

GFP Worms on the LEICA Dissecting Microscope - Searching for and Looking at Worms

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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

Imaging Station – Formative Evaluation GFP Worms on the LEICA Dissecting Microscope

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PURPOSE

This study was conducted on the standalone LEICA microscope exhibit showing three different strains of GFP worms (*C. elegans*). The GFP is expressed in these 3 strains in the brain, the thorax, and in protein aggregates throughout the worms' body. The purpose of this formative evaluation study is

- to characterize visitor behavior at the standalone exhibit,
 - how long visitors stayed
 - what visitors tried to do at the exhibit
 - any difficulties visitors had using the exhibit
 - where visitors focused their attention
- to gauge how interesting visitors found the experience,
- to collect questions visitors had about their experience,
- to identify what connections visitors made between the microscope and the images they saw,
- to determine what connections they made between what they saw and humans, and
- to see if visitors were able to distinguish between different strains of worms

SETUP

Figure 1. Stand-alone Exhibit



METHOD

- Observations:
 - An evaluator sat 10 feet away from the stand-alone station and observed visitors as they used the exhibit. If visitors came in a group, the first visitor to stop for 3 seconds or more was observed. The evaluator noted when a visitor stopped at the exhibit, when s/he looked at the main monitor, the plasma screen mounted overhead, the media monitor, and the microscope, and when that visitor left the exhibit. Demographic information was also noted.
 - A video camera was set up to record what visitors were looking at on the main monitor.
 - A tracking program logged which media screens visitors visited on the media piece.
 - The above three data types were then coordinated based on a common clock, to determine what a visitor did and saw at the standalone. (The clocks used by the evaluator, the video camcorder, and the tracking software were synchronized before each day's observation.)
- Uncued Interviews
 - When possible, a visitor whom we've just watched was then approached and asked a series of questions about the experience and about what s/he saw. These questions are in Appendix A. We selected visitors to interview based on age (must be 8 or above) and holding time (must be longer than 15 seconds).

DATA COLLECTED

- N = 40
- Data were collected during these days:

Day	Date
Saturday	5/22/04
Sunday	5/23/04

- Demographics

Gender	Count
Female	17
Male	22
Total	39 ¹

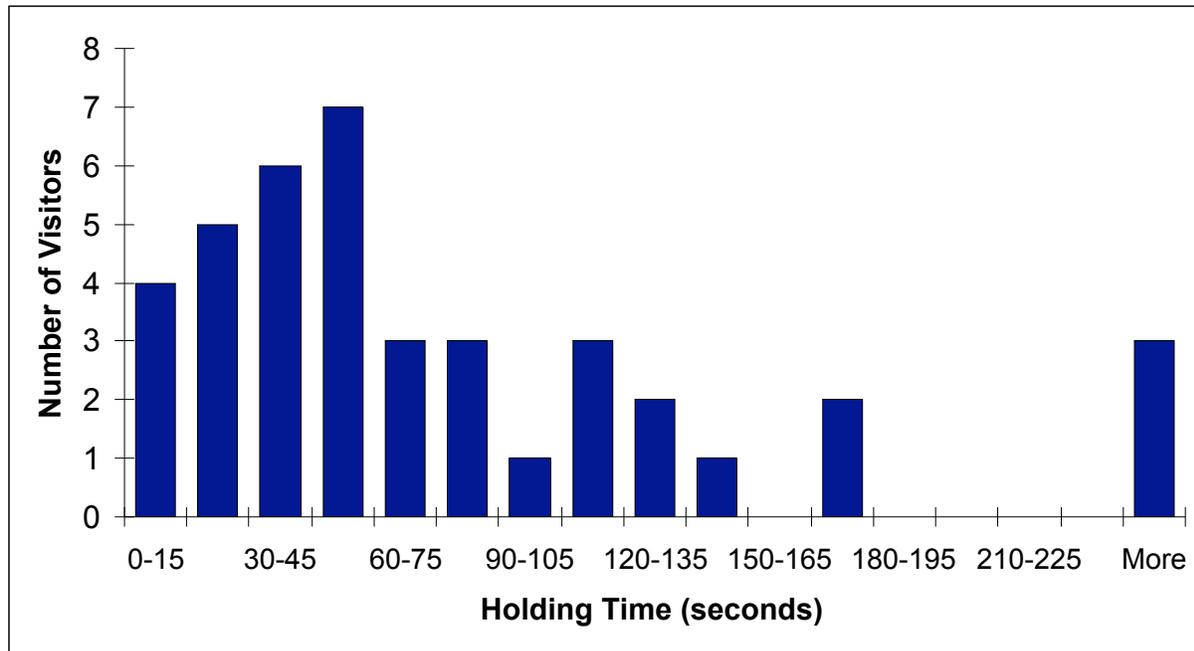
Age Group	Count
Adult	22
Teen	5
Child	3
Under 8	9
Total	39 ¹

FINDINGS**What did visitors do**

- Figure 2 shows the distribution of holding time at the exhibit. On average, visitors stayed for 54 seconds (median), 94 seconds (mean). The minimum holding time was 10 seconds; the maximum holding time was 10 minutes 26 seconds.

¹ Demographic information was not collected for 1 of the 40 visitors.

Figure 2. Histogram of visitor holding time. Median = 54seconds; mean = 94 seconds; minimum = 10 seconds; maximum = 626 seconds.



- All but one of the (37 out of 38²) visitors found a worm under the microscope. In this analysis, finding a specimen means that the visitor either stopped and looked at a specimen in focus for 3 or more seconds or followed a specimen with the joystick.
- Visitors (N= 36³) used the zoom in different ways:
 - To make fine adjustments (5 visitors)
 - To zoom all the way in and all the way out (12 visitors)
 - To both zoom to the extremes and to make fine adjustments (10 visitors)
 - Zoom was not used (9 visitors)
- Three (8%) visitors never saw the worms under UV light.
- Visitors (N=21) reported that they tried to
 - Compare the worms under UV versus normal light (7 visitors)
 - Watch the worms move and interact (6 visitors)
 - Find and look at worms, with nothing more specific (4 visitors)
 - Compare different worms, specifically their size and fluorescence (3 visitors)
 - Identify different strains of GFP worms (3 visitors)
 - Look at the worms zoomed in versus zoomed out (1 visitor)
- Visitors reported the following difficulties with the exhibit:

² Video data are missing for 2 of the 40 visitors observed.

³ Data are either missing or too difficult to interpret for 4 of the visitors observed.

- UV control

Visitor13: the lights turned on and off and on when we tried to just turn it on.

Visitor19: I tried to use the UV light, but it just kept turning on and off and make the screen flicker. I'm not sure what I'm supposed to see

Visitor32: The touch screen, switching between UV and not, it hesitated a bit.

Visitor38: The UV light turning on and off feature, it wasn't clear whether it was working or not. No immediate feeling as to whether it had turned on or off. I mean you tried turning it off and the worms don't stop glowing and that's troublesome.

Visitor43: [On the way over to my seat she was repeating that the UV light didn't work] It didn't work. It should glow, just a moment [someone has gotten the UV light to go on, she stares at it for awhile].

- The XY boundaries

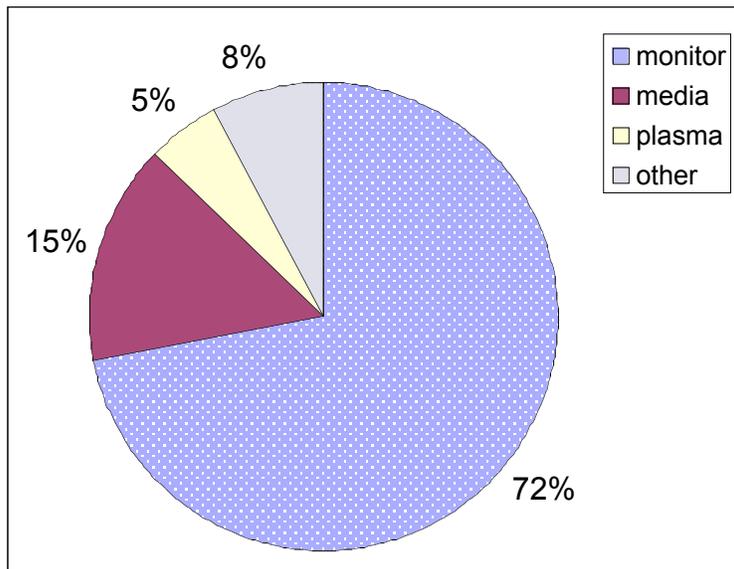
Visitor5: took a little to figure out why I couldn't go further down.

- Media navigation

Visitor11: there's one part. There were 3 different pictures [for the 3 different strains of worms]. You always have to go back to choose. You should have all 3 buttons on every page

- Where do visitors focus their attention? Figure 3 shows the average (mean) percentage of time visitors spent looking at the main monitor, the media piece, and the plasma screen.

Figure 3. Mean percentage time spent on different exhibit components



- Viewing Monitor
 - 100% (40/40) visitors looked at the main viewing monitor
 - Visitors spent 38 seconds (median) and 66 seconds (mean) looking at the main monitor. The maximum length of time any visitors spent was 456 seconds.
- Plasma Screen Viewing Monitor
 - 32% (13/40) visitors looked at the plasma screen
 - Visitors spent 8 seconds (mean) looking at the plasma. The maximum length of time any visitors spent was 128 seconds.
- Media Piece (There was no automatic reset implemented in the media version used.)
 - 73% (29/40) visitors looked at the media piece
 - 59% (17/29) visitors who looked at the media piece, used the touch-screen to jump to a different screen.
 - 38% (11/29) visitors who looked at the media piece saw a screen that described a connection between worms and human beings.
 - Visitors (N=40) spent 5 seconds (median) or 16 seconds (mean) looking at the media monitor. The maximum time a visitor spent was 79 seconds.
 - 43% (17/40) visitors used the UV buttons on the touchscreen to change the UV light.
 - 14 of these visitors (35%) toggled the UV buttons on and off
 - 3 visitors changed the UV setting from off to on.
 - Half the visitors (20/40) came to the exhibit with the UV light on and did not use the UV control buttons, whereas the remaining 8% (3/40) visitors never turned on the UV light.
- Microscope
 - 18% (7/40) visitors looked at microscope behind the glass

Visitors' Interest (uncued interviews, N=21)

- Visitors found the exhibit *interesting* or *somewhat interesting*.

Interest Rating	Count (out of 21)
Interesting	12 (57%)
Somewhat Interesting	9 (43%)
Neutral	0 (0%)
Somewhat not interesting	0 (0%)
Not interesting	0 (0%)

- Visitors found the exhibit interesting because
 - They saw worms glow (9 visitors)
 - They liked controlling the microscope (5 visitors)
 - They liked watching worms move (5 visitors)
 - They saw worms – nothing more specific (3 visitors)
 - They saw something novel (3 visitors)

- The exhibit had a visual impact (2 visitors)
- Visitors also reported that they appreciated seeing something close up, identifying the different strains of worms, and finding and explanation of what they saw on the media piece (1 visitor each)

Visitors' Questions (uncued interviews, N=21)

We then looked at the kinds of questions visitors had after their experience. They include questions about the following. Note that questions not addressed in the media piece are in italics.

- The worms
 - What are they?*
 - Are they parasites?*
 - Where did these worms come from?*
 - What kind of worms are they?*
 - Are they normal worms?*
 - How big are they?*
 - Are they under ground?*
- The glow
 - What's the green mean?*
- Those worms in the lab
 - How many worms there are in it?*
 - Kind of like, the worm farm is in that little room, right? [I] want to see what the big thing look like, the tank or whatever.*
 - What are they in?*
- Worm behavior
 - What are they doing?*
 - I was trying to determine if it was tunneling.*
- The point of the exhibit
 - The flies mutation I know, the UV light on flowers for the bees, I see all the purpose there. This one isn't very clear. You just said that scientists study this. How relevant is this. It's more like art than science. I'm not sure what I'm supposed to learn here. should be more clear with your message. [anything else?]*
- The technology
 - Is the microscope back here?*
 - Is it an electron microscope?*
 - What's the magnification?*
 - I was wondering, doesn't the microscope get damaged if people zoom in and out so much?*

Connections visitors made between what visitors saw and the microscope (uncued interviews, N=21)

- 95% of the (20 out of 21) visitors interviewed thought the image was live, as opposed pre-recorded.
- However, only 4 (19%) visitors thought the worms were on the microscope behind the glass.⁴ The other visitors
 - thought that the worms were maybe somewhere in the Imaging Station room but were not sure where (6 visitors, 29%)
 - thought that the worms were on some microscope in the Imaging Station room but were confused about which one (4 visitors, 19%)
 - had no idea where the worms were (6 visitors, 29%)
 - thought the worms were underneath the user cart (1 visitor, 5%)

Connections between what visitors saw and humans (uncued interviews, N=21)

- Nine (43%) of the visitors did not see any connections between what they saw and human beings.
- Seven (33%) of the visitors believed that there was a connection: worms are used in research. Three of these visitors specifically mentioned that scientists study worms to understand human diseases as mentioned on the media piece they saw. We found no significant difference between the percentage of visitors who visited a media screen describing this connection and mention a research connection and visitors who did not visit such a media screen and similarly mentioned a research connection; Fisher's Exact Test, $p = .33 > .05$.

Table 1. Visitors who visited a media screen explaining a human connection and who mentioned a research connection in the subsequent interview.

	Mentioned a research connection		Total
	Yes	No	
Visited a media screen describing human connection			
Yes	6	7	13
No	1	5	6
Total	7	12	19 ⁵

- Three (14%) of the visitors mentioned that we are similar in a very fundamental way: humans and worms have cells and humans and worms are alive.

Distinguishing different strains (uncued interviews, N=21)

- 19 out of the 21 visitors drew and described worms as part of their interviews. These visitors drew and noted the following types of worms:

⁴ Of these 4, only one was observed to have looked behind the glass.

⁵ Two visitors interviewed did not answer this question.

- worms with glowing spots (12 visitors),
 - worms with a glowing head (1 visitor),
 - worms with a glowing throat (1 visitor),
 - worms with a glowing brain (1 visitor), and
 - worms with no glowing parts (7 visitors).
- Only 3 out of these 19 visitors distinguished between the different strains of worms available in their drawings and in their descriptions.

SUMMARY WITH RECOMMENDATIONS

Visitor interest

In general, visitors found the exhibit engaging.

- The holding time for this exhibit prototype is about 54 seconds (median) and 94 seconds (mean). A one-way ANOVA of holding times for worms (with the LEICA microscope), zebrafish (with the Zeiss microscope), and amoeba (with the Zeiss microscope) showed no significant differences between specimens, $F(2, 150) = .137, p = .87 > .05$. The means and standard deviations are presented in Table 2. Note that this analysis was done for the ln-transform of the data, which passed the Kolmogorov-Smirnov test for normal distribution.

Table 2. Holding time for different specimens

Specimen	Holding Time Mean	Holding Time Median	Holding Time Standard deviation
Amoeba	101 seconds	81 seconds	93
Zebrafish	104 seconds	90 seconds	98
Worms	94 seconds	54 seconds	122

- Visitors rated the exhibit *interesting* or *somewhat interesting*.

Using the exhibit

- Visitors were able to find and look at worms under the LEICA microscope.
- Most of the difficulties visitors identified concerned the UV light. They were confused by the delay in switching from normal to UV light as well as the 'double' switch in the current design, wherein the filter wheel switches from normal to normal and then finally to UV light. Also, the touchscreen does not always show the state of the UV light, whether it is on or off, further confusing the visitors. Development is currently looking at ways of addressing these issues.
- More than half of the visitors never used the UV control. Most of these visitors came to the exhibit with the UV light on. Because all the activities we wish to support requires UV light to be on, we recommend that UV on be the default state. Interested visitors who would like to compare the worms under UV and normal light should still be allowed to do so with the UV button controls on the touchscreen.

- A small minority of the visitors interviewed reported trying to identify the different strains of worms, and only 16% of 19 visitors interviewed described seeing different strains. If we are interested in having visitors pursue finding and identifying the different strains as the main activity, we will need to redesign the media piece to give the activity more prominence and the visitors more support.

Making connections

- Less than one-third of the visitors looked behind the glass at the LEICA microscope. Of those interviewed (N=21), a minority (19%) connected that microscope with what they saw. Most visitors either had no idea where the specimen was or thought they were somewhere in the Imaging Station room but were not sure where. There may be several possible reasons for this: 1) The LEICA dissecting microscope does not look like a typical microscope. Furthermore, the LEICA was positioned so that visitors could not see the eyepiece, which we believe helps people identify a microscope as a microscope. 2) There is a jumble of wiring and at least 3 monitors surrounding the LEICA in the Imaging Station room that distracts from the microscope. 3) There is a Zeiss Axiovert sitting next to the LEICA. The Zeiss looks more like a traditional microscope. We can experiment with making the LEICA more visually prominent in this exhibit and with graphics that explicitly point out the connection between what visitors see on the viewing monitors and the equipment.
- Only 33% of the visitors interviewed thought there was a connection between what they saw at the exhibit and humans, specifically, that worms are used in biomedical research. We may want to further emphasize the connection in the next iteration of the media piece. In particular, questions visitors asked during their interviews suggest that some visitors were confused by the GFP worms: they were not sure if they are naturally occurring or that they have been ‘engineered’ for scientific research. At the very least, this point should be made more clear in the media.

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APPENDIX A

Interview Questions

1. How interesting would you say that was? Would you say that exhibit was ...

Uninteresting	Somewhat Uninteresting	Neutral	Somewhat Interesting	Interesting
1	2	3	4	5

2. What made it _____ for you?

3. What did you try to do at the exhibit?

4. Did you have any trouble using the exhibit? What? [Probe: You mentioned that you tried to xxx, did you have any trouble doing that?]

5. Do you have any questions about what you saw? What would you like to know about what you saw at that exhibit?

6. When you were playing with this exhibit, did you think that what you saw on the monitor was live or pre-recorded (for example, from a video tape)?

LIVE *PRE-RECORDED*

7. [Only if they said it's LIVE] Where do you think the living things that you saw are?

8. Did you feel there's any connection between what you saw and human beings?

9. Did you feel that there's any connection between what you saw and yourself?

10. We're interested in how memorable this exhibit is. Could you draw for me a quick sketch of whatever you remember seeing on the main monitor [the big one right in front of the joystick]? (Probes: Just draw whatever you remember seeing, as if you were showing a little kid what you saw.)

Great, and can you tell me what your drawing shows? I just want to be sure I understand it. Like, what's this here? And this?

Is there anything else you remember seeing that you thought was too hard to draw or you decided not to draw?