 Standard deviation 1.2506 Number 13 p=0.7089	Mean 2.5000 Standard deviation 1.3002 Number 22 p=0.2698

Conservation knowledge questions were scored as follows: 1 = none correct, 5 = all correct

TABLE 4: Mean Response to Conservation Attitude Questions – Pre-Test

	Male	Female
African-American	Mean 3.2054 Standard deviation 0.5309 Number 101 p=0.4507	Mean 3.1652 Standard deviation 0.5493 Number 94 p=0.7283
Caucasian	Mean 2.9951 Standard deviation 0.4549 Number 41 p=0.2595	Mean 3.1286 Standard deviation 0.6038 Number 42
Other	Mean 3.1692 Standard deviation 0.8199 Number 13 p=0.8468	Mean 3.2545 Standard deviation 0.5595 Number 22 p=0.4199

Conservation attitude questions were scored as follows: 1= no, 2 = probably not, 3 = maybe, 4 = yes

TABLE 5: Student Pre/Post-Test Comparison Data Based on Teacher Response to Inquiry

	Test Group [Teacher professional development included in intervention]	Control Group [Teacher professional development not included in intervention]
Students of Positive Teachers		
Pre-Test Correct Responses to Knowledge Questions	Mean 2.9692 Standard deviation 1.2496 Number 65	Mean 1.8659 Standard deviation 1.0973 Number 82
Post-Test Correct Responses to Knowledge Questions	Mean 3.6000 Standard deviation 0.9152 **p=0.0013**	Mean 2.3049 Standard deviation 1.1726 **p=0.0143**
Students of Other Teachers		
Pre-Test Correct Responses to Knowledge Questions	Mean 2.2394 Standard deviation 1.1397 Number 71	Mean 2.9684 Standard deviation 1.2330 Number 95
Post-Test Correct Responses to Knowledge Questions	Mean 2.5915 Standard deviation 1.2714 p=0.0845	Mean 2.9684 Standard deviation 1.2330 p=0.0549

Conservation knowledge questions were scored as follows: 0 = none correct, 5 = all correct