

Visualization Laboratory – Formative Evaluation Spiral Zoom on a Human Hand

Joyce Ma

August 2008

THIS IS **NOT** A DEFINITIVE FINAL REPORT

FORMATIVE evaluation studies like this one often:

- **are conducted quickly**, which may mean
 - small sample sizes
 - expedited analyses
 - brief reports
- **look at an earlier version** of the exhibit/program, which may mean
 - a focus on problems and solutions, rather than successes
 - a change in form or title of the final exhibit/program

Visualization Laboratory – Formative Evaluation Spiral Zoom on a Human Hand

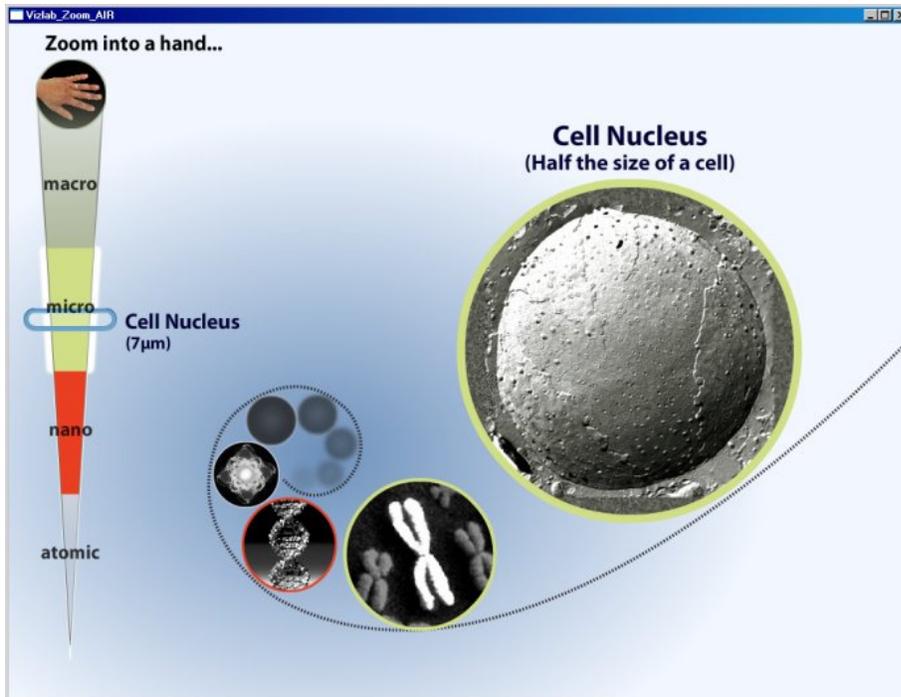
Joyce Ma
August 2008

PURPOSE

This report documents two formative evaluations on an interactive media piece that allows its users to zoom in from a human hand to an atom. This zoom uses a spiral (Figure 1) to connote zooming and is a departure from a more conventional zoom in which each successive image is a magnification of a portion of the preceding image. Eames' "Power of Ten" is an example of this later type of zoom.

The design rationale for the spiral zoom can be found in Diane Burk's Designer's Notebook. These evaluations were conducted to gauge how visitors interpret this new zoom format as applied to zooming into a human hand, and to iteratively improve this particular zoom. This work was done by the Visualization Laboratory as part of the larger NISE Net initiative.

Figure 1. Spiral Zoom for the Human Hand. (Iteration used in evaluation 2)



SUMMARY OF FINDINGS

- A large number of visitors (76% in the first iteration and 84% in the second iteration) thought that the images on the spiral showed how the human hand is made of smaller and smaller parts. The spiral was effective in communicating zooming into a hand.
- With the first iteration, most (88%) of the visitors saw a relationship between the scale bar on the left and the images on the spiral zoom. The percentage declined with the second iteration but still remained high at 74%. Most of the visitors who did not see a relationship between the scale bar and the spiral in the second iteration said that they simply did not pay any attention to the scale bar.
- At the end of the second evaluation, we found that very few people found anything confusing about the zoom. Many (75%) visitors did say that the zoom helped them better understand the size of the objects, but almost half of the visitors did not think they found out anything new.

FORMATIVE EVALUATION 1

Purpose

This first evaluation looked to identify points of confusion with the interactive zoom:

- What, if anything, did visitors find confusing?

It also focused on two aspects of the design that the development team identified as being possible issues for visitors:

The discrete images in the spiral form. A more traditional zoom ‘zooms’ into smaller and smaller parts of an object by magnifying a portion of the larger image. In addition to conveying a journey into the very small, this also visually connotes containment. That is; the smaller is contained in or is a part of the larger. In the spiral zoom, one image is not visually contained another. Instead, it’s the spiral shape that is used to connote this relationship, of drilling down into smaller and smaller parts of one object. This evaluation, therefore, tries to gauge:

- What, if any, relationships did visitors see between the images of the different objects?

The scale bar. To remind visitors of where they are in the larger scale context, this prototype includes a scale bar, placed on the left-hand side that notes where the object is between the macro and the atomic scale.

- Did visitors see a connection between the scale bar and the spiral zoom? What do visitors think is that connection?

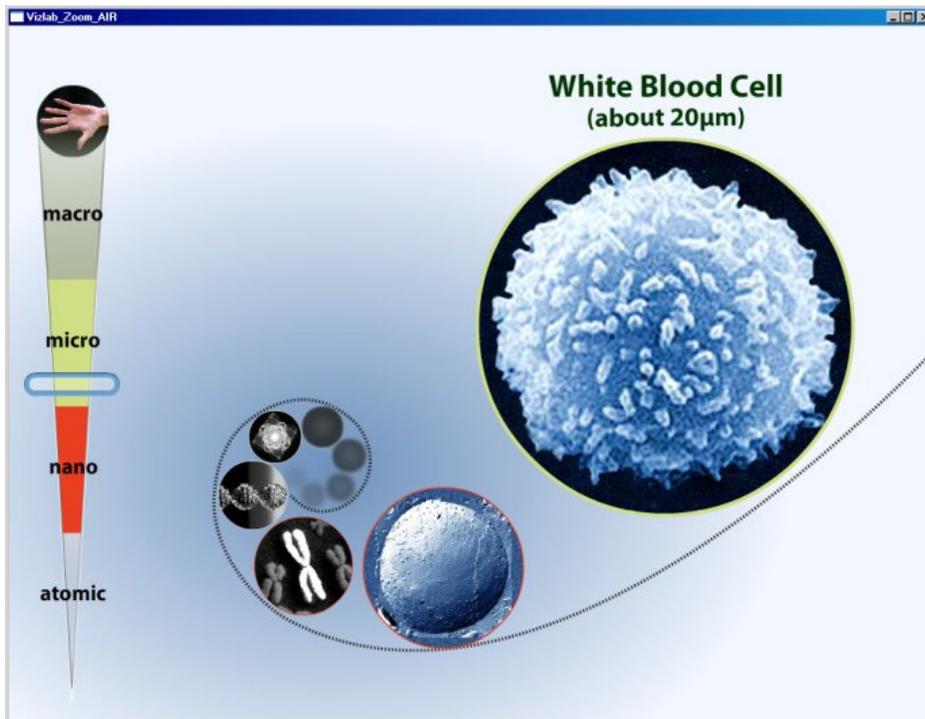
Method and Material

The media piece (Figure 2) was installed on a kiosk that was placed in the Life Sciences area of the Exploratorium. Before every interview, the evaluator would reset the zoom to start with the image of the hand, the largest object in the zoom.

The evaluator then approached every third visitor, who appeared to be 10 years old or older and asked him/her to use the prototype and provide us with feedback afterwards. In the case of a minor, we also asked the accompanying adult for permission to interview the youth. The questions for the interview can be found in Appendix A.

An interview lasted approximately 10 minutes and was done with individual visitors, not with groups.

Figure 2. Spiral Zoom for the Human Hand. (Iteration used in evaluation 1)



Data

We interviewed a total of 25 visitors ($N = 25$) for this evaluation. Data were collected on the following days:

June 24, 2008 Tuesday

June 29, 2008 Sunday

July 1, 2008 Tuesday

The demographic information is summarized below.

Gender	Count (out of 25)
Male	13 (52%)
Female	12 (48%)

Age Group	Count (out of 25)
Child (10-12)	5 (20%)
Teen	6 (24%)
Adult	14 (56%)

Results

What did visitors find confusing?

- Visitors were confused about:
 - Size notation (4/25)
 - Visitor3: I don't get what the "um" is
 - Visitor12: yes, it would be helpful to explain what the measurements are
 - Visitor13: pronunciation, and description of each item and symbols
 - Visitor20: yes, what are the pictures and symbols relative to?
 - Names of the objects (2/25)
 - Visitor13: pronunciation, and description of each item and symbols
 - Visitor20: What is a venule?
 - “Missing” subatomic images (2/25)
 - Visitor6: no, it looks like it should keep going (the end of the images seem to keep going after the atom image)
 - Visitor14: the grey circles at the end. They look like they are supposed to be images.
 - Input device (2/25)
 - Visitor7: I didn't know if I was supposed to take this (the knob) off or not
 - Visitor10: had to play with it a little to figure it out, but nothing was confusing [person was using gestural interface]
 - How the measurements were taken (1/25)
 - Visitor25: where are we (the Exploratorium) measuring from?

What, if any, relationships did visitors see between the images of the different objects?

- The majority (76%) of visitors felt that object belonged together. Only 6/25 (24%) visitors thought that there was an ‘odd man out’ in the zoom because they felt that:
 - An object is not really ‘contained in’ the previous object (2/25)
 - Visitor5: (blood vessel) because it's where your blood flows through. You don't see strands in your hand. Blood vessels are just in your other parts of body not your hand.
 - Visitor7: (blood vessel) thought it was weird that the blood vessel was there, not a cell

- An object is confusing or is unfamiliar (2/25)
 - Visitor12: (venule) Only because I don't know what a venule is.
 - Visitor21: (chromosomes) I've never heard of it
 - The image 'looks wrong' (1/25)
 - Visitor6: (cell nucleus) It doesn't look as messy.
 - The size jump is too large (1/25)
 - Visitor20: there seems to be a gap between the atom and DNA; it's not relative, incremental
- 19/25 (76%) visitors thought that the zoom showed how the smaller objects are part of the bigger objects. For example,
 - Visitor2: takes hand down; breaks it down farther into the human system
 - Visitor8: what makes up part of your body
 - Visitor11: they are inter-related. The skin is made up of creases; the creases are made up of venules...
 - Visitor18: pieces of each other
 - Visitor20: they're all building blocks (of the body)

That is, even though the images are not visually contained in the image of the larger object, most visitors knew that they were zooming into one object at this interactive. We, however, note that there is no clear evidence that this is due to the spiral zoom format. In fact, the interviews seem to indicate that, at least for some (9/25 or 32%) of the visitors, people knew they were zooming in because they already knew the relationship between the objects selected for this zoom:

- Visitor10: everything is just getting deeper and deeper, smaller and smaller... it seems to be the pattern on the screen and that's what I remember from biology
- Visitor23: chromosomes make up what are inside the nucleus... my science teacher told me

Determining if the spiral format alone would be able to convey 'zooming' apart from prior knowledge would require additional studies looking at the same format applied to a less familiar set of objects. This, however, is beyond the scope of this formative evaluation with its particular subject matter – zooming into a hand.

What relationships did visitors see between the scale bar and the images in the spiral?

- Most (88%) of the visitors did see a relationship between the scale bar, on the left side, and the images in the spiral. More specifically, they noticed the following connections:
 - The scale bar shows size progression (12/25). For example,
 - Visitor8: when you're up there (points to macro on scale) it zoomed out more
 - Visitor13: yes, as you get smaller, the scale gets smaller
 - Visitor20: size relativity
 - Visitor24: (the scale) this is going from the high level drilling down through the hand

- The scale bar shows size domain (5/25). For example,
 - Visitor15: Yes, the scale shows what group (size) all of the pictures are in
 - Visitor23: Yes, the scale shows where the pictures are in real life. It shows what groups the pictures are in.
- There is a (unspecified) size relationship (4/25). For example,
 - Visitor4: the scale shows the size of (the) pictures
 - Visitor16: yes, what the pictures are goes to the size on the scale
- There is an unspecified relationship (2/25). For example,
 - Visitor6: scale matches pictures

CHANGES TO THE ZOOM PROTOTYPE

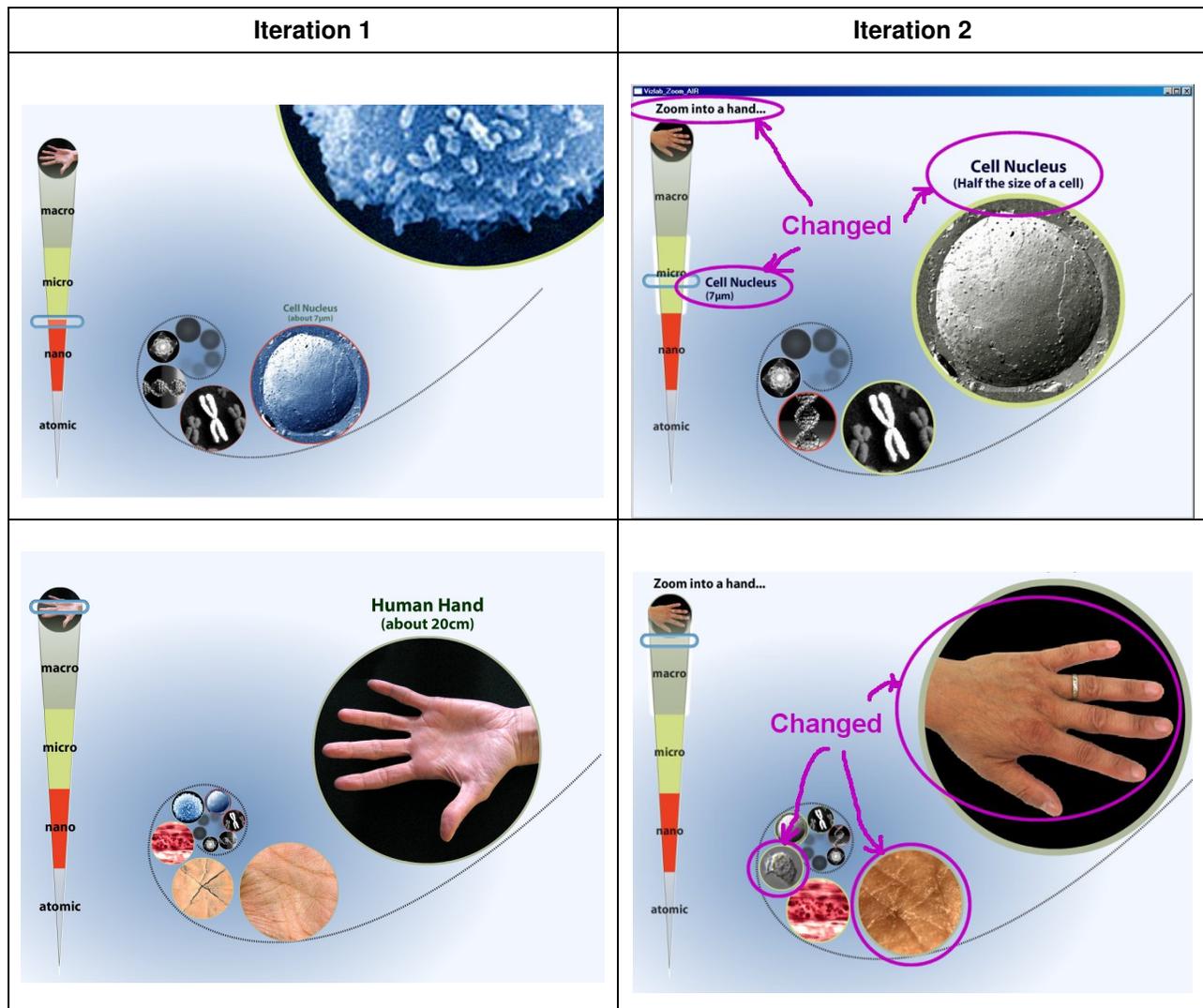
The development team made a few modifications to the zoom that we looked at in the first formative evaluation. More specifically, changes were made to

- The scale bar, which became the main means of noting information about exact measures
 - The marker now corresponds to the object's measure on a logarithmic scale
 - Numerical size information appears for each object on the scale bar as that object comes to the fore in the spiral.
- The images and the information on the spiral
 - Information that accompanies each image denotes size *relative* to the next larger object.
 - Different images are used to represent the hand and the skin creases.
 - A different image was chosen for the white blood cell. The team wanted all images to be as representative of the typical technology used to capture that size scale.

And, the title 'Zoom into a hand' was added to better indicate the purpose of the interactive.

These changes are noted in Figure 3.

Figure 3. Changes made to the spiral zoom.



FORMATIVE EVALUATION 2

Purpose

This second evaluation takes another look at the zoom interactive after these changes were implemented to determine:

- What was confusing about the zoom for the human hand?
- What connections did visitors see between the scale bar and the images on the spiral?

- What, if any, relationships did visitors see between the objects included in the zoom for the human hand?

In addition, it gauges

- Did visitors think that the zoom was useful in helping them imagine the size of things? How so?
- What, if anything, did visitors find out at this zoom that was new to them?

Method and Material

We followed the same setup and recruitment protocol as we did in the first evaluation. The interview questions can be found in Appendix B.

Data

We interviewed 25 visitors ($N = 25$) over the course of two days in the summer:

August 5, 2008 Tuesday

August 8, 2008 Friday

Gender	Count (out of 25)
Male	12 (48%)
Female	13 (52%)

Age Group	Count (out of 25)
Child (10-12)	2 (8%)
Teen	3 (12%)
Adult	20 (80%)

Results

What did visitors find confusing?

- Most (18/25 or 72%) of the visitors did not find anything confusing about the zoom. As one visitor put it:
Visitor1: It's the easiest thing to understand that we've seen all day.
- A few (6/25 or 24%) visitors were initially not sure what do at the interactive because they didn't see the control knob or expected to use a touchscreen.
Visitor2: didn't know how to work touch screen at first. Lot's of things are touch screen nowadays.
Visitor4: momentarily, how to use it
- One person did not know what a chromosome is.
Visitor18: chromosome- don't know what that thing is.

What relationships, if any, did visitors see between the images?

- A large number (21/25 or 84%) of visitors thought that the images on the spiral showed how the human hand is made of smaller and smaller parts. For example,
 - Visitor1: All a part of us. What we are made of.
 - Visitor20: they are all connected. All the way to my atomic structure, each cell has DNA and so on.
 - Visitor24: See hand, and then you get closer to the skin (etc.) you go smaller, all the way to the basic make up.

- A few (3/25 or 12%) visitors thought that the zoom was simply a progression of smaller and smaller sized objects. At no point in their interviews did they describe one object being a part of or being contained in the next. For example,
 - Visitor13: what is the magnification and relative scale of things ...ascending, and descending images of relative size

- When we asked if all the objects seem to belong together, some (15/22 or 68%) visitors thought they did, and some thought otherwise. The latter group explained that an image didn't seem to belong in the interactive because
 - The image characteristics seemed to have changed (3/ 22)
 - Visitor18: Atom, DNA. They're not the same color.
 - Visitor19: the picture of the nucleus was not very interesting
 - Visitor25: no. Should use a real picture of DNA
 - Another object would have made a stronger connection (2/22)
 - Visitor14: (weak connection between) Skin cell and blood vessel. You could go anywhere from the skin, why choose the blood vessel.
 - Visitor16: no, (maybe skin to blood vessel but it's ok cause it all ties into the hand)
 - They didn't think the object could be imaged (1/22)
 - Visitor3: I guess this (chromosome). Can you even see a chromosome? I didn't even think you could actually see a chromosome.
 - They didn't know that one object was a part of another (1/22)
 - Visitor10: chromosome I didn't know that chromosomes were made up of DNA

The above comments indicate some of the sensitivities visitors have to the objects chosen for a zoom and the types of images used to represent them, and may be factors to consider when designing another zoom with a similar format.

What connection, if any, did visitors make between the scale bar and the images in the spiral?

- Most (17/23 or 74%) visitors thought there was a connection. More specifically,
 - The scale bar indicates the (relative) size of the objects in the spiral (9/23)
 - Visitor4: relative to each other. Relatively, ones smaller than the other.
 - Visitor10: we went smaller, and it went lower.

- Visitor21: closer you got, the smaller scale. Relation - atom is on the atomic scale
 - It denotes which scale domain (e.g. macro, or micro or nano) the object is in (4/23)
 - Visitor22: definitely [how?] macro down, it's a size breakdown, mainly size
 - It tells you the size (5/23)
 - Visitor20: yes. The color. The size
- But, a few (4/23 or 17%) visitors did not pay attention to the scale bar to the left
 - Visitor6: I'd go w/o the scale, it's unnecessary
 - Visitor13: I blocked out the edge
- Two visitor saw no connection between the scale bar and the images in the spiral

(How) did the zoom help visitors understand the size of its objects?¹

- Most (9/12 or 75%) visitors thought that the zoom helped them better understand the size of things. In particular, they said that the following helped them:
 - The 'smaller than' label that accompanied the image (5/12)
 - Visitor16: Yes... little captions start with blood vessel (or higher) it tells you in captions how small you're getting. W/o captions it would be difficult.
 - Visitor17: yeah. You understand that it's smaller than the nucleus... It gives you a diameter. Then you can compare sizes.
 - The numbers on the scale bar (3/12)
 - Visitor25: The scale on the side, where you are in measurements of um and nm.
 - Other visual cues (2/13)
 - Visitor23: oh yes... the spiral. The colors. The bar (scale).
 - The scale bar in general (1/12)
 - Visitor14: well, it does b/c of this (scale)... the side bar.
- A few (3/12 or 25%) visitors did not think that the zoom helped them better understand the size of things.
 - Visitor19: not really, it looks pretty big here... It's nice how its says (hand crease) is 2time magnified, but it doesn't work from the other end (atom, you haven't seen DNA yet)
 - Visitor20: I think I knew that, so it didn't change... How connected it is (all the images)
 - Visitor21: Not really. ... It says (how small). But everything is zoomed to the same size

¹ We originally asked visitors to describe the size of a chromosome. However, visitors seemed confused by the question, and we suspect that visitors thought we wanted a numeric answer. Consequently, we changed the wording of the question. So, the following only captures the responses from 12 of the visitors after we modified the interview question.

Did visitors find out anything new?

- About (13/25) half of the visitors we interviewed reported that they did not find out anything new at this exhibit.
- The other 12 visitors claimed that the exhibit helped them realize:
 - How small these things really are (5/25)
 - Visitor2: never knew how small these things can be. I know what all these are, but never thought about how small they are
 - Visitor13: huge size gap between DNA and chromosome
 - The numeric sizes of different objects (2/25)
 - Visitor16: no, I already know. Maybe exact sizes
 - How something looks (3/25)
 - Visitor23: never seen DNA before, or a chromosome
 - What something is made of (2/25)
 - Visitor18: what they say (captions). Didn't know they (DNA, chromosome, atom) were inside of me.
 - The names of the different size scales (1/25)
 - Visitor5: yeah, a lot about names of sizes.

NEXT STEPS

This evaluation looked at the spiral zoom format as applied to a human hand, zooming from the macroscale to the atomic scale, though a sequence of discrete object, in which one is smaller than and contained in the next. We recommend additional evaluations to test the spiral as an effective way to communicate zooming and to describe size and scale. More specifically, we may want to develop and evaluate other zooms that use this format with other content matter, especially one that is less familiar to visitors and one in which zooming is not easily captured with a sequence of discrete objects.

ACKNOWLEDGEMENTS

The author would like to thank Stephanie Bahr and Leah Johnson for recruiting visitors and administering the interviews for this study.

This material is part of the larger NISE Network effort (www.nisenet.org), which is supported by the National Science Foundation under Grant number ESI-0532536. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.



APPENDIX A – Formative Evaluation 1

Note that the portions shaded grey were not included in the analysis reported.

Observations

Which imaged did they pause (more than 3 seconds) at?

Hand

Skin

Skin (super close)

Capillary

White Blood Cell

Cell Nucleus

Chromosome

DNA

Atom

Zoom in?

Zoom out?

Other observations

Questions

1. Did you have any difficulties using the exhibit? [Probe: anything else that was difficult? ... Probe to exhaustion]
2. In your opinion, what is this exhibit about?
3. Was there anything at all confusing about this exhibit? [Probe: anything else that was confusing? ... Probe to exhaustion]
4. When you look through these images, do any of these seem to not belong with the rest?
 - a. [If yes] Why's that?
5. What do you think is the relationship between these images? [gesture to images in circles] [Probe to exhaustion: like what does this have to do with these?]
6. I just want to make sure I understand. So looking at these two [pick *chromosome* and *Cell Nucleus*], how are they related? Are they related at all? [Probe to exhaustion]
 - a. Can you tell me, what made you think so?
7. Can you guess how much smaller this [show *Xsomes* image] is compared to this [show *Cell Nucleus*]?
8. Would you guess, about...

the same size	10X smaller	100X smaller	1000X smaller	> than 1000X smaller
---------------	-------------	--------------	---------------	----------------------

 - a. Can you say more? Why did you guess _____
9. Do you see any relationship between this [scale/slide] and these [balls/images]? [Probe to exhaustion.] What do you think this relationship is?
10. Did you find out anything new at this exhibit?
11. Do you have any suggestions for how we might improve this exhibit?

APPENDIX B - Formative Evaluation 2

Note that the portions shaded grey were not included in the analysis reported.

Observations

Which imaged did they pause (more than 3 seconds) at?

Hand

Skin

Skin (super close)

Blood vessel

White Blood Cell

Cell Nucleus

Chromosome

DNA

Atom

Zoom in?

Zoom out?

Other observations

Questions

1. In your opinion, what was that exhibit about?
2. Was there anything at all confusing about this exhibit? [Probe: anything else that was confusing? ... Probe to exhaustion]
3. Do you see any relationship between this [*scale/slide*] and these [*balls/images*]? [Probe for description of relationship: 'So, how are they related?']
4. When you look through these images, do any of these seem to not belong with the rest?
 - a. [If yes] Why's that?
5. What do you think is the relationship between these images? [gesture to images in circles] [Probe to exhaustion: like what does this have to do with these?]
 - a. Can you tell me, what made you think so?
6. Can you tell from this exhibit: How small this is [pick *chromosome*]?
 - a. Can you say more? What about the exhibit made you think _____?

Alternate wording...

6. Does this exhibit help you image how small this is [pick *chromosome*]?
 - a. Can you say more? What about the exhibit helped?
 - b. How would you describe how small this is?
7. We're trying different ways to note the size. This [pt to *hand crease*] and this [pt to *chromosome*] and this [pt to *nucleus*]. Which one do you find the most easy to understand at this exhibit?
8. Did you find out anything new at this exhibit?
9. Do you have any suggestions for how we might improve this exhibit?