



Three Drops

Formative Evaluation

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THIS IS A FORMATIVE EVALUATION 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



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Purpose

Three Drops is an Immersive Digital Interactive (IDI) designed and developed by Snibbe Interactive as part of the larger NISE initiative. It allows visitors to interact with simulations of water at different size scales where different physical forces dominate. See Figure 1. There are three size scales simulated in *Three Drops*, the macroscale where gravity dominates, the microscale where surface tension becomes more pronounced, and the nanoscale where electromagnetic forces are predominant. This IDI gives visitors an opportunity to interact at different scales and thereby discover *how natural forces affect the world of the very small differently*.

Previous formative evaluations conducted at the Science Museum of Minnesota (SMM) indicated that visitors had difficulties using the interactive, did not find *Three Drops* very engaging, and had trouble seeing its underlying content message. This evaluation looks at the current, revised version of *Three Drops*. More specifically:

- Have the usability issues been addressed? The developer thought that technical difficulties encountered during installations may have compromised system performance and caused some of the usability problems found in earlier evaluations. Would careful installation and troubleshooting solve these problems?
- Do visitors find the exhibit engaging? The usability problems encountered earlier may have interfered with visitors' ability to enjoy the exhibit. This evaluation looks again at visitor engagement after the technical issues have been addressed.
- Does an accompanying video better highlight the IDI's underlying content message? In this study, we played a video created by Snibbe Interactive in a continuous loop on a kiosk placed next to the main screen of *Three Drops*. (See Figure 2.) The video showed an actor interacting with the simulation for each three size scales while subtitles describe the dominant forces for that scale.^{1 2} We compared the accompanying video with a static label (Figure 3) placed in the same position to gauge if a video can better convey its content message.

¹ The video is not coordinated with the IDI. That is, the video can be showing an actor playing with the water droplet while the IDI is simulating interactions at the nanoscale.

² There were two versions of the video, a long (more than 2 minutes) and a short (approximately 1 minute) version. The short version is an edited version of the long, with the introductory scenes of running water deleted. The evaluation includes a few interviews with the long but was conducted mostly with the short version. Because low counts precluded statistical comparisons between long and short videos, we grouped visitors' reactions for the long with the short versions in this study.



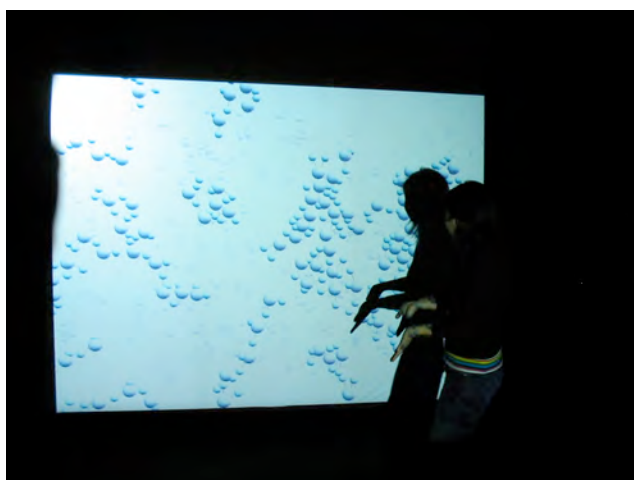
Figure 1.

Three Drops at the three simulated size scales. The three simulations play serially, with each lasting about one minute before transitioning to the next



Simulation 1. Human-scale (Macroscale)

Simulation 2. Microscale



Simulation 3. Nanoscale

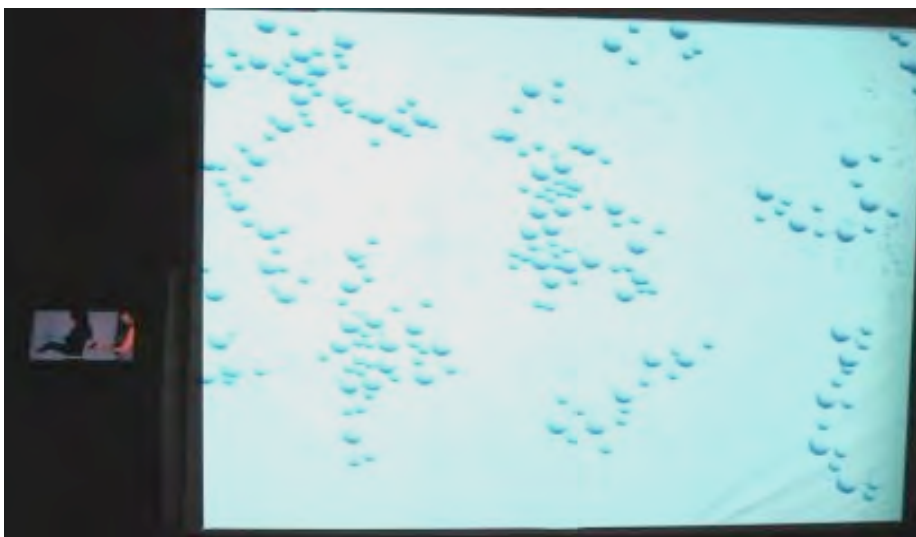


Figure 2.

Setup - Looking towards the screen. The video kiosk is on the left.

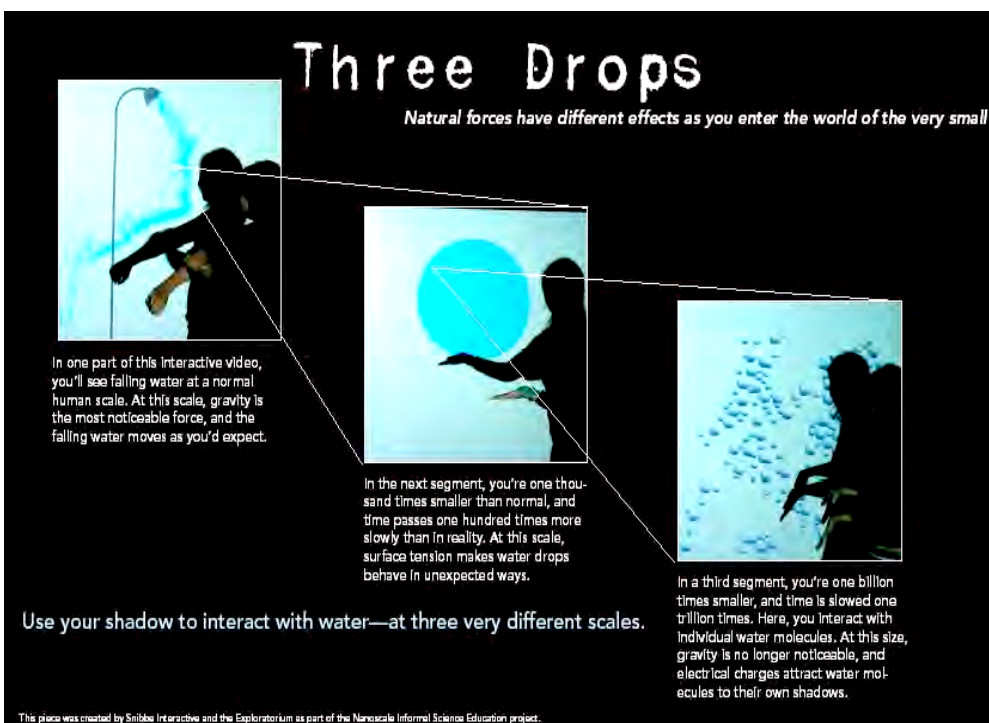


Figure 3.

Static label for Three Drops

Earlier evaluations of *Three Drops* were conducted during NISE Workshops at SMM. In this evaluation, however, the IDI was placed in the Seeing Collection, the only space available on the Exploratorium floor that fit the needs of the exhibit, and there were no other exhibits about the nanoscale anywhere nearby. Since context can affect visitors' interactions and interpretations, comparison with the earlier results provide rough indicators only.

Key Findings

- Setting up *Three Drops* at the Exploratorium required time and knowledgeable staff. We recommend that a museum allot appropriate resources for careful installation and calibration of the system.
- Overall, *Three Drops* was easy to use and visitors reported enjoying using the exhibit.
- However, the nanoscale portion of the IDI was the least likely used (66%) and seemed the most difficult to figure out.
- Only about half of the visitors saw all three parts of the exhibit. Consequently, only they had an opportunity to compare the macro, micro and nanoscale and induce that different forces dominate at different size scales.
- Despite having a video or a static label that articulated the main message of the piece, a minority of visitors (33%) reported thinking that *Three Drops* was about how the very small behaves and even fewer thought its main message was about the different forces at play at different size scales. Some people simply did not look at the video or label. Of the other 65%, some of these visitors were more interested in finding out *what to do* and *not what is the exhibit about* from the video or label.

Setup

Three Drops was set up in the Seeing Collection in a dark space towards the back of the Exploratorium. We used velvet ropes to better define the space and encourage visitors to interact with the exhibit at the screen instead of near the projector. See Figure 2 and Figure 4.



Figure 4.

Exhibit setup – Looking to the side. The projector housing that also contains the computer, sensor, and speakers is on the right in the photograph. Stanchions and velvet ropes help delineate the space. The main screen, not shown, is on the left.

The Exploratorium decided that the projector, sensor and the computer would need to sit on the floor to allow easy access for troubleshooting and maintenance. In previous setups, the sensor and projector were placed on a suspended platform. Placing the equipment on floor level required that the Exploratorium build a cabinet to house and secure the equipment. This also meant that the sensor would be placed behind plexiglass.

In our first attempt, reflections from the plexiglass interfered with sensor readings, and the exhibit would not calibrate properly unless the plexiglass were removed. Even after calibration, artifacts from these reflections made the plexiglass problematic. Drilling a hole in the plexiglass for the sensor did not dissuade curious visitors from reaching in to touch the equipment. At times, even with the plexiglass removed, the system would not calibrate properly. Staff from Snibbe Interactive came to the Exploratorium several times to make adjustments to the exhibit and setup. After a few tries, we were jointly able to configure *Three Drops* to automatically calibrate properly and to survive and function as a stand-alone exhibit on the museum floor.

Our experience with setting up this IDI suggests that a museum allot time to fine tune the system for the particularities of the installation environment and find expertise to address technical issues should they arise.

Method

We watched every third person that entered *Three Drops*, who was 10 years old or older. When the floor was very quiet, we observed every person who entered as separated by at least a 10-minute gap. The evaluator noted how long that person stayed, which size scale s/he interacted with, and the visitor's demographic information.

After the visitor left the exhibit, the evaluator approached that visitor for an interview. The interview questions are the same as those designed by and used in earlier evaluations conducted at the Science Museum of Minnesota, but supplemented with questions about visitors' reactions to the video/label. The interview questions can be found in Appendix A along with the observation protocol. We alternated between the video and the static label every 45 minutes.

Data Collected

We observed and interviewed 33 visitors. Their demographic information are as follows:

Gender	Count (out of 33)
Male	17
Female	16

Age Group	Count (out of 33)
Child (10-12)	8
Teen	8
Adult	17

Results

Size Scale Visitors Used

Our observations showed that a large majority of people played with the shower, or macroscale, simulation. A smaller percentage, 66% of the visitors, used the nanoscale simulation, and slightly over half used all three scales:

Size Scale	Count out of 32
Macroscale - shower	29 (91%)
Microscale - droplet	23 (72%)
Nanoscale - molecule	21 (66%)
All three	17 (53%)

That is, only about half of the visitors stayed long enough to experience and compare the behavior of water at all three size scales. And, of the three size scales, the nanoscale was the least used.

Ease of Use

Overall, most visitors found the exhibit easy to use:

How easy was it to figure out what to do at the exhibit?	Count out of 33
It was so easy, I didn't have to think about it.	8 (24%)
It was easy to figure out.	17 (52%)
It was a little difficult to figure out.	8 (24%)
It was so difficult, I couldn't figure it out.	0 (0%)

This is an improvement over the first two iterations of *Three Drops* that were evaluated as part of two NISE workshops at the Science Museum of Minnesota.³

However, of the 8 visitors who found the exhibit a little difficult to use, half of them thought that the interaction at the nanoscale was the hardest to figure out. For example,

Visitor7FTS: The shower one was easy, the bubble one was more difficult, and I didn't get the 3rd step at all.

Twenty-one out of the 33 visitors we interviewed, looked at the label or the video, and of these 9 (43% of the 21 or 27% of all 33) thought that the video/label placed at the side of the exhibit helped them figure out what to do at the exhibit.

Enjoyment

Most visitors found the exhibit enjoyable:

³ In the first version, 20% of the visitors gave the IDI the lowest rating in ease of use, and in the next version, 25% gave Three Drops the lowest rating.

How enjoyable was the exhibit?	Count out of 32
It was so enjoyable, I'd encourage others to try it.	12 (38%)
It was enjoyable.	20 (62%)
I didn't really enjoy it.	0 (0%)
I didn't find this enjoyable at all.	0 (0%)

These results indicate an improvement in how enjoyable visitors found their exhibit experience. In earlier evaluations, only about half of the visitors gave *Three Drops* the top two ratings.

Furthermore, the median holding time for the exhibit was 141 seconds, which is considered high at the Exploratorium.⁴ Holding time is one indication of how engaging an exhibit is, especially where there are multiple exhibits competing for a visitor's attention.

⁴ The average holding time for an APE (Active Prolonged Engagement) exhibit was 132 seconds. The longest average holding time for a Traits of Life exhibit was 109 seconds.

Clarity of the Content Message

We asked visitors what they thought the exhibit was trying to show people:

What would you say the exhibit was trying to show, if anything?	Count out of 33	Examples of Visitors' Responses
How small things behave	11* (33%)	Visitor11V2: How gravity affects molecules. Visitor14S: how it feels to be smaller. Reminds me of that show blue planet, with little creatures moving through water. So I've thought about it before - but not day to day.
... and how things behaves at <i>different</i> sizes	5 (15%)	Visitor8S: Interaction with different sizes of water Visitor12V2: F1: What a shower is, like when you're really close up, how with the shower and the water droplets you could bounce them away, but when you get to the molecule stage, you attract them.
A new way to interact with light and shadow	8 (24%)	Visitor3S: you can control stuff with your shadows Visitor15S: shadows, light and visibility. How technology can interface with light. That the shadow works better than touch [in this exhibit] Visitor14V2: How people can move the things on the screen
Nothing / Don't know	5 (15%)	
Something (unspecified) about the properties of water	4 (12%)	Visitor18V2: physical properties of water
Optical Illusions	2 (6%)	Visitor5V: illusion - to give brain an illusion. Water is there even though it isn't, and you move accordingly
Other	3 (9%)	Visitor11S: To encourage kids to take a bath. Visitor3V: how science is put up and how you can learn how to do it, try to do something similar at home Visitor10V2: The advancement of technology [anything else?] no.

* This count includes the 5 visitors, in the subsequent row, who thought the main message was about how things behave at different size scales.

Eleven out of 33 visitors (33%) of the visitors we interviewed thought that the exhibit showed them something about behavior in the world of the very small. This is almost half the number of visitors (~60%) who in the earlier studies at SMM thought that the exhibit showed them something about a smaller size scale. So, even with an accompanying video or label, most visitors did not see the underlying content message of the exhibit. Why might that be?

Part of the reason is that not everyone looked at the video or label. About 64% of the visitors we interviewed reported paying attention to the interpretation on the side; the rest spent all their time playing at the screen. Of the 21 visitors who did look at the video

or label, 14 (67% of the 21) found it useful, but more for showing them *what to do* (9 visitors) not *what it's about* (6 visitors).⁵

Furthermore, because only 53% of the visitors experienced all three size scales, only about half of the visitors even had a chance to make a comparison between the three to discover how different forces dominate the interactions and behavior at different scales.

Summary and Recommendations

Setting up *Three Drops* required time and knowledgeable staff to calibrate the system and ensure that the IDI can function as a stand-alone exhibit on a busy museum floor. After the initial installation challenges were met, the IDI required minimal maintenance for the remaining time (a month) it was on the floor.

This formative evaluation found that in general, *Three Drops* was easy to use and visitors reported enjoying using the exhibit. The long holding times at the IDI support these self-reports.

However, we also found that a little over half the visitors saw all three size scales. So, only half would have even had an opportunity to compare their interactions at the macro, micro and nanoscale. Furthermore, about 66% of the visitors we observed and interviewed interacted with the nanoscale portion of the IDI, while a larger percentage used the macro and the microscale simulations. Of the visitors who engaged with the nanoscale simulation, a few reported not knowing what to do. So, the nanoscale portion of the IDI seems to be the least likely used and most difficult to figure out.

There could be several reasons why this may be. Here are a few of our speculations:

- Visitors are more familiar with the interactions at the larger size scales. Visitors can readily recognize the shower, and people can play with the water droplet like a big blue beach ball. But, at the nanoscale, even if they recognized the ball-and-stick representation, visitors may not necessarily know how to interact with 'molecules'.
- Furthermore, learning to interact with molecules and, therefore, to see the effects of electromagnetic forces, requires that a visitor stand still and wait for the molecules to be attracted to his/her shadow. This entails a bit more time and a different type of interaction compared to the more physical activities at the macro and microscale.

Finally, we found that despite having a video or a static label that articulated the main message of the piece, a minority of visitors reported thinking that *Three Drops* was about how the very small behaves and even fewer thought its main message was about the

⁵ The counts were too small for us to statistically compare the static label to the video.

different forces at play at different size scales. This may be in part because some people do not look at the video or label, or when they do, they are trying to first figure out what to do, not what it's about.

A main challenge remaining for *Three Drops* is to encourage more visitors to engage with the nanoscale simulation and help visitors interpret those interactions through means other than a looping video or a static label.

Appendix A

Observation

3rd person to cross the line AND is \geq 10years old

Start Time: _____

What stage of the IDI did they interact with?

IDI

Shower

Tension

Electromag

What part of video did they look at?

Video

Intro

Shower

Tension

Electromag

End Time: _____

Other notes:

Interview Questions

Selection:

- Only visitors who used the IDI (stand in front of the IDI)
- Visitor must be 10 and above

1. How easy was it to figure out what to do at the exhibit? Would you say ...

It was so easy, I didn't have to think about it.
It was easy to figure out.
It was a little difficult to figure out.
It was so difficult, I couldn't figure it out.

a. [for those who thought it was difficult] What was difficult to figure out?

2. How interesting was this exhibit? Would you say...

I was so interested I'd do it again.
I was interested, but I wouldn't do it again.
I wasn't really interested.
I didn't find it interesting at all.

a. [for those who thought it was interesting] What made it interesting for you?

3. How enjoyable was this exhibit? Would you say ...

It was so enjoyable, I'd encourage others to try it.
It was enjoyable.
I didn't really enjoy it.
I didn't find this enjoyable at all.

4. How relevant was the exhibit’s content to your life? [Does it have any connection to your own life?]

It was extremely relevant to my life.
It was somewhat relevant to my life.
I didn’t really see much relevance to my life.
I didn’t find any relevance to my life at all.

5. What would you say the exhibit was trying to show, if anything?
6. Can you say a little about why you think it showed _____? [Probe: why did you think it was about _____? What clued you in?]

7. Did you get a chance to look at that [*point to video kiosk*]? **YES** **NO**

- a. Did you see a connection between this [*pt to IDI*] and that [*pt to kiosk*].

YES **NO**

- b. So, how useful was that in helping you understand the exhibit here [*gesture to IDI*]?

Not at all	A little bit	Somewhat	A lot	Completely
1	2	3	4	5

- c. How was it helpful/ not helpful?
- d. Was there anything confusing about what you saw there [*point to kiosk*]?
What?