

IMLS-KU Natural History Museum Project Summative Assessment Report

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I. Objective and Approach of the Assessment

This assessment serves as the summative assessment of the IMLS-funded project at KU Biodiversity Institute and Natural History Museum: *Natural History Mystery: Immersing families in a problem-solving game using museum collections*. The assessment employs a mixed methods approach, in which both quantitative and qualitative data are collected. More specifically, quantitative data are generated from surveys that are administered to participants at the beginning and end of the game and analyzed by using descriptive statistics (i.e., mean, standard deviation, and histogram) and paired sample t-test. Qualitative data are generated from the evaluator's observations of participants' interactions when playing the game and the interviews of participants at the end of the game. The data are analyzed by using themes.

II. Recruitment and Participants

Participants were recruited in two ways. First, 5 middle school students, including 3 boys and 2 girls, were recruited from KU TRIO programs that serve economically disadvantaged minority students in Kansas. Four of them are 12 years old and one is 11 years old. Second, 4 families (see Table 1 for family composition) were recruited by KU Biodiversity Institute and Natural History Museum on its social media page. Each student and family received a museum membership as compensation for their time.

To summarize, a total of 18 participants took part in the summative assessment of the game, including 6 adults and 12 children. Children range from 7 to 12 years old, with an average age being 9.83. There was an equal number of girls and boys (n =6).

Table 1.

Participating Family Composition

Group	Family Size	# Of Adults	Who are Adults	# Of Children	Who are Children
1	4	2	mom, dad	2	2 girls (9 & 10 years old)
2	4	2	mom, grandma	2	1 girl and 1 boy (7 & 10 years old)
3	3	1	dad	2	1 girl and 1 boy (9 & 7 years old)
4	2	1	mom	1	1 boy (7 years old)

III. Results

1. Quantitative Results from Surveys

A pre-game and a post-game surveys (see Appendix 1 & 2) were administered to participants before the start of the game and right at the conclusion of the game, respectively. All items are statements based on a 5-point scale indicating participants' degree of agreement with the statements (1- *Strongly Disagree*; 5-*Strongly Agree*). To make the scale easier to select, each point in the scale is replaced with a smiley/sad face. The evaluator read the items to the youth and recorded their responses when needed.

The first two items in the pre- and post-game surveys are the same, aiming to compare participants' perceptions before and after the game. Table 2 shows every participant's response and the mean and standard deviation of all responses. Two paired sample t-tests were conducted to compare the two same items that are included in the pre- and post-game surveys. Both tests showed statistically significant results. Overall, participants believed they know more about evolution after playing the game ($t(17)=3.01, p = 0.008$), with a moderate magnitude of the difference (Cohen's $d = 0.71$). They are also likely to agree that evolution can help solve or prevent medical problems after playing the game ($t(17)=3.34, p = 0.004$), with a large magnitude of the difference (Cohen's $d = 0.79$). These results suggest that playing the game increases participants' knowledge about evolution and its relationship with medical problems.

For the four items in the post-game survey (Item 3-Item 6) that ask about participants' experience of playing the game, most participants provided very positive responses (see Table 2). The average scores of the four items are all above 4 (out of 5, see Figures 1-4). The average score of Item 4 ("I have fun playing this game") is 4.94, with only one participant selecting 4 and all others selecting 5 (see Figure 2). The average score of Item 6 ("This game helped me look at the museum exhibits in a new way") is 4.78, with 4 participants selecting 4 and all others selecting 5 (see Figure 4). These results suggest that, overall, participants enjoyed playing the game and learned more about museum exhibits and science when playing the game.

Table 2.

Participants' Responses to Survey Items

Surveys ID	Pre		Post					
	Item1	Item2	Item1	Item2	Item3	Item4	Item5	Item6
1	3	3	3	3	5	5	4	5
2	4	5	4	4	3	5	5	4
3	4	3	5	4	5	5	5	5
4	4	3	4	4	5	5	5	5
5	2	3	3	4	4	4	3	4
6	1	1	1	1	3	5	5	4
7	1	4	4	4	4	5	4	5
8	2	4	2	4	3	5	4	5
9	4	4	4	4	3	5	5	5
10	4	3	4	4	4	5	5	5
11	3	4	4	5	5	5	5	5
12	2	3	3	4	5	5	5	5
13	1	3	3	4	3	5	1	5
14	5	5	5	5	5	5	5	5
15	3	3	5	5	5	5	5	5
16	3	3	5	5	5	5	5	5
17	5	4	4	4	5	5	5	5
18	2	4	3	5	2	5	2	4
Mean (SD)	2.94 (1.30)	3.44 (0.92)	3.67 (1.08)	4.06 (0.94)	4.11 (1.02)	4.94 (0.24)	4.33 (1.19)	4.78 (0.43)

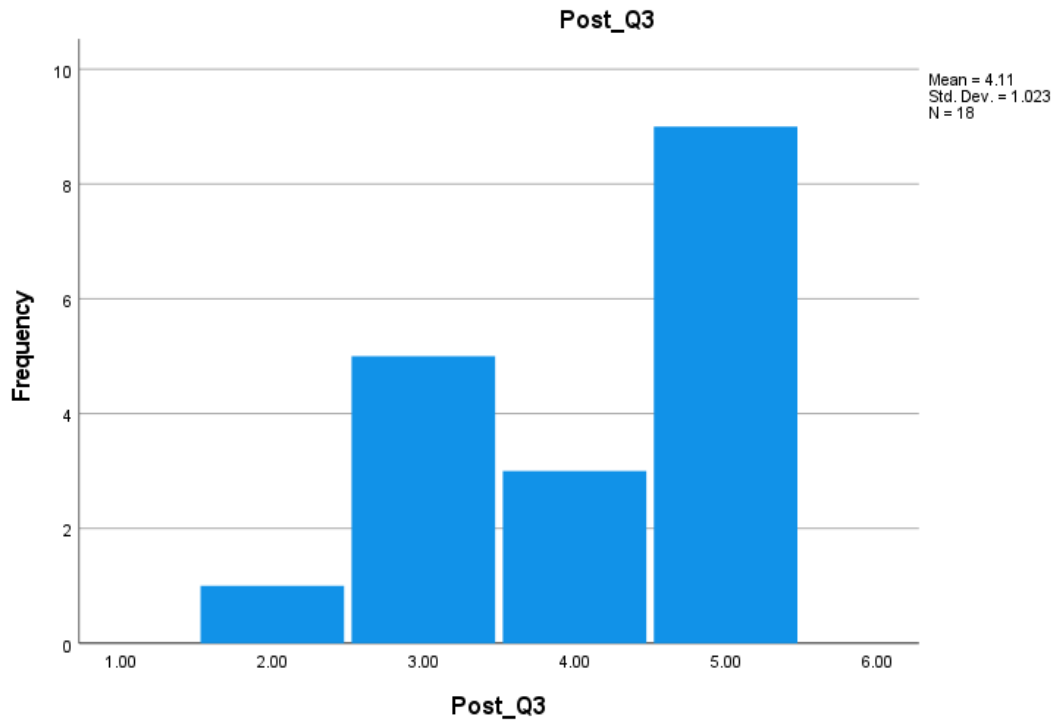


Figure 1. Frequency Distribution of Post-Survey Item 3

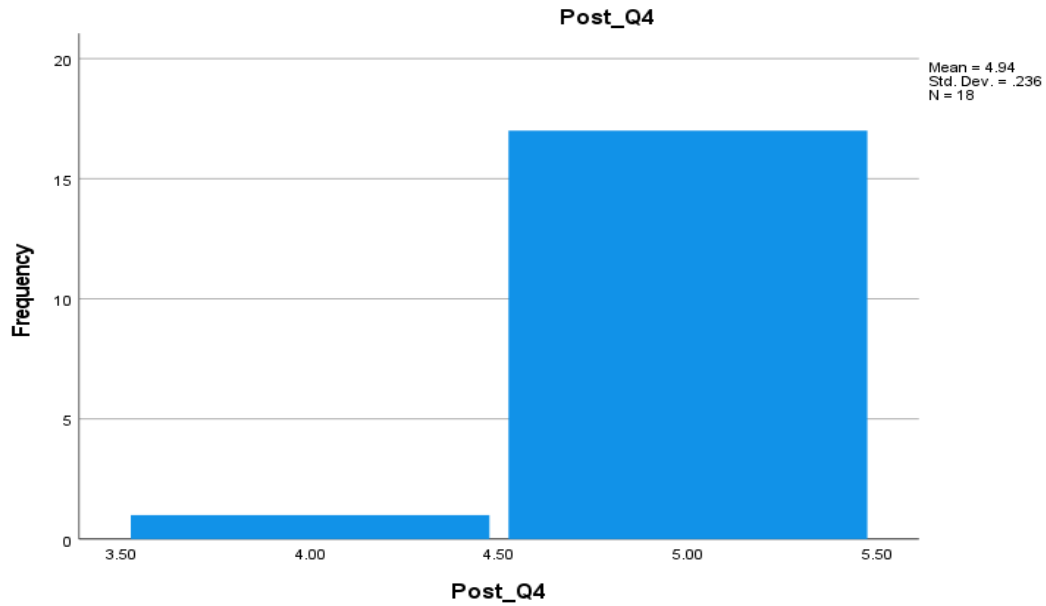


Figure 2. Frequency Distribution of Post-Survey Item 4

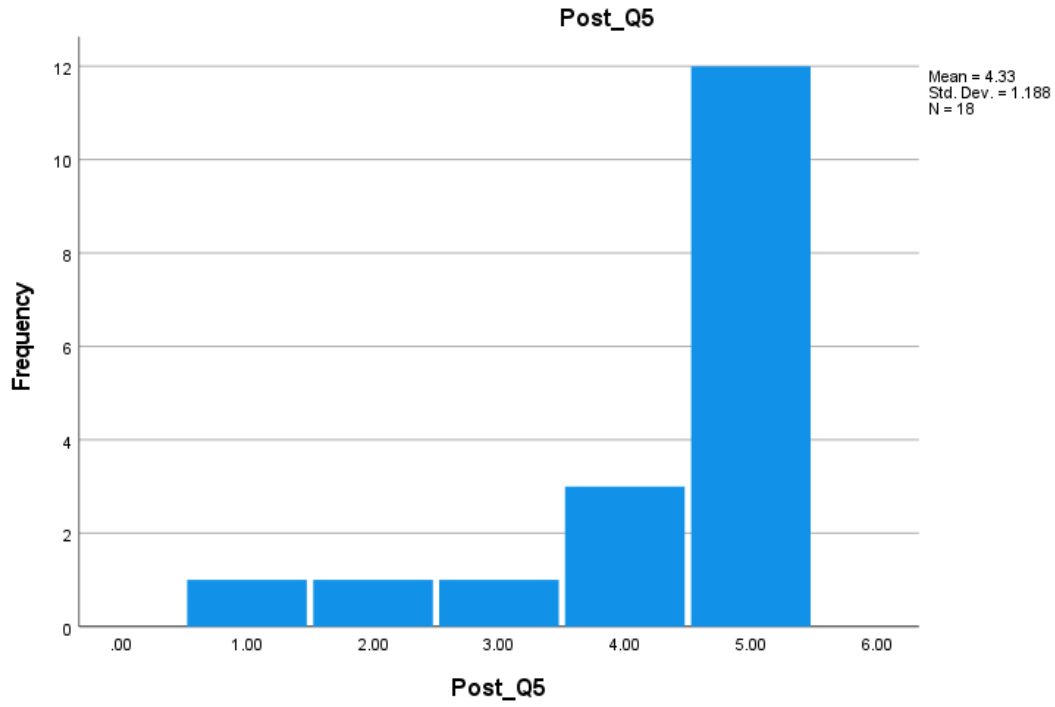


Figure 3. Frequency Distribution of Post-Survey Item 5

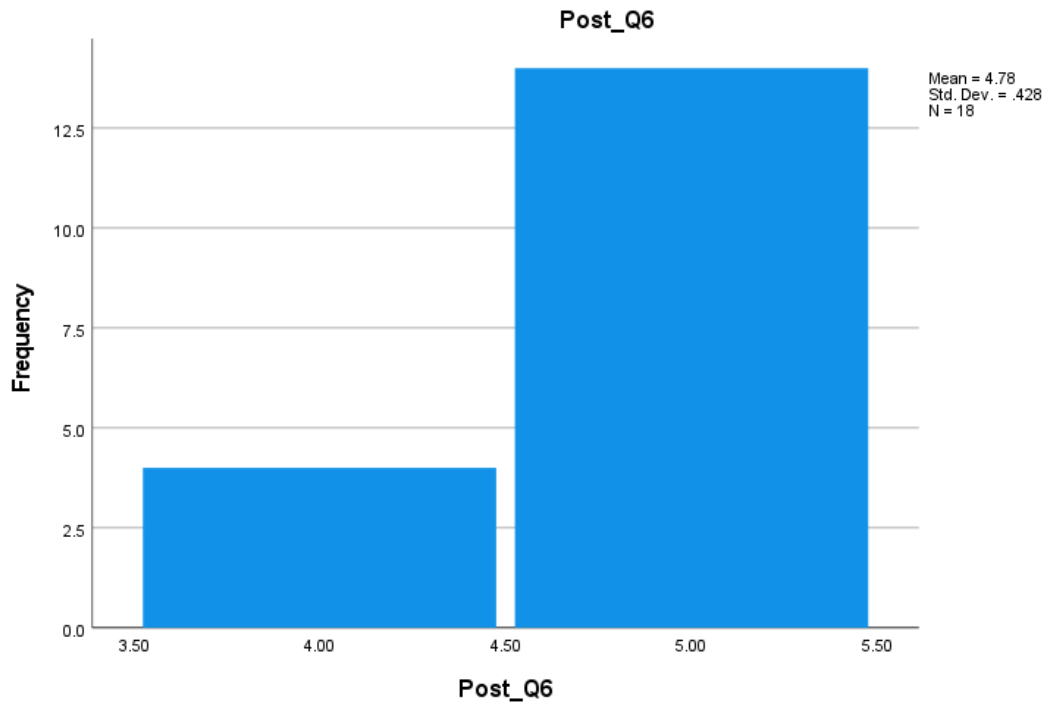


Figure 4. Frequency Distribution of Post-Survey Item 6

2. Qualitative Results

2.1 Qualitative Results from Observations

Observations of participants' interactions were made when they were playing the game based on the observation guide (see Appendix 3). Observation notes of each group can be found in Appendix 5.

The Length of Completing the Game

The time length that the five groups played the game ranges from 42 minutes to 90 minutes, with an average of 62.6 minutes. The group used 90 minutes because they not only played the game but also looked at the exhibits and walked around the museum. Other groups looked at the exhibits, but they only did so when they were traveling from one location to another location of the puzzles.

The Process and Strategies of Solving the Puzzles

All groups successfully solved the puzzles. A few groups needed a little support from the associate director due to a few issues they encountered, such as they did not know where to get started, forgot to take out the props, forgot to check the matrix chart, and put wrong codes in the matrix chart. But no groups used the clues prepared for them in the backpack. The main strategies that the groups used to solve the puzzles included connecting prop and specimen, talking about different traits and variations, referring to the traits of humans and other animals, and tracing along the branches in the evolution tree. These just show that the game is not too difficult to complete, but it is also challenging enough for the group to engage and participate in.

The Engagement Level of Adults and Youth

All the adults were highly engaged, and adults in some groups mainly led the game by asking questions to children and asking them to look for answers. They also explained things

they saw in the exhibits, shared their knowledge about the animals and evolution, and worked together with the youth to solve the puzzles. Most youths in the groups were highly engaged in the game. Some of them took the lead in solving the puzzles, asked questions, and showed independent, critical, and logical thinking. There were times the youth were struggling with one part of the puzzle, but with a little scaffolding and assistance from the adults, they were able to successfully solve the puzzles and complete the game. By the end of the game, most of them can make a connection between the animals and the evolution tree and can correctly place the trait card at the right place on the evolution tree and provide correct explanations. Although some of them did not mention such words as “evolution” or “science” in their interactions, they did talk about what happened in the past and in the present and made a connection between animals appearing in the game and human beings.

2.2 Qualitative Results from Interviews

All groups mentioned that the game was fun, which was consistent with what the participants indicated in the surveys about the game. Most of them enjoyed most in solving the puzzles, walking around the museum, and looking at the animals in the exhibits. They learned from the game about animals, especially those they did not know before, such as tapir, sabertooth, and fish; some interesting traits, such as one-two-many bone arm, animals’ jawbones and toe patterns. Although the interview question about the museum exhibit was a bit harder for youth to answer, most of them mentioned that they will use what they learned from this museum and exhibits to explore other museums in the future. All the youth placed the new trait card, if given to them, at the right place in the evolution tree and were able to explain the reason correctly. This shows that they did gain a good understanding of the evolution tree and the

evolution time from playing the game, although some of them, in the survey, did not agree that they knew evolution more after playing the game.

IV. Conclusions

Both quantitative and qualitative data showed that the tested game is a fun, family-friendly, and youth-friendly game that all age groups can enjoy playing. It provides a great opportunity for adults and youth to learn more about evolution, the relationship between evolution and medical problems, museum exhibits, and science through hands-on, tangible activities in a fun way at museums. This game, including its theme, format, and contents, can be easily applied to games on other themes at other museums.

Appendices

Appendix 1

Natural History Mystery – Pre-Game Survey Group # (completed by evaluator): ____

Age: _____

Circle a response to say how much you agree with each:

1. I know a lot about evolution.



YES!



Yes



Not sure



No



NO!

2. Evolution can help solve or prevent medical problems.



YES!



Yes



Not sure



No



NO!

Appendix 2

Natural History Mystery – Post-Game Survey Group # (completed by evaluator): ____

Age: _____

Circle a response to say how much you agree with each:

1. I know a lot about evolution.



YES!



Yes



Not sure



No



NO!

2. Evolution can help solve or prevent medical problems.



YES!



Yes



Not sure



No



NO!

3. This game made me more interested in learning about how evolution can help solve medical problems.



YES!



Yes



Not sure



No



NO!

4. I had fun playing this game.



YES!



Yes



Not sure



No



NO!

5. I learned about science while playing this game.



YES!



Yes



Not sure



No



NO!

6. This game helped me look at the museum exhibits in a new way.



YES!



Yes



Not sure



No



NO!

Appendix 3

Natural History Mystery – OBSERVATIONS

Group #: ____

STAR/TOES PUZZLE

Puzzle completed: correctly needed help/took answer

Concepts mentioned:

- Relationship/related
- Different traits/variation

Interactions with props that facilitate meaning making

- Connecting prop and specimen

Adult/youth-led: adult-led mostly adult-led equal mostly youth-led youth-led

Engagement: low medium high

Points of confusion:

CRESCENT/JAW PUZZLE

Puzzle completed: correctly needed help/took answer

Concepts mentioned:

- Relationship/related
- Different traits/variation

Interactions with props that facilitate meaning making

- Touching traits (e.g., on x-ray or self)
- Connecting prop and specimen

Adult/youth-led: adult-led mostly adult-led equal mostly youth-led youth-led

Engagement: low medium high

Points of confusion:

EGG/TREE & PUZZLES

Puzzle completed: correctly needed help/took answer

Concepts mentioned:

- Tree/branch/phylogeny
- Lineage
- Relationship/related
- Evolved/evolution
- Time/Old/ancient/past/Now/today/modern/living
- Ancestor/descendant/came from/turned into/became
- Changes traits/things
- Different traits/variation

Interactions with props that facilitate meaning making

- Trace along branches

Adult/youth-led: adult-led mostly adult-led equal mostly youth-led youth-led

Engagement: low medium high

Points of confusion:

CROSS/ARM BONE PUZZLE

Puzzle completed: correctly needed help/took answer

Concepts mentioned:

- Relationship/related
- Evolved/evolution
- Time/Old/ancient/past/Now/today/modern/living
- Changes traits/things
- Different traits/variation

Interactions with props that facilitate meaning making

- Touching traits
- Connecting prop and specimen

Adult/youth-led: adult-led mostly adult-led equal mostly youth-led youth-led

Engagement: low medium high

Points of confusion:

FINAL TREE PUZZLE

Puzzle completed: correctly needed help/took answer

Concepts mentioned:

- Tree/branch/phylogeny
- Lineage
- Relationship/related
- Evolved/evolution
- Time/Old/ancient/past/Now/today/modern/living
- Ancestor/descendant/came from/turned into/became
- Changes traits/things
- Different traits/variation

Interactions with props that facilitate meaning making

- Trace along branches

Adult/youth-led: adult-led mostly adult-led equal mostly youth-led youth-led

Engagement: low medium high

Points of confusion:

Appendix 4

Natural History Mystery – INTERVIEW QUESTIONS & TASK

Group #: ____

PART I - INTERVIEW QUESTIONS

What did you enjoy most about playing the game?

What did you learn from this game?

How did this game change how you explored the museum or looked at exhibits?

PART II - TASK: Trait card. This is a card for a trait that you didn't look at in the game – bony skeleton. Place it on the branch where you think this trait evolved (hand them the 'bony skeleton' trait card; correct placement is on the root).

How did you figure that out?

Appendix 5

Observation Notes of All Groups

➤ **Group 1** (length: 54 minutes)

The group got the backpack, map, and the matrix chart and read the prompt. One girl was taking the map, the other girl was taking the matrix chart, and a boy was having the backpack. The group was led by their TRIO advisor who was guiding them all the way but did not complete pre- or post-game surveys or participate in interviews.

○ **Solving the 1st puzzle**

In the beginning, there was some confusion about what are needed to figure out the puzzle, the order of the matrix chart, and which lock to look for. With the guidance of the advisor, they got all the pictures in the backpack and started to look for them in the exhibits. They easily found puffer fish and frog, but it took them a while to find lizard on the other side of the exhibit and went back to find bear. They successfully solved the puzzle. During their conversation, they mentioned different traits of the animals. The process was mainly led by youth, especially the two girls. Three boys were not playing a leading role but still helping girls to find the animals and traits. Though the advisor did not lead the process, her prompting played a key role in solving the puzzle.

○ **Solving the 2nd puzzle**

The youth group was a bit confused about where to go and what the task was. The advisor asked a few questions to help them find the location, look at x-rays, and look for more clues in the backpack. It was easy for them to find out the animals from 3 x-ray pictures, but the group had difficulties finding the other two animals. They knew the answer was related to “fold map” as stated in the instructions, but when they folded map, they did not fold it in the correct way and had to ask for help from Teresa. They tried different combinations of codes randomly but did not get the correct combination and had to get a clue from Teresa to get the pocket unlocked. The whole process was mainly led by two girls in the group. Two of the three boys were helping to look for x-rays, finding animals, and folding the map. One boy was walking around and looking at other exhibits. The teacher tried to engage the boys more in the game and provided a few clues in her best capacity. In their interaction, the group used touching traits or referring to x-rays when finding the animals and discussed the similarities between x-ray and animals and the different traits that animals have.

○ **Solving the 3rd puzzle**

The group found the instructions and put together the evolution puzzle, but then only referred to the animals on the matrix chart that they needed to complete, such as the water bear, and just wandered around the floor to find the water bear in the exhibit. They were confused about questions on another piece of paper about eggs and did not know what to do until Teresa reminded them of using the evolution puzzle to get the answers. They were a bit struggling to find answers about eggs by using the evolution puzzle but eventually figured out how to trace along evolution branches to find the correct answers about the eggs and got the correct codes. The process was mostly led by youth, particularly two girls. Two of the three boys were occasionally engaged in tracing the evolution branches but not actively engaged. The third boy was still not engaged despite the advisor’s reminder.

○ **Solving the 4th puzzle**

The group found all samples and tools for this puzzle and used the flashlight to find the names of the animals on the map. When they went to the floor to find animals, they passed the right locations and wandered around the floor. They found sabertooth fish but did not realize it was the fish they were looking for, passed it, and got back to it later after Teresa's reminder. They were still struggling with the order of the matrix chart that they were required to complete and how each cell in the chart matches each animal. They also messed up the codes, and wrote 1 in a cell that was supposed to be 0. The advisor provided a few reminders and tried to engage boys more, but mainly led by girls, the group found the correct code. Again, boys were not fully engaged and one boy was not engaged.

- **Solving the final puzzle**

The group was still struggling with what to do with this final task. They later figured out that codes were needed to unlock the big chart. When they were working on how to place cards on the chart, they realized that they needed to refer to the chart that they completed. But they did not know what to do next until Teresa reminded them of referring to the evolution chart/tree. They paid attention to the evolution chart/tree but did not find the connection between the chart/tree and the cards. They tried to put the cards based on the order of the chart they completed, in alphabetical order, and a random order but were not certain. Teresa gave them a hint about the toe, and then they started to make some connections between the cards, traits, and evolution chart/tree. But they still did not figure out the order. Teresa stepped in and sorted out the card order and asked a few questions about what they found earlier and how it is related to what they are doing now. After a few more tries, they placed the cards in the right order and found all the letters used to unlock the box. The process was mainly led by two girls. Only one boy was helping, one was looking, and the other was not engaged.

- **Group 2** (length: 90 minutes)

The group got the backpack, map, and matrix chart and read the prompt, and got excited. One girl was taking the map, the other girl was taking the matrix chart, and the dad was having the backpack. This family was not in a hurry to complete the game (dad did want but followed others). Instead, they walked around the museum, read the exhibits, discussed the exhibits and animals, explored the museum, and took completing the game as a part of the museum visit. While playing the games, the parents asked questions to kids and let kids look for answers. Most of the game was led by parents, and parents made sure kids were engaged.

- **Solving the 1st puzzle**

At first, the group was struggling to get started. Teresa reminded them of checking the backpack, instructions, and using things in the backpack. They checked pictures one by one, found puffer fish, frog, and bear, then went to the other side of the exhibit to find the lizard. But they also discussed other exhibits, like the big feet, and read the introductions placed beside the exhibits. They had all the correct codes. The process was mainly led by adults, who asked questions and asked girls to look for answers. The two girls were highly engaged. When they were working on this puzzle, mom mentioned evolution, and the girls talked about different categories of animals. They connected prop and specimen.

- **Solving the 2nd puzzle**

The group went to the location and explored the exhibits on the floor. Girls asked questions about animals and habitats. They looked at x-rays and found one animal at first. Girls were confused about how many bones were in the jaw, dad explained how skeletons are different for humans and animals, what to look for in the animal's skeleton to figure out the bones,

compared skeletons of animals on x-rays, and how these animals are related, how they had different traits. Then girls found other two animals easily from the exhibits. One girl found the fish and frog on the map. The process was mainly led by adults, but girls were highly engaged looking for answers.

- **Solving the 3rd puzzle**

They did not go to the location for this puzzle. Girls put together the evolution tree puzzle pieces together on the floor where they solved the 2nd puzzle. They traced the evolution tree and found answers about eggs easily. This process was mainly led by girls, who mentioned lineage, and different traits/variations in their interactions.

- **Solving the 4th puzzle**

The group went to the floor and read and discussed exhibits. Girls looked at the matrix chart and had questions about the number of arm bones of fish and how to count arm bones of Rhino. Dad reminded the girls of reading instructions first. Mom asked the girls to look for clues. Girls used the flashlight to find the locations of the other two animals and found them easily. The process was mainly led by adults, and the 9-year-old girl was more engaged than the 10-year-old girl.

- **Solving the final puzzle**

The group figured out that they needed codes in the matrix chart to unlock the evolution tree. The girls immediately knew the key to correctly placing the cards is to trace along the evolution tree. They also made a connection between the cards and the traits they examined in the matrix chart. The girls, especially the 9-year-old girl, mainly led the process and successfully found the letters to open the box. They talked about different traits/variations, change traits along the evolution tree, and the relationships during their interactions.

➤ **Group 3** (length: 70 minutes)

The group got the backpack, map, and matrix chart and read the prompt, and talked about how fun this would be. The girl was taking the map, the mom was taking the matrix chart, and the boy was having the backpack. Mom was also having a baby. Although grandma was part of the group, she was mainly helping mom with the baby. Mom needed to take care of the baby while walking through the game with the kids. The baby became a distraction at times, but the mom did a good job guiding the kids overall. The game was mainly led by the mom, though she asked kids to look for answers.

- **Solving the 1st puzzle**

The group followed the instructions, went to the location, got out the pictures, and started to look for animals. Mom asked questions and guided the kids, but the kids found the puffer fish, frog, and then bear quickly in the exhibits. They figured out that the lizard might be on the other side of the exhibit. While they were looking for animals, they also looked at other exhibits (e.g., big foot) and discussed animals. The process was mainly led by the mom, but the kids were highly engaged. They made a connection between prop and specimen, talked about different traits, discussed things like toes of fish, and compared the animal they were looking for and the same types of animals (e.g., lizard).

- **Solving the 2nd puzzle**

They went to the location, with the mom and two kids each holding an x-ray picture and looking for animals. Mom let kids pay attention to the different habitats of the animal. Kids found the animals, the boy knows the number of jaw bones for the animal but the girl was unsure of the jaw of the bear. Mom discussed the components of x-rays of different bones and referred to human jaws and compared them to the animals'. Kids found frog and fish on

the map and figured out the jawbone. The process was mainly led by the mom, but the kids were highly engaged.

- **Solving the 3rd puzzle**

They went to the location, put together the puzzle, and the kids got excited about the evolution tree. Mom seemed to know evolution and told kids it was an evolution tree and they needed to trace the tree to find the animals and eggs. The kids at first did not know the answers about the eggs. Mom asked kids how fish lay eggs, how embryos are protected in mammals, and finding brachiopods and reminded them of the animals they see in their lives, like those in the creek and the exhibits. They figured out the answers together and solved the puzzle. The process was mainly led by the mom. The girl was more engaged than the boy.

- **Solving the 4th puzzle**

They found the Rhino and the kids started to count the bones. But they were confused about the number of bones on the card. Mom showed the arm bone picture provided and showed the kids about their own arms and the structure. Kids used the magnifying glass to look at the arm bone picture and found the right answer for Rhino but felt confused about the next steps. Mom read the instructions, and the kids used the flashlight to find the locations of the other two animals. The process was mainly led by the mom. The girl was more engaged than the boy. The baby became a bit fussy when the group was working on this puzzle, but the mom managed to guide the kids to find answers.

- **Solving the final puzzle**

The group was reminded by Teresa about the final puzzle. They were at first confused about what codes they needed to use to unlock the evolution chart. Teresa gave them the direction. They finally unlocked the evolution chart. When they were placing the cards on the chart, they made a connection between the cards and the matrix chart they completed and matched the cards with the animals on the matrix chart. Mom guided kids to trace branches and traits and talked about evolution and timeline in the evolution chart. This process was totally led by the mom. The girl was engaged a little bit, but the boy was not engaged. At one point, mom asked him to hold the baby, which might keep him from being engaged.

➤ **Group 4** (length: 57 minutes)

The group got the backpack, map, and matrix chart and read the prompt. They were very excited to get it started. Dad mentioned that they had just been talking about genetics and traits yesterday evening. The boy was taking the map, the girl was taking the matrix chart, and the dad was having the backpack. When playing the game, dad let the kids take the lead. He only stepped in when kids asked for help. But he did not offer help even when he saw kids struggling.

- **Solving the 1st puzzle**

They went to the location with the boy's guide. They read the instructions and got the pictures. Kids found puffer fish, bear, and frog easily. Dad referred to their own feet. The kids did not see the lizard, and dad said it might be at the other side of the exhibit. Then kids found the lizard. They also looked around other exhibits and animals and discussed them. The process was mainly led by kids, who were highly engaged.

- **Solving the 2nd puzzle**

They went to the location and followed the x-ray. Kids found the three animals on the x-ray very easily. Dad reminded the kids about going back to the matrix chart and completing it. Dad talked about human teeth. Kids started to complete information about the other two animals on the matrix chart but felt a bit confused. Dad asked them to read the instructions. The boy easily folded the map correctly and found the answers. When they were putting

together the codes, they tried the ones on the matrix chart but did not work. They tried different ways but were not successful. Teresa reminded them of checking the matrix chart. Eventually, they found that the numbers they put on the matrix chart did not match the animals. After they corrected the order, they unlocked the next puzzle. The process was mainly led by kids, and they were highly engaged.

- **Solving the 3rd puzzle**

They went to the floor but did not find the right location at first and directly went to other places (Rhino). They went back and found the location, and the kids saw the evolution tree on the exhibit. Kids referred to the evolution tree in the exhibit, put together the puzzles of the evolution tree, and started to trace the tree to find the animals on the tree. They needed some assurance from dad, and dad just asked them questions to guide them to find answers. Kids got out the eggs from the green box but felt confused about what they were supposed to do with the eggs. Dad let them struggle a while. When kids asked for help, he stepped in and told them to look at the matrix chart to know what information they needed about the egg. Kids finally figured this out and got the correct codes. This process was equally led by the dad and kids, but the kids were highly engaged and thinking a lot.

- **Solving the 4th puzzle**

They went directly to the Rhino exhibit because they passed it earlier. Girls looked at the arm bone and explained the one-two-many pattern. Dad asked the kids to look for other clues. Kids use tools to watch the bone pattern and found the answers easily. Kids used flashlights to find out the locations of the other two animals on the map. They went to those locations while looking at the exhibits and discussed the animals. They found the animal and fish. They discussed the fish and mentioned some key characteristics, such as fin. The process was mainly led by kids, and they were highly engaged.

- **Solving the final puzzle**

At first, kids opened the first pocket. Dad reminded them of the final puzzle that is in the top pocket. Kids realized they needed to refer to the codes they had on the matrix chart and unlocked the evolution chart. They pointed and read shared ancestors on the evolution chart and pointed at traits to place lizard and frog. They made a connection between the evolution tree chart they had in the egg puzzle and the evolution chart they were having. They remembered animals and traits that they looked for in the last puzzles (e.g., which had lower jaw bones). Dad reminded the kid about the same branches they had earlier and asked them to trace the animals on the top of the chart. They placed the cards by using the clues and referring to the matrix chart too. They placed the cards correctly in a short time.

- **Group 5 (42 minutes)**

The group got the backpack, map, and matrix chart and read the prompt. They were very excited about the game and being the scientist to solve an important problem. Mom mentioned their experience with escape room games. The boy is only 7 years old and does not read well. Although mom guided the boy through the game, they worked together more like a team. Mom let the boy take the lead and solve the puzzles independently, and she just asked questions or helped when needed.

- **Solving the 1st puzzle**

They went to the location, checked the matrix chart, and started to look at the exhibits to find the answer. Teresa reminded them of other stuff in the pocket. Then they took out all the props. The boy found puffer fish, frog, and went to the other side of the exhibit and found the lizard. They discussed different traits, what belong to the same category, and connected props

and specimen. The process was mainly led by the mom, the boy worked very closely with her and actively looked for answers. They also looked at the exhibits and discussed other animals.

○ **Solving the 2nd puzzle**

Mom read the instructions, got all the x-ray pictures, and reminded the boy to find out the location. They went to the location, read the x-rays, and found the animals easily. Mom read the words on the exhibits about the habitats and discussed colder or warmer climates but let the boy find where the animals were. After finding the three animals, she read the instructions, and the boy folded the map and figured out the other two animals were on the back of the map. He found them and got the correct answer. When solving the puzzle, they connected props and specimen and mentioned different traits. Mom led the game, and the boy was highly engaged.

○ **Solving the 3rd puzzle**

They first went to the wrong location. Mom let the boy lead. Then they went back and found the evolution tree exhibit. The boy put together the evolution tree. With mom's help with reading the words on the evolution tree, he traced the tree and found the animals easily. He unlocked the egg box, took out each egg, and wrote the number in the matrix chart. Mom also mentioned evolution and different traits. Mom led the game, and the boy was highly engaged.

○ **Solving the 4th puzzle**

They went to the location. Mom asked the kid to use the clues provided. She read the instructions and clues and asked the kid to observe Rhino's arm bone. The boy found the pattern easily. He used the flashlight to find the locations of the other two animals and found them easily. They looked at other exhibits while looking for animals. Mom led the game, and the boy was highly engaged.

○ **Solving the final puzzle**

They were excited about all the locks on the evolution chart. The boy was confused about what codes to use at first. Mom gave the clue about using all the different codes in the matrix chart. They used the evolution chart, and made a connection with the evolution tree they saw earlier and the matrix chart. Mom reminded the boy of using all the knowledge they used to solve earlier puzzles and match the clues. The boy quickly knew how to trace the branches, referred to the matrix chart, and found where to put the card. They mentioned different traits, and evolution when solving this puzzle. The boy and mom worked together very well to solve this puzzle.

Appendix 6

Interview Notes of Each Group

Group 1

What did you enjoy most about playing the game?

unlocking locks (x2), pops; flashlight; look around the museum; different names; it was cool; team work;

What did you learn from this game?

(They said they learned something but did not specify what they learned. With the advisor's prompts and unpacking of the evaluator, they answered the question) science; what types of animals; fish; animals have different characteristics, some have bones; extinct animals

How did this game change how you explored the museum or looked at exhibits?

Now can look more at different aspects of bodies, like bones but paid more attention to the habitat in the past; read more descriptions; pay more attention to labels and signs; know where to find what animals, such as fish, bear.

(The evaluator skipped the trait card activity because she saw the group were struggling with the evolution tree).

Group 2

What did you enjoy most about playing the game?

Go around museum, get to know exhibits; solving puzzles, seeing one puzzle leading to another.

What did you learn from this game?

Things like skeleton that did not know before; (answered yes to evaluator's follow-up questions) learned more about fish bones, 1/2/many arm bone pattern, and connect to the human.

How did this game change how you explored the museum or looked at exhibits?

10-year-old girl said she has no idea about museum exhibits; (after evaluator's follow-up questions) learned more about exhibits, how animals are displayed.

TASK: Trait card. This is a card for a trait that you didn't look at in the game – bony skeleton. Place it on the branch where you think this trait evolved (hand them the 'bony skeleton' trait card; correct placement is on the root). How did you figure that out?

They correctly placed the trait card on the root; explained that all animals on the tree had bones and connected.

Group 3

What did you enjoy most about playing the game?

Solving puzzles, spending time at the museum.

What did you learn from this game?

(They said a lot of things but cannot talk more about specific things. With evaluator's follow-up questions, they mentioned) animals, tapir, sabertooth, other fish; arm bones

How did this game change how you explored the museum or looked at exhibits?

Contents in the exhibits; ow to get information from an exhibit.

TASK: Trait card. This is a card for a trait that you didn't look at in the game – bony skeleton. Place it on the branch where you think this trait evolved (hand them the 'bony skeleton' trait card; correct placement is on the root). How did you figure that out?

They correctly placed the trait card on the root; mom guided them to think through where to place it on.

Other thoughts/comments: Mom said the game was a fun family game, it was hands-on, and good for kids. The backpack is fun and portable. They will try the same or similar games in the future.

Group 4

What did you enjoy most about playing the game?

Very fun game; break codes; to know which is which for the animals.

What did you learn from this game?

Animals' traits; (with evaluator's follow-up questions, they mentioned) numbers of toes different animals have, the 1/2/many arm bone pattern.

How did this game change how you explored the museum or looked at exhibits?

(at first they did not answer much, then with evaluator's follow up questions, they mentioned) they could use things they learned or did this time to visit other museums.

TASK: Trait card. This is a card for a trait that you didn't look at in the game – bony skeleton. Place it on the branch where you think this trait evolved (hand them the 'bony skeleton' trait card; correct placement is on the root). How did you figure that out?

They correctly placed at root and explained they placed it there because all have bones.

Other thoughts/comments: Dad said it was an excellent game for family, high-quality clues: not just a piece of paper, but real objects; hands-on for kids.

Group 5

What did you enjoy most about playing the game?

A lot of fun; walking around the museum; doing puzzles; looking for stuff; using what we found to solve the puzzles.

What did you learn from this game?

(The boy first did not know how to answer. After mom's elaboration, he mentioned) toes, jaw bones, he remembered most of the animals they encountered in the game and only had knew some of them before the game.

How did this game change how you explored the museum or looked at exhibits?

The evaluator thought this might be a harder question for the boy to answer so it was skipped.

TASK: Trait card. This is a card for a trait that you didn't look at in the game – bony skeleton. Place it on the branch where you think this trait evolved (hand them the 'bony skeleton' trait card; correct placement is on the root). How did you figure that out?

They correctly placed at root and explained they placed it there because it has bones.

Other thoughts/comments: Mom said it was a very fun game for kids. They enjoyed it. The game was very hands-on. Kids can do tangible things to get those connected and learn things. The boy wanted to go back to check the evolution tree and understand more about the protected egg.