National Leadership Grants for Museums

Sample Application MG-50-18-0026-18
Project Category: Diversity and Inclusion
Funding Level: Research grants $50,000-$1,000,000

Exploratorium

Amount awarded by IMLS:	$647,245
Amount of cost share:	$0

Attached are the following components excerpted from the original application.

- Abstract
- Narrative
- Schedule of Completion

Please note that the instructions for preparing narratives for FY2019 National Leadership Grants for Museums differ slightly from those that guided the preparation of FY2018 applications. Most obviously, the names and descriptions of project categories have changed slightly and there is one new project category – Data, Analysis, and Assessment. Be sure to use the narrative instructions in the FY2019 Notice of Funding Opportunity for the grant program and project category to which you are applying.

ABSTRACT

The Exploratorium proposes *Cultivating Confidence: Young Women's Self-efficacy in Science Museums* (hereafter Cultivating Confidence), an NLG Diversity and Inclusion research project that studies the impact of a single science museum visit on "emerging adult" learners (young adults aged 18-29, not yet married, no children). Cultivating Confidence builds directly on prior IMLS-funded research that found that a science museum visit mitigated a pre-existing gender gap in science self-efficacy: Young women entered the museum with significantly lower science self-efficacy (confidence to do or learn science) than young men, experienced a significant increase over the course of the visit, and remained at that same level, equal to men's, three months after the visit. This unanticipated benefit for young women was discovered via post-hoc analyses, necessitating the additional exploration and hypothesis-testing proposed in Cultivating Confidence. While the prior project—Research on Emerging Adult Learners (REAL)—offered clues about possible explanations for the results, it left many questions unanswered.

Cultivating Confidence will replicate and investigate this effect further by studying male and female emerging adults in greater depth during their visit and over the course of the following three months. The project will attempt to understand how museum visits help young women build crucially important science self-efficacy (SSE). Cultivating Confidence will also attempt to untangle the confounding variables of gender and initial SSE, since the women in the prior study tended to have lower pre-visit SSE than the men.

The research questions in Cultivating Confidence are:

1. How does the museum experience contribute to immediate increases in science self-efficacy? Which sources of science self-efficacy are most impactful for people of different genders?
2. What happens after the visit? Does the visit influence the number and type of subsequent, science-related experiences participants have? How do post-visit activities affect long-term science self-efficacy? Do the results differ by gender?
3. To what extent are the immediate and longer-term boosts to science self-efficacy due to initially low levels of self-efficacy, rather than gender? Do the results from the original REAL study replicate and confirm a gender effect?

The project will be implemented in two phases, a pilot phase and a full study phase. During the pilot phase, we will improve existing measures and develop and validate new methods in order to answer our three Research Questions. The full study phase will expand upon the repeat-measures design of the REAL study, with the addition of new methods as developed in the pilot phase. The study will gather data before, during and after the visit through interviews, surveys, experience-sampling and analysis of participants' social media posts. To control for any Hawthorne effect, the design includes two conditions, one with a full complement of assessments and one with only surveys.

The Cultivating Confidence study will achieve several objectives:

- **Examine heightened self-efficacy**. Cultivating Confidence will generate new knowledge about the kinds of science museum experiences that boost emerging adults' SSE.
- **Investigate women's increase in self-efficacy**. Discriminating among competing hypotheses, the study will determine why young women's self-efficacy remained elevated after the visit.
- **Replicate previous results**. The REAL results were unanticipated and difficult to interpret. Cultivating Confidence will replicate REAL and tease apart the confounding variables within the results, specifically exploring whether gender or lower initial SSE was the more influential factor.

Cultivating Confidence:
Young Women's Self-efficacy in Science Museums

I. Project Justification

The Exploratorium proposes *Cultivating Confidence: Young Women's Self-efficacy in Science Museums* (hereafter Cultivating Confidence), an NLG Diversity and Inclusion research project that studies the impact of a single science museum visit on "emerging adult" learners (young adults aged 18-29, not yet married, no children). Cultivating Confidence builds directly on prior IMLS-funded research that found that a science museum visit mitigated a pre-existing gender gap in science self-efficacy: Young women entered the museum with significantly lower science self-efficacy (confidence to do or learn science) than men, experienced a significant increase over the course of the visit, and remained at that same level, equal to men's, three months after the visit. Cultivating Confidence will replicate and investigate this effect further by observing male and female young adults during their visit and over the course of the following three months. The study will attempt to understand how museum visits help young women build crucially important science self-confidence. What happens during the visit and how does that affect young women's subsequent behavior and beliefs? The study will also attempt to untangle the confounding variables relating to gender and initial science self-efficacy (SSE), since the women in the prior study tended to have lower pre-visit SSE than the men.

Gender equity in science, technology, engineering and math (STEM) has been a national and global aim for over half a century (Ceci & Williams, 2007; National Center for Education Statistics, 2003; National Center for Science and Engineering Statistics, 2017; National Science Board, 2008, 2016; Organization for Economic Cooperation and Development, 2013). While the disparities between males' and females' STEM participation in educational and career pursuits have decreased over the past 30 years, important gender differences remain (Cunningham, Mulvaney Hoyer, & Sparks, 2015; Hyde, 2005; Hyde, Lindberg, Linn, Ellis, & Williams, 2008; National Science Board, 2016; Organization for Economic Cooperation and Development, 2013). Women now obtain more than 50% of the degrees in science (e.g., Coley, 2001; National Science Board, 2008, 2016), but they still earn a much smaller percentage of degrees in math, computer science and physics than men (National Research Council, 2009; National Science Board, 2008, 2016; Organization for Economic Cooperation and Development, 2013). Once women have acquired STEM degrees, they remain less likely than their male counterparts to work in STEM fields—regardless of their chosen STEM field (Beede et al., 2011; National Center for Science and Engineering Statistics, 2017). In fact, if gender representation in STEM aligned with the overall workforce, twice as many women would be in STEM positions (Beede, et al., 2011).

Unfortunately, females entertain far lower assessments of their STEM abilities than their male counterparts (Betz & Hackett, 1981; Else-Quest, Hyde, & Linn, 2010; Fredricks & Eccles, 2002; Lindberg, Hyde, & Hirsch, 2008), even when their actual abilities are equivalent. This low self-assessment compared to genuine ability has been found across decades and various topics, such as math (Bandura, 1997; Correll, 2001; Zeldin & Pajares, 2000), math as it relates to STEM (Nix, Perez-Felkner, & Thomas, 2015; Perez-Felkner, Nix, & Thomas, 2017), professional role fulfillment (Cech, Rubineau, Silbey, & Seron, 2011), topic areas traditionally unavailable to women (Betz & Hackett, 1981); and technology (Hargittai & Shafer, 2006). Females' low self-efficacy has been related to fewer STEM college degrees and lower STEM career interest (Perez-Felkner, et al., 2017; Zeldin & Pajares, 2000).

In contrast to the disheartening news on gender inequities in science, our prior study—Research on Emerging Adult Learners (REAL)—revealed a bright spot, showing that informal learning experiences positively affected females' perceptions of themselves in relation to science. A single museum visit improved young women's science self-efficacy, eliminating differences with young men three months after the visit. For example, one young woman felt that she was more capable of contributing to conversations about science: "I feel like I know a little about a lot more….I don't feel that I'm by any means an expert, but just going there makes me feel like I have a little bit more, I feel a little bit more entitled to kind of be like, 'Oh, I know. You're talking about—I saw that at the museum'….Someone will mention something and I'll be like, 'Oh, I kind of know what you're talking about.'" This unanticipated benefit for young women was discovered via post-hoc analyses, necessitating the additional exploration and hypothesis testing proposed in Cultivating Confidence. While REAL offered clues about possible explanations for the results, it left many questions unanswered. In order to motivate and describe the Cultivating Confidence study, we must first delve into the REAL project.

Emerging Adulthood

REAL focused on "emerging adults," young adults aged 18-29 years old who have neither married nor become parents. We chose this age group based on the growing psychological and sociological literature describing this period as a distinct and potentially impressionable life phase (Arnett, 2000, 2012). The traits of being unmarried and childless are critical, more important than the particular age range, because a key attribute of this life stage is a freedom from responsibility for others. Moving from adolescence toward adulthood, people undergo a process called "recentering" in which they leave behind the rule structures and family relationships of childhood to create new bonds through marriage or parenting (Tanner, Arnett, & Leis, 2009). They progress from childhood interactions that foster dependence to adult peer relations and responsibilities that require interdependence. Emerging adulthood lies between these milestones, providing emerging adults with the liberty to engage in identity work (Rounds, 2006), often seeking out experiences of self-discovery (Tanner, et al., 2009).

A relatively recent phenomenon, emerging adulthood has grown out of vast social changes in developed countries (Arnett, 2000, 2012). Perhaps the most relevant societal shift in the United States over the past 45 years has been the rapid rise in educational opportunities, especially for women. Women obtain college degrees at much higher rates today than in the 1970s, and now match college graduation rates with men (Ryan & Bauman, 2016). As women have come to spend more time within the formal education system, they have delayed traditional marriage by about 6 years and are five times more likely to become parents after the age of thirty, compared to women in the 1970s (Center for Disease Control and Prevention, 2016; Elliott & Simmons, 2011; Mathews & Hamilton, 2002; Ventura, 2012) The societal changes in marriage and child-rearing have significantly extended the period of freedom associated with re-centering and identity development, essentially creating the developmental phase of emerging adulthood. Sometimes referred to as the "age of possibility," this period allows people to feel they can try anything, even making "dramatic changes in their lives" (Tanner, et al., 2009, p. 37).

We believed that by directly engaging emerging adults, science museums might help to launch or strengthen lifelong science learning patterns, empowering those who felt less capable in science in school and broadening the connection for those who studied particular science topics. At the time of the REAL study, science museums had begun reaching out to this audience as never before with adult-only programming. Continuing today at the Exploratorium and museums around the country, such programs are typically offered in the evening, involve music and alcohol, and provide a social atmosphere for engaging adults in science learning, even those who may not think of themselves as identified with science. Examples of such programs include *Tinkering and Drinkering* at the North Carolina Museum of Life and Science, *After Hours* at the Denver Museum of Nature and Science, *NightLife* at the California Academy of Sciences, *Science After Hours* at the Franklin Institute, *Social Science* at the Science Museum of Minnesota and *After Dark* at the Exploratorium, just to name a few. Until the REAL study, the field had known little about emerging adults and their learning experiences within science museums, whether during adult-only events or normal visiting hours. Evaluation studies of adult-only programs concentrated mainly on attendance, demographics and attitudes toward the program, rather than on participants' learning experiences (e.g., Schidlow, Wright, Alexander, & Garcia-Luis, 2012; Tinworth, 2011). The REAL study focused on changes in science interest, self-efficacy and growth mindset as potential learning outcomes of the museum visit. Self-efficacy for women showed significant, long-term improvement as a result of the visit, motivating this proposal for new research; hence, we will focus on self-efficacy here.

Self-efficacy

Science museums seek to empower learners to use the process and content of science to understand and improve the world (e.g., Boston Museum of Science, 2016; Exploratorium, 2016; Science Museum of Minnesota, 2016). For example, Frank Oppenheimer, founder of the Exploratorium—a museum that helped establish the field of science centers (Ogawa, Loomis, & Crain, 2008)—once stated, “The whole point of the Exploratorium is to make it possible for people to *believe they can understand* the world around them” (Semper, 1990, p. 55, italics added). This belief about one’s capacity to learn and understand, referred to as self-efficacy in the cognitive sciences literature, can have a strong effect on performance in school and associated learning behaviors such as persistence, expended effort and even emotional responses like excitement or fear (Bandura, 1986, 1997; Pajares & Usher, 2008; Yoon, 2009; Zimmerman, Bandura, & Martinez-Pons, 1992).

In a review of the research on self-efficacy, Ellen Usher (Adviser to Cultivating Confidence) and Frank Pajaraes found evidence from dozens of studies that greater self-efficacy leads to myriad positive outcomes for school students, including productive cognitive states, greater academic achievement, and constructive choices in college major and career (Usher & Pajares, 2008). Several studies in the review focused specifically on science self-efficacy, revealing its positive relationship to science learning. Many centered on college students, who represent part of the emerging adult population. Additional research on college students bear out the positive effects of self-efficacy on achievement (e.g., Chemers, Hu, & Garcia, 2001).

Unfortunately, women have been found to have lower STEM self-efficacy and higher “science anxiety” than men in some domains (Hill, Corbett, & Rose, 2010; Nix, et al., 2015). Recently, researchers investigating underrepresentation in STEM at the college and career levels have studied how a broad spectrum of factors such as self-efficacy, interests and outcome expectations can influence an individual’s career goal attainment (Byars-Winston, Estrada, Howard, Davis, & Zalapa, 2010; Lent et al., 2008; Marra, Rodgers, Shen, & Bogue, 2009; Nauta & Epperson, 2003; Nix, et al., 2015; Perez-Felkner, et al., 2017; Scott & Mallinckrodt, 2005; Zeldin, Britner, & Pajares, 2008). Self-efficacy has typically been the largest contributing element (Lent, et al., 2008; Lindley, 2005; Pajares, 1996).

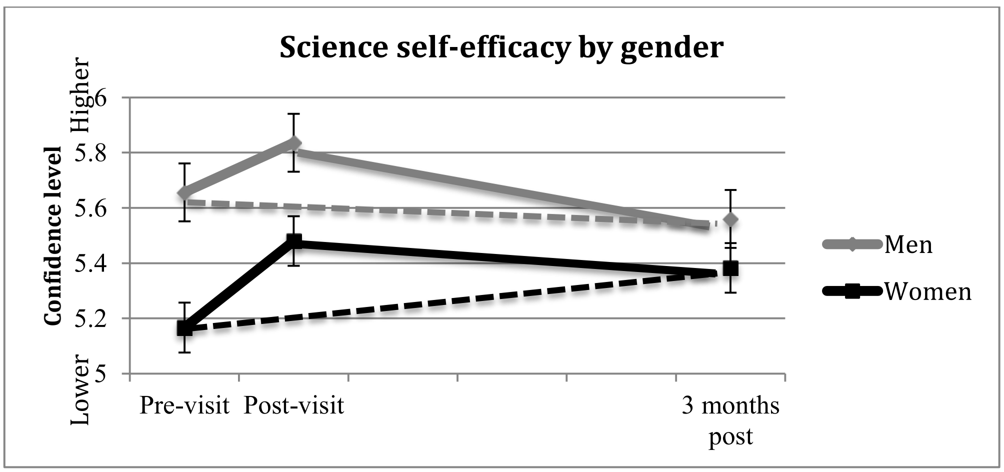
When Albert Bandura (1977a) proposed his theory of self-efficacy forty years ago, he posited that different types of experience would influence a person’s self-efficacy, either positively or negatively, and named them “sources.” Since that time, many research studies have found support for his four sources of self-efficacy (Bandura, 1997; Chen & Usher, 2013; Usher & Pajares, 2008):

- Performance Interpretation—perceived success or failure in a task,
- Vicarious experiences—observation of others and exposure to role models,
- Social Persuasions—evaluative messages from others, and
- Physiological/Emotional states—affective or emotional responses.

Museums offer many opportunities for positive encounters with all four sources. REAL found examples of visitors successfully using and understanding exhibits (performance interpretation), watching others to learn how to manipulate exhibits (vicarious experiences), complimenting one another on their successes (social persuasions) and feeling joy in discovery and creation (physiological/emotional). In most studies of self-efficacy, performance interpretation has been found to be the most influential source of self-efficacy, for both females and males (Chen & Usher, 2013; Usher & Pajares, 2008). Meanwhile, some evidence has indicated that women in STEM careers rely more heavily than men on vicarious experiences and social persuasions for self-efficacy in their chosen fields (Zeldin, et al., 2008). In addition, women in college have been found to utilize physiological/emotional experiences as sources of self-efficacy to a greater degree than men (Usher & Pajares, 2008). Cultivating Confidence will investigate and analyze the different sources of science self-efficacy for emerging adults in a science museum.

Prior Exploratorium Research on Emerging Adults' Science Self-efficacy

The REAL study employed a repeat-measures design in which we surveyed 244 emerging adults as they entered the Exploratorium, then again as they exited and a third time 3 months after the visit. Half of the participants were also interviewed at exit and 3 months after the visit. To assess science self-efficacy (SSE) in emerging adults, the surveys employed 7 Likert-type items worded in accordance with Bandura's (2006) guidelines and adapted for the museum context (Chen & Usher, 2013). Participants rated their confidence in their ability to engage in seven different science activities (e.g., "Learn about a new science idea," "Come up with fruitful questions to ask about a science-related issue," and "Do a little experiment to figure out how something behaves or works"). The graph below shows the means and standard error bars of self-efficacy, yielding these results: (1) Men had significantly higher SSE than women upon entering the museum; (2) The museum visit significantly increased SSE for men and women; (3) Three months after the visit, women's SSE significantly increased to meet that of men's (dashed lines). (For a full description of the study and its results, please see Gutwill (in press)).



Through exit interviews that asked participants to describe an experience in the museum that raised their science self-confidence "even by a little bit," we found that both women and men most often cited performance interpretation as a source of heightened self-efficacy. For them, successful interactions at exhibits—effectively manipulating the exhibit, doing productive inquiry or understanding its content—increased their confidence to do or learn science. A majority of them also cited positive physiological/emotional states as sources of their SSE, a rare result in studies of SSE in schools, reflecting the joyful learning experiences offered in science museums. We did not detect gender differences in the sources of SSE, but our methods were not designed to do so. Moreover, these results emerged from self-reports at the end of the visit, rather than observations made during actual interactions at exhibits. Cultivating Confidence will gather additional data during the visit to better understand museum-inspired sources of SSE.

The interviews we conducted three months after the visit offered us hints about why women's self-efficacy remained elevated. In those delayed-post interviews, significantly more young women than men told us that they had had some sort of confidence-boosting experience related to science since the visit, as shown in the table below.

Gender	Confidence-boosting Experience after Visit		
	Yes	No	Total
Male	3 (12%)	22 (88%)	25 (100%)
Female	12 (43%)	16 (57%)	28 (100%)

Note: $\chi^2 = 6.2$, $p < .05$

For example, immediately after the visit, a young school teacher talked about her experience playing with magnifying glasses in the museum. Three months later, she mentioned that she introduced magnifying glasses to her students and felt greater confidence teaching science with them:

> I have, in my classroom, put magnifying glasses, and now all my kids are obsessed with looking at them, looking at each other, looking at different things. And they go around the room exploring everything with the magnifying glasses….[The museum visit] definitely made me feel like I understand more, learning the magnifying glasses, telling the kids….So it just kind of made me feel more confident in knowing more about what I knew in science and giving—and trying different things.

It seems that confidence-enhancing experiences after the visit were more prevalent for young women than young men. But why? And in what ways did the visit to the Exploratorium set the stage for such experiences? Although post and delayed-post interviews captured some aspects of the SSE-boosting experiences that occurred during and after the museum visit, those self-reports lacked critical information about the type and frequency of events that may enhance SSE. In addition, the REAL study was not designed as a gender study. It did not include a large enough pool of young men with initially low SSE for conclusive interpretation of a gender effect. Multiple, competing explanations remained for how the visit may affect immediate and long-term science self-efficacy. Here are the possibilities we would like to explore in Cultivating Confidence, with the hopes that the findings will discriminate among them:

Activating new behaviors for young women. Educators in the museum field have hypothesized that a museum visit "activates" people, making them crave additional, related experiences (Dorph, Cannady, & Schunn, 2016; Falk & Dierking, 1992, 2000; Falk et al., 2016; Vincent-Ruz & Schunn, 2017). Employing this model of museum visits to explain the REAL results, one would posit that the female participants' increased sense of self-efficacy from the visit led them to seek out more science experiences in the three months following the visit. We can explore this hypothesis by assessing whether participants with an elevated level of SSE pursued more science experiences after the visit. Evidence that women sought out even more science-related activities than men after the museum visit would offer additional support for this hypothesis.

Priming awareness for young women. Another possible explanation is that the young women's greater science self-efficacy during the visit made them more aware of those positive beliefs. This greater awareness helped them notice when they felt greater SSE in subsequent experiences. In short, the visit may prime women to be aware of subsequent, confidence-boosting encounters with science. Priming fits well with Bandura's (1977b) theory that learners' current self-efficacy will influence how successive experiences affect future self-efficacy: "The extent to which people will alter their perceived efficacy through performance experiences depends upon…their *preconceptions* of their capabilities" (p. 81, italics added). According to this view, participants with increased SSE should remember the visit better or be more aware of the science in their subsequent activities. Evidence that the priming effect was stronger for women would lend further support for this hypothesis.

Leveling the playing field for all. Emerging adult women entered the museum with lower science self-efficacy than men. It is possible that the REAL project's results were due more to disparities in initial SSE than to gender differences. Perhaps people of both genders with lower initial SSE were more affected by the visit than those with higher self-efficacy, or perhaps there was a ceiling effect for the high SSE participants. Some researchers argue for a “gender similarities hypothesis”—the notion that most gender differences are much smaller than commonly believed—and point out that emphasizing gender differences comes at the cost of strengthening stereotypes and limiting the roles that both men and women take in society (Hyde, 2005, 2014). In the REAL project, there were too few young men with low initial SSE in the sample to rule out the possibility that the true effect was masquerading as a gender effect. Cultivating Confidence will oversample young men to find enough with lower initial SSE to disentangle this potentially confounding variable. If both men and women with low initial SSE increase their SSE three months after the visit, we would conclude that museums support all learners in need, regardless of gender. We would also explore differences between low and high SSE participants in their visit experience and post-visit activities.

The proposed study will attempt to discriminate among these hypotheses by exploring emerging adults’ experiences within and outside the museum in greater depth. In doing so, we will view gender as a spectrum and will ensure participants identify their own genders (see Assessments below).

Research Questions

The research questions in Cultivating Confidence are:

RQ1. How does the museum experience contribute to immediate increases in science self-efficacy? Which sources of science self-efficacy are most impactful for people of different genders?

RQ2. What happens after the visit? Does the visit influence the number and type of subsequent, science-related experiences participants have? How do post-visit activities affect long-term science self-efficacy? Do the results differ by gender?

RQ3. To what extent are the immediate and longer-term boosts to science self-efficacy due to initially low levels of self-efficacy, rather than gender? Do the results from the original REAL study replicate and confirm a gender effect?

In the next section, we describe our study design to pursue these questions.

II. Project Work Plan

The project will be implemented in two phases, a pilot phase and a full study phase.

Pilot Phase

During a 6 month-long pilot phase, we will improve existing measures and develop and validate new methods in order to answer our three Research Questions.

RQ1. **Self-efficacy experience sampling**. We wish to learn more about the sources of self-efficacy that lead to increased confidence immediately after the visit. To accomplish this goal, we will pilot a technique for gaining in-situ information, called the Experience-Sampling Method (ESM), in which participants receive a short survey via text message at random intervals throughout their visit (Csikszentmihalyi & Larson, 2014; Zirkel, Garcia, & Murphy, 2015). The survey will ask them to rate the degree to which they experienced the four sources of self-efficacy at the most recent exhibit they encountered, as well as the valence (positive or negative) of those sources on their SSE. The ESM surveys will indicate which sources are most prevalent in exhibit experiences, the direction of influence (positive or negative) of those sources, and the strength of that influence. The data will be related to changes in participants' science self-efficacy.

RQ2. Capture and analysis of social media. Learning more about participants' post-visit activities is an important new aspect of the proposed research. Participants actively seeking out new science-related experiences would constitute support for the *Activating new behaviors* hypothesis, whereas participants feeling more confident about their normal pursuits would provide evidence in favor of *Priming awareness*. In addition to asking participants to report on their SSE in interviews, we will build on the work of Goodman and Light (2016) to pilot-test a process for analyzing participants' social media streams—Twitter, Facebook, Instagram, Pinterest—for science activity. (Dr. Light is a Cultivating Confidence adviser.) With participants' permission, we will download all messages from participants' public accounts for the period beginning one month before the visit until three months following it. Using sophisticated algorithms offered by firms such as Lexalytics, we will pilot a semi-automated process for coding posts for science-related experiences. If that fails to work well in the pilot, we will randomly sample a subset of the full study participants, and researchers will code their postings. Coding social media posts will detect changes in frequency and type of shared science activities (e.g., formal or informal), and possibly yield information about sources of self-efficacy in those activities. We would expect that participants who are *activated* will publish more science-related posts per week after the visit than before, whereas those who are merely *primed* will not.

RQ3. Recruitment methods. We will utilize the same survey and interview questions for self-efficacy employed in the REAL project, allowing us to replicate that study. To determine whether long-term differences were due primarily to gender or pre-visit self-efficacy, we must recruit more young men with low self-efficacy. The gender similarities hypothesis highlights the problem of claiming gender differences where none exists (Hyde, 2005). We will pilot new recruitment methods to oversample young men, measuring their initial self-efficacy to ensure a large enough low-SSE subset for inclusion in the study.

The pilot phase to develop new methods in experience-sampling, social media analysis and recruitment will involve working with individuals and focus groups. This phase will gather valuable information about emerging adults' experience in the museum and their willingness to participate in the kinds of activities outlined above.

Full Study Phase

Cultivating Confidence's full study design will replicate and expand upon the repeat-measures design of the REAL study, with the addition of new methods as developed in the pilot phase. There will be two conditions, with random assignment to each:

1. **Deep Investigation Condition:** Participants in this group will be given all of the assessments, including pre/post/delayed-post surveys, experience-sampling, pre and post social media analysis, and post and delayed-post interviews. This group will allow us to pursue RQ1 and RQ2.
2. **Replication Control Condition:** These participants will be given the pre/post/delayed-post surveys and have their social media posts analyzed. They will serve to replicate the REAL study and act as a control group for the impact of the in-depth assessments on science self-efficacy. Analysis of their social media posts will help us answer RQ2 and analysis of their surveys will permit us to resolve RQ3 in an ecologically valid manner.

The figure below provides an outline of the study design, with assessments implemented chronologically from left to right.

Time →						
1 Month Before Visit		**Museum Visit**				**3 Months After Visit**
		Pre-Survey	Experience Sampling*	Post-Survey Post-Interview*		Delayed Post Survey Delayed Post-Interview*
Social Media Analysis					Social Media Analysis	

*Only Deep Investigation participants will contribute responses.

Assessments. Gender is a complicated variable. In the post-visit survey, we will ask visitors to self-identify as: female, male, and "another category" with a write-in space. These three options were developed by a panel of non-binary and gender-queer advisors for the Exploratorium's exit survey. Results from the past year find less than 1% of visitors self-identify as another category for gender. We will run and report descriptive results or case studies for participants in another category, if there is too small a sample for statistical analyses.

The surveys will use Likert-type scales to assess participants' SSE, interest in science, museum experience and demographics. Surveys will also include IMLS-required questions about interest and understanding. Experience sampling will measure in situ sources of science self-efficacy, with responses transformed into positive and negative scores for each participant and SSE source. Social media analysis will determine frequency and type of science activities each participant describes in their posts. Expanding on questions and coding schemes from REAL, interviews will delve into participants' science self-efficacy, sources of self-efficacy and relevant activities within the museum and after the visit. Responses will provide richer understanding and also be coded for quantitative analyses. Pre-post change in social media posts and interview responses will be integrated to categorize each participant as activated, primed or other in order to help us discriminate among the first two competing hypotheses in the study. To explore the third hypothesis, we will categorize participants as having initially low SSE, or not, using their pre-visit SSE score.

Planned Comparisons. To answer our research questions, we will conduct the following planned comparisons with pre/post and pre/delayed-post change in science self-efficacy as our main outcomes measures:

RQ1: Within-group comparisons in the Deep Investigation Condition. We will run separate linear regressions for each gender category, where the dependent variable will be pre-to-post change in SSE and the predictor variables will be the four sources of self-efficacy measured via experience sampling. These models will allow us to control for the effects of each source and understand its unique contribution to change in SSE for each gender category.

RQ2: Within-group comparisons in each of the two Conditions. We will conduct a repeat-measures Analysis of Variance (ANOVA) with gender and time (pre to post) as independent variables to determine whether the frequencies of social media science posts change as a result of the visit.

We will conduct an Analysis of Variance (ANOVA) with gender and activated/primed as independent variables and pre-delayed-post change in SSE as the dependent variable. This will allow us to explore influences on long-term change in SSE: the main effects of gender, the main effects of the activated/primed variable to distinguish between alternative hypotheses, and the interaction effects to see how these alternatives may vary by gender.

We will analyze data from both interviews to help categorize participants as activated, primed or other. Analyses of the delayed-post interview will identify the sources of SSE found in experiences after the visit. Codes may be represented in descriptive statistics.

RQ3: Within-group and between-group comparisons in the Replication Control Condition. We will employ ANOVAs, where the dependent measures are pre-post and pre-delayed-post SSE difference scores and the independent variables are gender and low initial self-efficacy, looking for main and interaction effects. This will serve as a larger scale replication of the original REAL study and a test of whether gender or initial SSE level have greater support as underlying factors.

To determine whether the SSE impacts are due to the museum visit or our deeper investigation assessments (i.e., a Hawthorne effect), we will conduct two ANOVAs with pre-post or pre-delayed-post SSE difference scores as dependent variables, and gender and Condition as the independent variables. We are interested in the main effects of Condition, and the interaction effects of gender by condition to check if the impacts of assessment vary by gender. If there are differences by Condition, we will use the Replication Control Condition to replicate the initial REAL results, otherwise the analyses in RQ2 will serve to replicate those findings.

Based on the sample sizes and effect sizes from the REAL study, we estimate that a sample size of 160 in each of the two conditions will allow us to detect small but significant effects in our comparisons. To ensure that 320 participants complete our assessments at all three stages—pre, post and delayed-post, we must account for attrition (the REAL study had a 60% retention rate). In addition, we wish to recruit equal numbers of young men and women who have *low* SSE when they enter the museum, but men were found to have generally higher SSE in REAL. Thus, we will need to oversample young men by a factor of 2 to find enough men with low SSE. To achieve our aim of 320 final participants, then, we estimate we will need to recruit 670 participants. The REAL study recruited only 253 participants with 152 completing the study, divided into two cohorts (interview+survey and survey-only). Cultivating Confidence more than doubles the number of participants and adds two entirely new assessment methods—experience sampling and social media analysis—to dig deeper into the impact of the visit on participants.

Dissemination. We will share the results of the study with both the research and practice communities within the museum field. We hope to inform researchers who study gender gaps in STEM learning and self-efficacy in informal environments. (Cultivating Confidence advisers Drs. Cannady, Eccles and Perez-Felkner have expertise in these areas.) We also wish to reach practitioners who develop adult programs as well as leaders in museum marketing to help them better understand the value of the museum experience to emerging adult learners, and to young women in particular. To accomplish these aims, we will organize sessions on self-efficacy and museums at three conferences. Two conferences will speak to science museum researchers and practitioners (e.g., ASTC, AAM, and VSA) and the other will be a gender conference (e.g., Gender Summit). We will also publish at least one article in a museum journal (e.g., Curator or Visitor Studies). Finally, we will create an aesthetically pleasing, single-page document that depicts the motivations for the study and its results. To inform emerging adult women directly about the benefits of a museum visit, this document will be shared on the Exploratorium's social media channels, website, distributed to local universities' STEM departments and circulated among local organizations that reach young women (e.g., meetup.org).

III. Project Results

This study will achieve several objectives:

- **Examine heightened self-efficacy**. Cultivating Confidence will generate knowledge about the kinds of science museum experiences that nurture emerging adults' SSE.
- **Investigate women's increase in self-efficacy**. Discriminating among competing hypotheses, the study will determine why young women's self-efficacy remained elevated after the visit.
- **Replicate previous results**. The REAL results were unanticipated and difficult to interpret. Cultivating Confidence will replicate REAL and tease apart the confounding variables within the results, specifically exploring whether gender or lower initial SSE was the more influential factor.

IV. List of Key Project Staff and Consultants

Project Leaders

PI Joshua Gutwill, PhD, is Director of Visitor Research at the Exploratorium. He was Principal Investigator (PI) for the REAL project and will lead Cultivating Confidence, overseeing all aspects including communication with advisers, experimental design, development of assessment instruments, data collection, coding, analysis, and dissemination.

Co-PI Toni Dancstep, PhD, is Senior Researcher at the Exploratorium. Dr. Dancu was PI for the NSF-Funded project Exhibit Designs for Girls' Engagement, a large-scale multi-institution study that identified important exhibit designs for engaging girls. She will co-lead the project, focusing on designing and implementing both phases of the study.

Advisers

Matthew (Mac) Cannady, PhD, is Director of Quantitative Studies at the University of California, Berkeley's Lawrence Hall of Science, and a co-PI of the Learning Activation Lab, a national research and design effort to learn and demonstrate how to activate children in ways that ignite persistent engagement in science, technology, engineering, art, and mathematics learning and innovation.

Jacquelynn Eccles, PhD, is Distinguished Professor of Education at the University of California, Irvine. Dr. Eccles conducts research on a wide variety of topics including gender-role socialization, teacher expectancies, classroom influences on student motivation, and social development in the family and school context. (Note: Dr. Eccles has agreed to be an advisor, but is travelling in Mexico and was unable to get a Letter of Commitment to us by the proposal submission deadline).

Daniel Light, PhD, is Research Scientist at the Educational Development Center (EDC) in Massachusetts. He brings expertise in both qualitative and quantitative methodologies to his leadership of studies that seek to identify new strategies to improve outcomes for learners of all ages, particularly those in under-resourced communities. He is currently the PI on an NSF grant, Twitter and Informal Science Learning and Engagement (NSF1438898).

Lara Perez-Felkner, PhD, is Assistant Professor of Higher Education and Sociology in the College of Education at Florida State University. Her research investigates racial-ethnic, gender, and socioeconomic disparities in collegiate educational attainment and entry to scientific career fields.

Ellen Usher, PhD, is Associate Professor in the Department of Educational, School, and Counseling Psychology at the University of Kentucky where she also directs the P20 Motivation and Learning Lab. Her research focuses on exploring how the beliefs people hold are influenced by social, environmental, and internal events and how these beliefs, in turn, influence people's behaviors and the environments in which they live.

IV. Schedule of Completion

Year 1

	2018			2019								
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Pilot-Test New Methods												
Adviser check-in	■											
Literature search	■	■										
Recruitment strategy trials	■	■										
Experience sampling trials		■	■	■	■							
Social media (SM) capture trials				■	■	■						
Focus groups		■		■		■						
Revise surveys & interviews						■						
In-person Adviser meeting							■					
Conference to check methods							■					
Full Data collection												
In-museum assessments								■	■	■	■	■
SM capture											■	■
Delayed-post assessments											■	■
Data Management												
Check quantitative data								■	■			
Transcribe interviews									■	■	■	■
Adapt REAL coding schemes									■	■		
Code interviews											■	■

Year 2

	2019			2020								
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Full Data collection (cont.)												
In-museum assessments	■	■	■	■	■	■	■					
SM capture	■	■	■	■	■	■	■	■	■	■		
Delayed-post assessments	■	■	■	■	■	■	■	■	■	■		
Data Management (cont.)												
Transcribe interviews	■	■	■	■	■	■	■	■	■	■	■	■
Code interviews							■	■	■	■	■	■
Develop SM coding schemes	■	■	■									
Code SM posts				■	■	■	■	■	■	■	■	■

Year 3

	2020			2021								
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Data Analysis												
Planned Comparisons	■	■	■									
Post-hoc analyses			■	■								
Case studies					■	■						
Dissemination												
Deliver conference presentations	■						■			■		
Write & submit journal article(s)							■	■	■	■	■	■