

OUR EARTH'S FUTURE



FINAL EVALUATION REPORT

September 2015

Rockman et al
Independent · Insightful · Informative

ATTRIBUTIONS

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INTRODUCTION

In its program, “Maximizing Lifelong Learning Opportunities: Innovative Strategies for Science Museums,” the American Museum of Natural History sought to develop, implement and assess a series of online and face-to-face adult learning courses, that shared the name “Our Earth’s Future” and focused on the topic of climate change. An external evaluation of this effort was conducted by Rockman et al, an independent evaluation firm that specializes in the evaluation of informal science learning programs. This research effort builds on prior knowledge gained from studies of adult learning programs in the museum’s Sackler Lab, and sought to provide a more detailed understanding of adult’s learning preferences and processes in addition to examining course outcomes and impacts.

PROGRAM OVERVIEW

AMNH offered adult learners an opportunity to “become fluent in the science of climate change” through a series of onsite and online courses in 2014 and 2015. Instructional themes emphasized within the course included scientific knowledge and limitations of knowledge, dynamic systems in climate change (Eulerian vs. Lagrangian perspectives), logic (including risk assessment and cognitive bias), temporal and geospatial scales, and verbal and visual communication of scientific information. The course addressed the following factual content: climate system, paleoclimate, climate models and sources of climate variability, and sought to promote the following skills: evaluation of information from multiple sources, interpretation of visualizations, articulating a basic understanding of climate change, and the ability to respond to arguments against climate change.

All courses in the “Our Earth’s Future” were taught by Debra Tillinger, a Physics professor at Marymount Manhattan College who specializes in the study of ocean and climate physics. Guest lecturers included experts in climatology, oceanography, Earth science, and anthropology. Debra was supported in her instructional efforts by specialists and support staff at the museum.

A total of nine courses were studied as part of the evaluation associated with the Maximizing Lifelong Learning Opportunities project including four five-week “Our Earth’s Future” onsite courses at the Museum:

- May 1st—May 29th 2014
- June 10th – July 8th 2014
- March 3rd – March 31st 2015
- June 6th—June 29th 2015

Two ten-week “Our Earth’s Future” online courses:



- October 20th — December 14th 2014
- June 15th – August 23rd 2015

And three three-week online courses, focused on more specific themes:

- Extreme Weather: March 30th — April 19th 2015
- Rising Seas: April 20th – May 10th 2015
- Life Responding to Climate Change: May 11th – May 31st 2015

The following table provides an overview of when each course was offered, broken down by onsite and online offerings. All five-week and ten-week courses were titled “Our Earth’s Future,” whereas the three-week online courses were given an additional title to qualify the topic on which they were uniquely focused.

Table 1: Overview of Onsite and Online “Our Earth’s Future” Courses

	 ONSITE	 ONLINE
2014	5-Week: May 1 st —May 29 th	
	5-Week: June 10 th —July 8 th	
		10-week: October 20 th —December 14 th
2015	5-week: March 3 rd —March 31 st	
		3-week: March 30 th —April 19 th Extreme Weather
		3-week: April 20 th —May 10 th Rising Seas
		3-week: May 11 th —May 31 st Life Responding to Climate Change
	5-week: June 6 th —June 29 th	
		10-week: June 15 th —August 23 rd

EVALUATION METHODOLOGY

The evaluation of the “Maximizing Lifelong Learning Opportunities: Innovative Strategies for Science Museums” program, and its various offerings, adopted the following overarching goals:

- **Enrollment Trends:** To better understand adults’ reasons for participating in informal learning programs - including adult-learner’s decision-making process, a better understanding of how the museum fits into the overall adult learning landscape, learners’ decision to enroll and subsequent outcomes:
- **Participation Trends:** To track participation patterns in the various course formats and to identify characteristics and trends including frequencies of higher and lower levels of engagement with course resources and other learners, and factors that influence engagement during the course and course completion.
- **Course Outcomes:** To identify outcomes of the course including self-identification as life-long learners and content knowledge ranging from the science of climate change to skills related to argumentation about scientific topics in a more general sense.
- **Take-Aways:** To find broad and generalizable take-aways that are applicable to the larger field of adult informal learning.

To accomplish these goals, the two-year evaluation effort included a mix of qualitative and quantitative methodologies including pre- and post-course surveys, onsite and online observations, monitoring of online participation data and trends, focus groups with course participants, and participant interviews. Each of these methodologies are described in greater detail below.

Pre/Post-Course Surveys

Pre and Post-course surveys were developed by Rockman et al, in conjunction with stakeholders at AMNH and administered to participants in online and onsite courses. Various iterations of the pre-course survey were used during the evaluation, but the following goals remained at the heart of each pre-course survey:

- Determine the extent to which different program elements and features, including the perceived value of the museum setting and museum resources, were a factor in participant's decision to enroll in the course,
- Establish participants' attitudes and beliefs toward the museum as an institution that offers life-long learning opportunities,
- Establish participants' self-rated levels of identification as life-long learners,
- Establish a sense of participants' prior experiences as adult learners, and
- Establish participants' self-rated confidence in their ability to speak about climate change and other scientific topics.

Likewise, there were slightly different versions of the post-course survey used over the course of this evaluation, but all instruments were designed to fulfill the following goals:

- Establish the relative value of different course elements in terms of enjoyability, educational value, level of engagement and interest they produced, and the extent to which they foster greater conversational ability,
- Establish the extent to which participants' views on the value of a museum as a source and site for adult learning have changed,
- Re-assess participants' self-rated levels of identity as life-long learners,
- Re-assess participants' self-rated confidence in their ability to speak about climate change and other scientific topics, and
- Seek constructive feedback about the course.

Course Observations

In addition to a mix of quantitative and qualitative data from the pre- and post-course surveys, a member of the evaluation team observed sessions during three of the four onsite five-week courses that were offered at the American Museum of Natural History. As part of those observations, a member of our research team was able to speak with participants about their experiences in the course and note aspects of the course where participants were particularly engaged.

Members of the evaluation also observed online course participation. Our virtual observations of the online courses included reading and tracking the number of posts in online course discussion forums and observing trends and patterns associated with online course participation (e.g., number of participants who logged in, and the numbers of participants who took quizzes, read articles, and watched videos).

Focus Groups and Interviews

A focus group was conducted with participants after the final onsite course session at the American Museum of Natural History. Informal interviews were also conducted with course participants during the cocktail party held as part of the final course session. To gather feedback from online course participants, a series of interviews were conducted with people who had participated in either a three-week and/or ten-week online course.

REPORT OVERVIEW

This report is broken up into sections that correspond with the overarching goals of the evaluation, i.e.: enrollment trends, participation trends, course outcomes, and big takeaways that can potentially be generalizable to other adult learning programs. These sections are followed by appendices where-in examples of specific questions and response options can be found. Where applicable, this report references literature and previous findings related to other adult learning programs at the American Museum of Natural History that were also evaluated by Rockman et al.

THE ADULT LEARNING LANDSCAPE

Malcolm Knowles (1913-1997) was one of the first modern scholars to assert that adults learn differently than children. He is credited with popularizing the term “andragogy” to describe instructional practices oriented toward adults and he developed adult learning theories based on the unique characteristics of adult learners. Knowles organized a list of unique characteristics that apply to adult learners, including adults’ tendency toward self-directed learning, adults’ goal-oriented, relevancy-oriented and practical learning preferences, and adults’ wealth of life experiences and subsequent need for respect.

How Adult Learners Learn

Adult learners learn differently than children. Adults and adults’ brains are different than children and children’s brains. Subsequently, there are neurological differences in how adult brains are wired to learn new things. Children learn by creating new cell assemblies and phase sequences whereas adults learn by forming new arrangements with those assemblies and sequences that have been created in the past (Conner 2007). Adults, on the other hand, must make connections to previous knowledge and experiences, and misconceptions may need to be corrected along the way.

Adult learners must make connections to prior knowledge. Unlike youth who start off with a more or less blank slate on which to build new understanding, adult learners, who have amassed a wealth of experience and knowledge over the course of their lifetimes, need to be supported in their effort to form connections between new information and information that has been previously learned.

Adult learners may need to correct misconceptions. In addition to prior knowledge that helps adult learners to better connect and integrate new information, adults may hold some “knowledge” that is incorrect, or improperly associated. This can result in mental conflicts that may ultimately require more time and more effort for an adult to learn new information.

Adults are goal-oriented. When adults seek out learning opportunities they often have specific goals in mind. These goals can vary over time depending on an adult learner’s needs at different points in their life, and often vary from one adult learner to the next. Within the same adult learning program, one adult learner may be seeking to expand her knowledge to help advance a career or performance at work, another may be seeking information that can help improve the way he lives or raises his children, and another may simply be looking to have fun socializing with other adults while being mentally stimulated. Because adults’ goals can vary so widely, especially in the context of informal learning, it is important for instructors to seek information from each participant on their own unique goals, and understand the potential for there to be competing interests among adult participants in any educational program.

Adults seek relevancy. Instinctively, adults focus on the things that are most useful to them in their own lives—the more relevant information is to an adult’s own experiences, the easier it is

for them to understand and retain the information. Conner (2007) suggests that “*rote learning frustrates [adults] because the brain resists meaningless stimuli. When we invoke the brain’s natural capacity to integrate information, however, we can assimilate boundless amounts.*” In instances where the relevancy of certain information may not be readily apparent to adult learners, pointing out how or why it is important—especially on a personal level—can help to build buy-in to the learning process.

Adult learners are practical. Adults have many responsibilities and great demands on their time and attention. They are therefore interested in learning things in the most efficient way possible. They prefer focusing on the key points and being given options and resources to expand their knowledge or explore related topics that pique their interest as time permits.

Adults are self-directed learners. Adults appreciate the flexibility to learn at their own pace and in their own way. Adult learning programs that provide options and a wide range of resources for participants to take an active role in directing their own learning can help to ensure that each learner’s goals are being met. On a similar note, adult learning programs that make assignments or activities mandatory may displease some adult participants.

Adults want to be respected. While they value the expertise of others, adults want their own experiences and knowledge to be acknowledged and equally valued by instructors and peers. Opportunities for participants to share examples from their own experiences can help create a sense that all participants are a valuable part of a learning community, where everyone—novice and expert alike—have important things to share and contribute. Being able to share examples from their own experiences can also help adult learners form connections and learn new information better. Instructors should seek to set a tone where all participants’ contributions to the learning experience are valued. Adult learners appreciate facilitators who share information about their own connections to the content as well.

Adults need a learning environment that helps minimize their fear of failure. A young child learning to walk fails hundreds of times before he finally succeeds, but over time, humans come to fear failure. By the time we become adults we tend to avoid situations where we might fail. This fear of failure may lead adults to be more reluctant to fully participate in educational experiences, even though failure can be an important part of the learning process. Instructors can address adult learners’ fears by assuring them that it is okay to make a few mistakes along the way. Providing opportunities to practice or prepare in private before doing something in front of their peers may also help to put adult learners at ease. Additionally, instructors can help moderate discussions so that participants whose views or beliefs differ from those of their classmates still feel like they are a part of the group, rather than outsiders. Because adult learners learn in different ways and at different speeds, it is important for instructors to be attentive to differences among participants and remind everyone that it is okay to take more or less time or different paths to learning something.

Why Adults Seek to Learn

There are different reasons that adult learners seek out learning opportunities. In his book, *The Inquiring Mind: A study of the adult who continues to learn* (1963), adult education scholar Cyril Houle identified three types of motivational orientations within adult learners: goal-oriented, activity-oriented and learning-oriented. Goal-oriented learners seek to achieve a specific goal, activity-oriented learners enjoy the act of learning including the social nature of many learning experiences, and learning-oriented adults are driven by an innate desire to learn.

Subsequent researchers have sought to enhance and refine Houle's list of motivations. Morstain and Smart (1974) developed the following shortened list of motivational factors based on Boshier's (1971) 48-item Educational Participation Scale:

- Social Relationships – making new acquaintances, having social interactions
- External Expectations – sometimes adult learners are required to learn new things
- Professional Advancement – while not required, adults may also seek out learning opportunities to advance along their career path
- Social Welfare – wanting to serve others and the community
- Escape/Stimulation – learning is something to do; a hobby for some
- Cognitive Interest – genuine interest in learning for the sake of learning

An adult learning program can benefit from seeking input from participants about their own personal motivations for participation. There may also be value in strategically seeking to meet one or more of the needs stated above.

Stakeholders at AMNH took much of the information presented above into consideration when developing the "Our Earth's Future Course." As such, the course was well-grounded in available theory and research related to adult learning and they strategically sought to capitalize on the best-practices put forth by scholars in the field of adult learning. With this IMLS-funded initiative, the museum stakeholders and external evaluation team also sought to expand the field's understanding of the unique considerations for adult learning in informal settings.

ENROLLEMENT TRENDS

Adult learners have many competing demands on their time and mental resources. As part of this evaluation, we were therefore interested in learning more about the decision-making processes that underlie adults' pursuit of informal learning opportunities.

NUMBER OF PARTICIPANTS

Each of the online courses had about 30 enrolled participants, whereas the number of participants in each of the online courses varied. The following table displays the number of enrolled participants and the number of survey respondents. In general, the numbers reported below best approximate the number of potential respondents for any question on a given survey.

Table 2: Number of Enrolled Participants and Survey Respondents*

		Number Enrolled	Pre-Course Survey Respondents	Post-Course Survey Respondents
Onsite	5-Week: May 1 st —May 29 th 2014	~30	16	16
	5-Week: June 10 th —July 8 th 2014	~30	0**	18
	5-week: March 3 rd —March 31 st 2015	~30	25	15
	5-week: June 6 th —June 29 th 2015	~30	12	18
Online	3-week: March 30 th —April 19 th 2015 Extreme Weather	128	150***	15
	3-week: April 20 th —May 10 th 2015 Rising Seas	87		13
	3-week: May 11 th —May 31 st 2015 Life Responding to Climate Change	144		23
	10-week: October 20 th —Dec.14 th 2014	103	55	12
	10-week: June 15 th —August 23 rd 2015	224	81	39

* Enrollment number for online courses are based off of roster of participants who registered for the course and who were emailed the link for the pre- and post-course survey. In some cases, enrolled participants did not actually go on to participate in the course. Participation trends will be explored in greater detail in the next section of this report.

** The pre-course survey was not administered to participants in the second onsite course.

***Since there were many participants in the series of three 3-week courses who took multiple courses, but did not elect to complete a pre-course survey each time, we have consolidated all pre-course surveys for the 3-week courses into one data set.

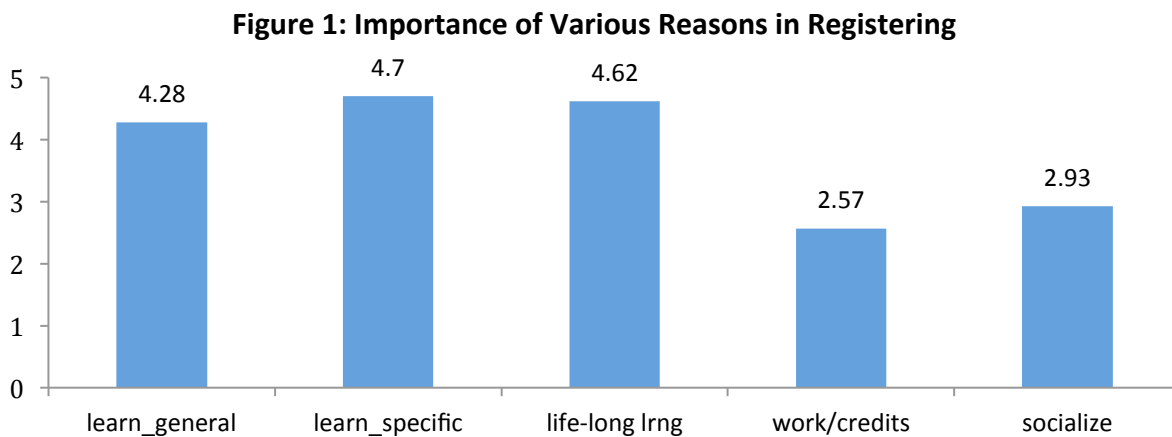
REASONS FOR ENROLLMENT

Available literature about adult learning suggests that a general desire for learning, specific learning goals/interests, a life-long love of learning or self-identification as a life-long learner, professional objectives, and socialization opportunities may have been driving factors in adults' decisions to participate in the courses offered by the American Museum of Natural History as part of the "Our Earth's Future" series. Subsequently, on pre- and post- course surveys, we asked participants to indicate how important each of these elements were to them as they were making the decision to enroll.

Given a five-point scale where "not important at all" was scored as a 1 and "very important" was scored as a 5, we asked pre-course survey respondents to rate the importance of each of these factors in their decision to enroll in "Our Earth's Future."

- To learn new things **in general**.
- To learn **specific things** about the topic of this course.
- I consider myself to be a life-long learner.
- Taking this course allowed me to gain credits or knowledge that I could apply to my work.
- I appreciate opportunities to socialize with other adults.

The figure below presents average responses for each of the factors listed above across all pre-course surveys for "Our Earth's Future." Data suggest that participants' interest in learning—both in general and in terms of the specific topic being featured—took precedent over work-related and social goals for participation.



General and specific learning interests and goals

Many participants have a general interest in learning and about the topic in particular. One onsite focus group participant said that she periodically checks the AMNH website for learning opportunities that look interesting. Similarly, online course participants who were interviewed stated that they had learning goals that aligned well with specific course

objectives, e.g., “I was interested in learning how to better communicate on the science behind climate change,” and “I was interested in learning more about how the earth functions and what humans activity effects climate systems,” and “My dad denies climate change and I was hoping to get more information about how to communicate with those who will not be swayed by evidence.”

Building upon previous learning experiences

Some participants sought to expand on prior science and climate-change learning. One focus group participant indicated that she had studied environmental science as undergrad and is now in an urban studies graduate program. She was curious to see what types of informal learning opportunities existed, and was delighted to find this course being offered by the museum because it is a source she trusts. “I wanted to see what’s out there, what’s new, especially under an institution like this, which is really prestigious, I thought it would be a good opportunity.” Before signing up for the onsite course, she had also participated in the online course on the Rising Seas. Her positive experience in that online course motivated her to seek out other learning opportunities at the museum and found that this course was well-aligned with her interests. Another focus group participant had also completed one of the online courses prior to attending the face-to-face course. He’d learned about the online course via materials distributed on the information table at an amateur astronomy event at the museum, and after taking the online course, then went on to register for the onsite course as well.

Professional reasons and motivations

Some participants had professional motivations to participate. Although work-related reasons were not as prevalent among participants’ reasons for taking the course, there were some teachers and people whose work related to climate change issues in some way. For example, one participant who participated in the post-course focus group held at the museum in June of 2015 indicated that she taught a course on the politics of global warming. She explained that she used to tell her students, “Global warming is real...now we’re moving on to why it’s political.” She wanted to be able to stop and explain the science behind climate change in greater detail and indicated that this desire was a motivating factor in her decision to take the “Our Earth’s Future” course at the museum. Two of the eight onsite course participants who were interviewed explained that they were teachers and had reasons for participating that related to their teaching, e.g., “I wanted up to date information, visual, and resources I could use in my classroom and share with other teachers to develop our ecology unit, including climate change. Expectations were exceeded with information and graphics.”

Personal reasons and motivations

A few participants were motivated to enroll in the course because of personal interests or past experiences, as was the case with two participants who lived in areas hit hard by Hurricane Sandy. “There was a lot of destruction during the storm to my home,” one participant explained. “It was really easy afterwards to get exasperated by all the talk about

the changing climate and I felt like I was susceptible to the media at that point because I'd had such a personal experience, and I wanted to be able to sift through the information better." Another participant who'd been impacted by Hurricane Sandy as well stated "I've been working in my community for many years about the environmental injustice...and as a result of Hurricane Sandy there was a lot of damage done and so the idea of taking a climate change class interested me." Survey respondents also indicated personal reasons that spurred interest in taking one or more course offered by the museum as part of this series on climate change, including experiences with Sandy and other catastrophic weather events or exposure to the effects of climate change around the world while traveling or living elsewhere.

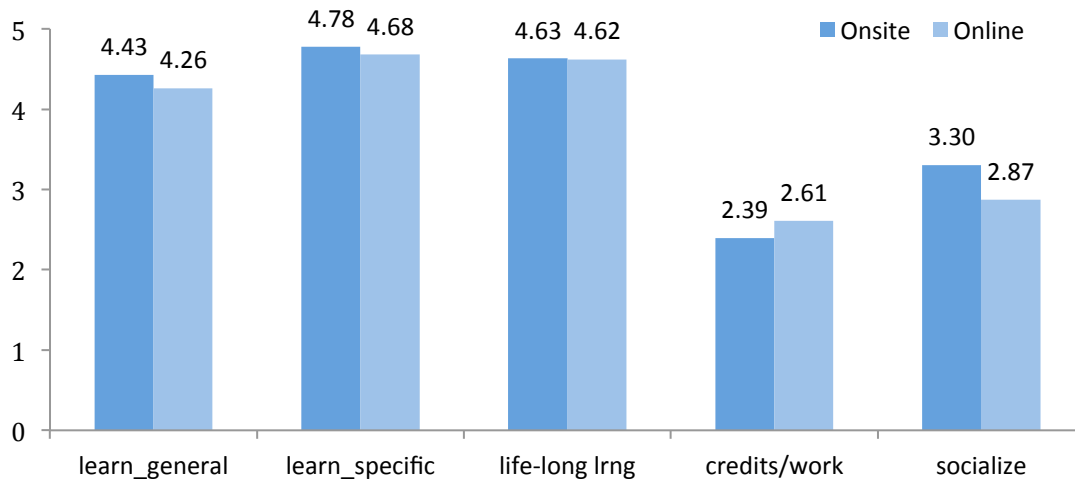
Another participant, who's goals aligned extremely well with those of the course stated that he found himself "in conversation with climate skeptics from time to time that are really into their own arguments, I want to be able to have more intelligent conversation with them." Another participant said she'd first become more aware of climate change and what we can do about it while living overseas. She's been seeking to learn more ever since.

A few of the onsite course participants who took part in the post-course focus group in June of 2015 noted that they had heard about the course through the Climate Justice Group. Others had heard about the course when Dr. Tillinger, the course instructor, spoke at a meeting for 350.org (a local environmental advocacy group) wherein she suggested that activists sometimes attribute too many things (or the wrong things) to climate change, and that can actually hurt the cause. This point struck a chord, and the participant went on to explain "I really wanted to learn what were the most cogent arguments so that I would be fluent in those and not be guilty of being one of those people that exaggerates." Another participant added that "knowing how to communicate some of this to other people is important...the only thing that many of us can do [about this issue] is to try and talk about it."

Differences in motivation for onsite and online course participants

As part of our analysis, we also examined differences between online and onsite participants. The figure below suggests that onsite participants are seizing learning opportunities that are available to them locally—regardless of topic, though the course topic does seem to be an important factor for online and onsite enrollees alike—and onsite participants are slightly more motivated by the social elements associated with a face-to-face class, whereas online participants are slightly more likely to have specific work-related objectives for their participation in the course.

Figure 2: Differences in Reasons for Participating Among Online and Onsite Participants



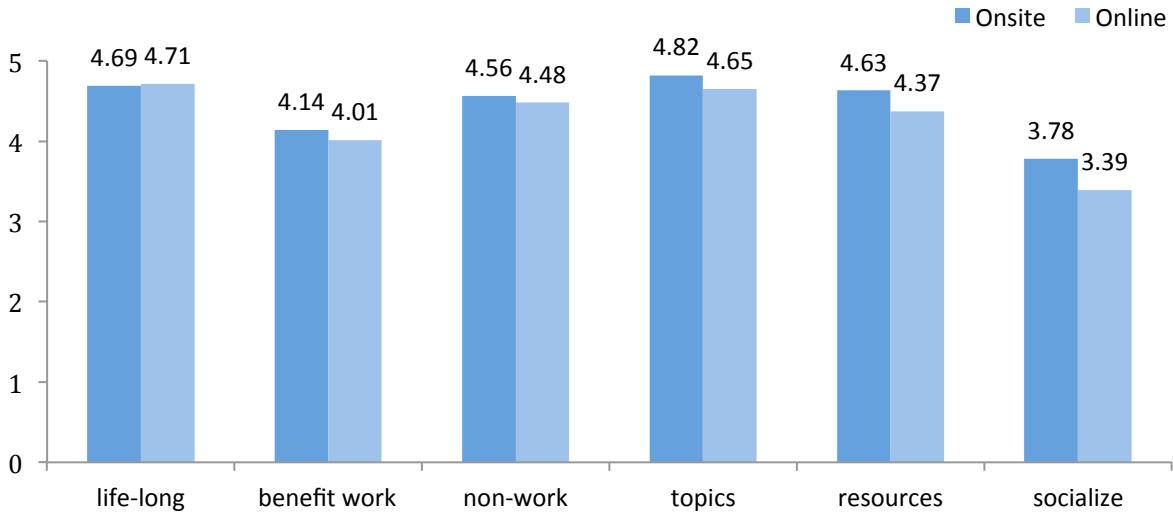
Open-ended responses to a question that asked participants to list other reasons for participating suggest that the advertised course objective, i.e., helping participants to better understand the science of climate change and to be better able to advocate for the fact that climate change is happening was a motivating factor, e.g., “To bolster my knowledge of climate change issues and to be able to talk with some authority with others” and “I hear all kinds of conflicting statements about climate change and I want to have a better understanding of this subject.” Participants also express a desire to build upon knowledge gained as part of their formal educational experience (be it recently or somewhat longer ago)—“want build upon what I’ve learned through news articles, lectures, and update what I learned in college (10+ years ago).” Likewise, one-day course offerings on a similar topic seemed to bolster interest in participating in longer-courses.

An additional set of questions also sought to assess participants’ disposition and potential motivations for learning. Specifically, participants were asked to indicate their level of agreement with each of the following statements:

- I consider myself to be a life-long learner.
- I regularly seek out learning opportunities that are related to my work.
- I regularly seek out learning opportunities for reasons other than professional advancement (e.g. for personal enjoyment).
- I am primarily taking this course because I am interested in the topic (i.e., Climate Change)
- The resources provided by AMNH enhance its value as a source for adult learning programs.
- I appreciate opportunities to socialize with other adults.

For each of the statements above, participants’ responses were coded as follows: “strongly disagree”=1, “disagree”=2, “neutral”=3, “agree”=4, and “strongly agree”=5.

Figure 3: Agreement with Statements about Learning for Online and Onsite Participants



The data above suggest that onsite and online learners are similar in their motivations for participating in informal learning experiences. Both groups of learners identify as life-long learners, are slightly more likely to explore learning opportunities that are not related to work, than those related to work, and more motivated by the specific topic of the course than general opportunities to socialize with other learners.

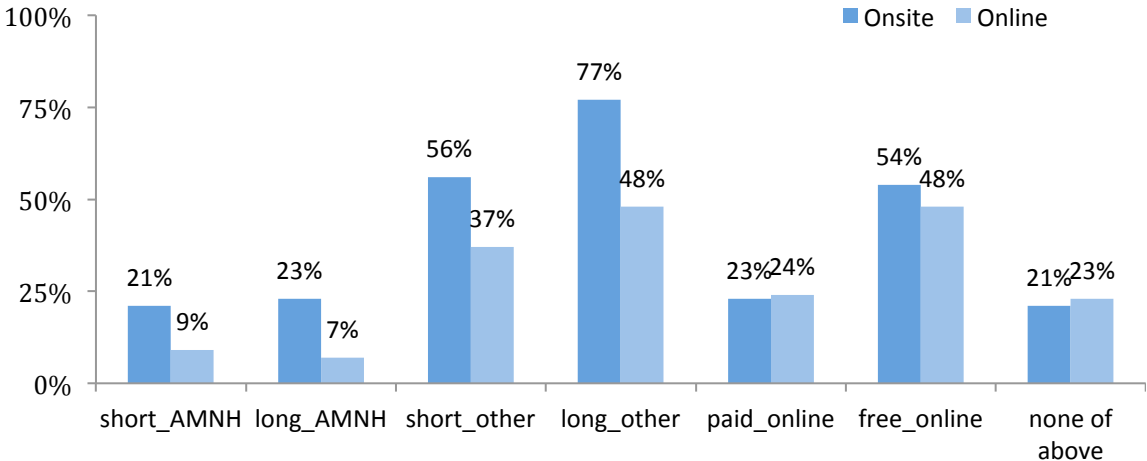
Despite many similarities for taking onsite and online courses, a few focus group participants who had participated in both online and onsite “Our Earth’s Future” courses noted some of the differences. One participant explained that “the idea of being in a classroom, to me, is much more stimulating and interesting than taking online classes.” Two other participants who had taken online courses—including climate change courses offered by AMNH—agreed that the face-to-face experience was more engaging. “Its just harder with an online class, its not as engaging.” However, one other participant who had taken an online course disagreed; she liked the fact that when she posts a question online the instructors answered her directly; unlike other classes she’d taken, she felt that her online learning experience was “very personal.”

PREVIOUS ADULT-LEARNING EXPERIENCES

Participants were asked to indicate what types of learning experiences they had had as adults prior to enrolling in an “Our Earth’s Future” course. Not surprisingly, participants enrolled in onsite courses at the American Museum of Natural History were more likely to have taken other courses at the museum; 21% of onsite vs. 9% of online participants said they had taken a short course at the museum (i.e., one day or less). Likewise, 23% of onsite vs. 7% of online participants said they had taken a longer course (i.e., more than one day or session) at the museum. Onsite participants were also more likely to have taken short and long informal courses at other museums or educational institutions (56% of onsite participants had taken short courses elsewhere, in comparison to 37% of online participants, and 77% of onsite participants had taken longer courses elsewhere in comparison to 48% of online participants).

Interestingly, onsite and online participants were equally likely to have taken a paid course online (i.e., 23% of onsite participants had done so and 24% of online participants had done so), however, onsite participants were slightly more likely to have previously taken a free online course (i.e. 54% of onsite participants had previously taken a free online course in comparison to 48% of online course participants). Less than a quarter of both groups had not previously participated in any of the aforementioned informal learning experiences.

Figure 4: Previous Participation in Informal Learning Programs



The data suggest that participants in the onsite courses at the museum were highly motivated learners who seek out learning opportunities in a variety of different settings and through a variety of different modalities. We expected to see a much higher percentages of online participants having had prior online learning experiences, but found that fewer of the online course respondents who responded to the pre-course survey had in fact done so. This finding is important to note since it suggests that the online learning experience was new to more than half of the online course participants, and this may have had an impact on subsequent success in and completion of the course.

PARTICIPATION TRENDS

PARTICIPATION IN ONSITE COURSES

Observations of onsite courses suggest that participants were engaged—as indicated by the number of questions that were asked, the amount of participants taking notes (despite the lack of any formal assessments or academic requirements) and high levels of participation in small and large group discussion. Likewise, there seems to have been a very low attrition rate for the onsite courses.

Course Pacing

Onsite course participants' feelings about the pacing of the course varied greatly, due in large part to variations on prior levels of knowledge and understanding about the topic. On the post survey we asked if participants thought the course was too slow, just right, too fast or "other." The majority of survey respondents (65%) said that the course was "just right;" 9% thought it was too slow, and 9% thought it was too fast and 17% picked the other option, often going on to explain that the pacing seemed to vary from week to week and topic to topic—some days and sections moved very quickly and may have been over some participants heads, where as other parts of the course felt too slow, or just right.

In the focus group, five participants thought the course moved too fast, one thought it moved too slow, and each of the remaining eight participants thought the course moved at just the right pace. However, based on comments that were later shared, it seemed that participants' feelings about the pacing varied from week to week. "It's a really hard question to answer...depending on who the guest lecturer was, there were things that were very repetitive...or things that went way too quickly. There were some basic things that were not really addressed or those were glossed over." Other participants expressed a desire to spend longer on some of the basic, fundamental concepts.

Course Length

Most participants thought the face-to-face courses were just right at 5-weeks, however, there were a few participants who suggested that the course could have been a little longer (e.g., 6-8 weeks). Those who thought that too much information had, at times, been presented too quickly, suggested lengthening the course to allow content to be covered at a more reasonable pace. Alternatively, some suggested that course content could be potentially scaled back to

allow more time for concepts to sink in during a 5-week period—and providing more time for participants to ask questions.

Difficulty Level

Most participants in the focus group felt that the course was at the right difficulty level for them, though admittedly, they found some concepts easier to grasp than others. Participants felt that Dr. Tillinger did an excellent job of presenting information in a way that was easy to understand, but felt that some guest lecturers were better than others at doing so. But not all participants felt that the course was at the right level. Two focus group participants thought the overall level of the course was too advanced (or at least moved too fast). One of the participants who felt the course was too advanced stated that she “would have loved a private tutor because many of the questions that people asked and things they brought up were way beyond me.” On the other end of the spectrum, three of the participants in the focus group thought the course was too basic. Because of the wide variability in adult’s knowledge about various topics, participants in the focus group suggested offering different levels of a course so that participants could select the one that best-matched their knowledge and skill levels.

Course Resources

The post-course surveys asked onsite course participants to rate the quality of resources available via the course website and use of resources at the museum, using a five-point scale where 1=“extremely low,” and 5=“extremely high.” Onsite course participants rated the digital resources moderately high (3.85) and museum resources very high (4.33).

Focus group participants went into additional detail about online resources and museum resources as well as other aspects of the course including guest lectures, class discussions, the instructor, and assignments. Each of these course resources are discussed further in the paragraphs below.

Online Resources: Most of the focus group participants accessed the course website site at least once when they were prompted to submit a question online. However, some participants acknowledged that they had forgotten about the online site by the end of the course and suggested that there could be more regular reminders. The majority of focus group participants said they visited the site a few times, but a small number visited the course website on a weekly basis.

Museum Resources: Onsite course participants agree that there is great potential value in incorporating resources from the museum, however, some fieldtrips to halls and exhibits within the museum proved more helpful than others due to after-hours logistics (e.g., lighting and sound issues) that kept those experiences from being as powerful as possible.

Guest Lectures: One of the advantages that participants see in courses offered by a prestigious museum like the American Museum of Natural History is the access they have to experts in various scientific fields. For the most part, participants found the guest lecturers to be

engaging, though they found some to be better communicators than others. To make the most out of their experience with guest lecturers, participants suggested offering a short bio for each speaker in the course syllabus and providing a little more contextual background to help ensure that participants understand how each speaker's knowledge and expertise relates to the overall objectives of the course. Participants also expressed a desire for more question and answer time with guest lecturers.

Discussions: Opinions were mixed about small group discussions. Some participants placed great value on opportunities to discuss issues with their fellow classmates. Those who found these discussions to be valuable suggested that there weren't enough and/or not enough time allotted to small group discussions. Other participants found less value in small group discussions. Those in the later group suggested a few simple enhancements to help ensure more meaningful discussions, e.g., making sure that all participants have a clear understanding of what they are discussing and why.

Instructor: Across the board, there was great praise for the instructor, Debra Tillinger. On numerous occasions during the focus group, participants shared their appreciation for her ability to explain information clearly, provide concrete examples and arguments, and to be diplomatic and diligent in her efforts to ensure that every comment and question tied back into the course. Another positive aspect of the instructor was her approachability and accessibility. One participant who didn't feel that she'd yet accomplished her goal to understand enough about climate change to be able to confidently communicate about it said that she planned to spend time going back through her notes from the course and revisiting some of the resources on the course website (i.e., a self-study follow-up to the course). It was at this point that another participant indicated that the course instructor seemed "very available" and there was a general consensus among participants in the focus group that she would continue to answer their questions even after the course had ended.

Assignments: There were no regular out-of-class assignments, though focus group participants did reference a 30-minute video that they had been asked to watch outside of class. Some participants welcomed the idea of having assignments between class sessions, with the caveat that those assignments not take very long to complete (e.g., "more than an hour a week outside of class would probably be too much to ask"), and be well integrated with the content and objectives of the course (i.e., not just homework for homework's sake). There seemed to be a consensus within the group that optional assignments—such as extra readings or videos—were a valuable component of the course, but the length of those assignments needs to be realistic (e.g., a half hour seemed like the right length to most participants—but definitely no longer than an hour). They also noted that outside readings or videos should be referenced in the course so as to ensure sufficient incentive to do the assignments.

PARTICIPATION IN ONLINE COURSES

There was evidence of significant and sustained engagement among a subset of online course participation, however, there was markedly more attrition among online course participants. Rather than an indicator of the success of the course or the desirability of the online learning format in general, attrition is a common factor among freely available online learning experiences.

Table 3: Overview of Participation Trends for Online Courses

	10-Week Courses		3-Week Courses		
	Fall 2014	Summer 2015	March 2015	April 2015	May 2015
Enrolled #	102	224	123	88	141
% Participated	68%	65%	66%	47%	44%
# of Quiz Submissions	22/14/12/10/6	57/37/28/18/*	37/18/15	25/15/11	28/21/13
# of forum posts	130	342	172	88	123

* Missing Data

Course pacing

Not all enrolled participants chose to/were able to log on at the beginning of the course. As such, the number of individual participants actively engaging with the course grew over time, but delayed starts to participation also seemed to mean that fewer participants were able to complete all coursework within the allotted timeframe for the course. That, combined with attrition among participants who started when the course launched, typically meant that there were far fewer participants completing the course than those who originally enrolled in the course.

On the post-course survey, online course participants were asked to indicate the extent to which they had participated in the course.¹ Sixty-nine of online course participants who responded to the post-course survey said that they had “participated in the majority of the course, i.e., viewing most course resources and engaging in most activities,” 20% “participated in some of the course, but only viewed a few of the course resources,” and 12% of respondents indicated that they had not been able to participate in the course after all. The most prevalent challenge noted by participants who were not able to complete all or any of the course was a lack of time, or an unexpected event in their lives that kept them from participating. A few respondents also noted having technical challenges that kept them from being able to participate.

Weekly Time-Spent: The post-course surveys asked online participants how much time they spent each week on the course. Thirteen percent said they spent less than an hour each week,

¹ The evaluation team invited responses from participants who had not completed the course,

45% spent 1-2 hours per week, 29% spent 3-5 hours per week, 11% spent 6-7 hours per week, and 3% spent more than 7 hours each week.

Course Length

Participants in the ten-week course were generally pleased with the length, though some wished that there weren't gaps between the weeks – so that they could keep moving forward if desired. One of the ten-week online course participants that we spoke with indicated that “ten weeks was perfect as individuals need time to understand how the class works while also gaining knowledge on the subject.” Several of the 3-week course participants that we spoke with indicated a desire for a slightly longer course, e.g., 4-weeks, so that they would have a little more time to digest course content.

Difficulty Level

In contrast to the onsite course, where there tended to be participants who felt the course was too difficult and others who thought it was too easy, we found that most of the course participants that we interviewed indicated that the level of instruction was just right. One participant noted that “the instructors did a good job providing sources that someone with a non-science background could understand, while at the same time responding to more complex questions with interesting and thorough answers.” Since online participants could move at their own pace and spend as much time with course materials as they wanted or had the ability to spend, there seemed to be an opportunity for participants to self-regulate or better accommodate to the difficulty level of the course. One of the online course participants also acknowledged the value of being able to interact with individuals who had different skill and knowledge levels as part of their online learning experience: “interacting with individuals with many different knowledge levels helped me change how I presented information while still delivering an informative and accurate message on climate change.”

Course Resources

Online course participants felt similarly to onsite course participants about many of the learning resources (including videos of lectures and other topics and reading materials). There were, however, mixed responses to the discussion forum, as exemplified by the following two comments: “The prompts are rarely good enough to provoke a discussion among participants. Merely people just posting their piece and then someone else posting their piece,” and in contrast “I liked the discussion forum the best. I felt like all of the sources were represented in the discussion questions and threads, and that the conversations provided me with a greater insight of the issues.” Clearly, the discussions were motivating for some participants, whereas they proved to be less engaging for others. Observations of online courses also revealed differences in discussion trends from course to course. When more participants (and/or more engaged participants) were involved in discussion forums, there tended to be more lively and engaging conversations that emerged between and among course participants, whereas in other courses the majority of dialogue seemed to go back and forth between participants and instructors. There was certainly value in the later instances, but the overall discussion

experience took on a much more lively and community-like feel in online courses where there were more extensive conversations between participants as well.

Unique features of online learning format

Online course participants frequently indicated their appreciation for the ability to work at their own pace (though noted it sometimes made discussion more challenging when participants were at different points in the course) and on their own time schedule. “I liked having the course available on my time schedule,” noted one of the online course participants. Another online course participant explained: “I didn't have a lot of time every week, so I was really thankful that I could come back in three weeks and cram in a bunch of learning.” A third participant highlighted both the pros and cons of self-pacing in his comments: “I found it difficult to engage at times since many others seem to still be interacting in previous week's topics. However, it was the perfect speed for individuals that work full time and have family obligations yet still want to learn.” The online format also provided participants with the ability to replay lecture videos—many participants in the onsite courses were taking notes during the instructors and guest speakers talks, but online participants had the advantage of literally being able to go back and re-watch anything they missed or didn't fully understand the first time through.

Additionally, online course participants also indicated an appreciation for the fact that participants were from all over the United States, and sometimes beyond. One participant noted that it was “nice to read and hear from people all over the country, makes you feel more connected,” and another stated that they enjoyed hearing “other people's perspective and how they were experiencing climate change in their environment.”

PARTICIPATION IN BOTH ONLINE AND ONSITE COURSES

We encountered a few participants who had participated in both online and onsite courses. In some cases, the online course experience preceded participation in an onsite course, and in other cases, participants who had taken the onsite course went on to enroll in one or more of the online courses. One of the participants who had experience with both online and onsite “Our Earth's Future” learning experiences, shared the following comment—highlighting the benefits of both formats: “Both experiences were very useful and had their advantages. The face-to-face course was able to cover some more in-depth, interesting topics while the online course was able to cover a wider amount of topics in a clear and concise manner.”

COURSE OUTCOMES

The “Our Earth’s Future” courses were designed to increase participants’ knowledge of issues related to climate change, increase participants’ understanding of the science related to climate change, including the role of various systems in influencing climate, and offer first-hand exposure to scientists and the scientific processes by which researchers come to understand climate change. The course was also designed to foster participants’ ability to better understand and assess evidence and more confidently discuss climate change. A description of the first onsite course stated that it offered participants a “unique opportunity to gain solid understanding of key scientific principles, analyze scientific data, confront misconceptions, visualize data-driven climate scenarios, and learn how to communicate about global climate phenomena.”

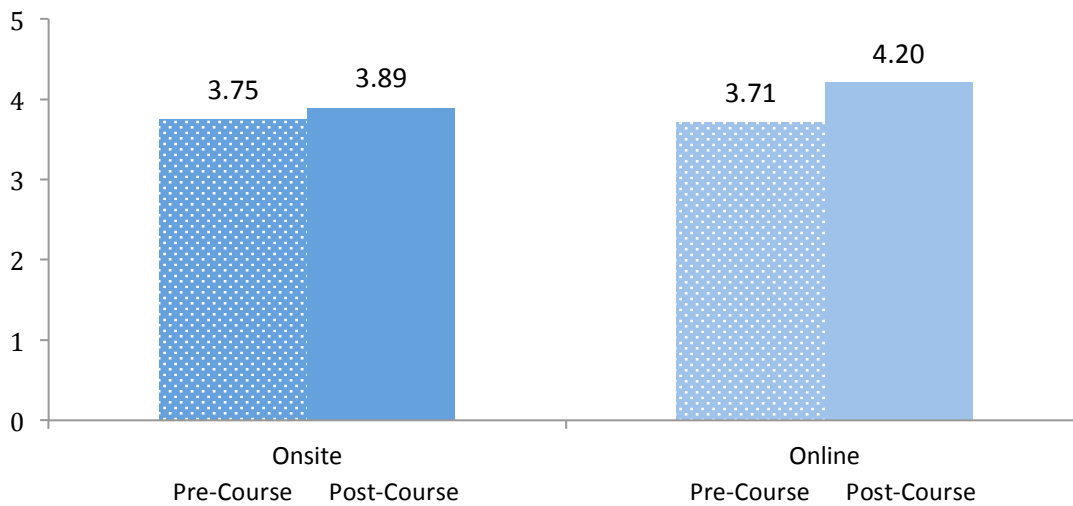
Our analysis of course outcomes focuses on participants’ self-rated knowledge of issues and topics related to climate change, and changes in their beliefs about climate change—including the ability to draw upon evidence to support those beliefs. We also explored self-rated skills associated with scientific literacy as well as the ability to process and communicate information about climate change. Lastly, we examined the effects of the course on participants’ intended behaviors and attitudes toward learning in general and in terms of climate change specifically.

EFFECTS ON PARTICIPANTS’ KNOWLEDGE

“Our Earth’s Future” course participants were asked a series of questions on pre-course and post-course surveys that addressed their self-rated knowledge on a variety of topics including climate change science and climate change impacts. On earlier versions of the surveys we also asked participants about their knowledge of climate change solutions and actions, whereas on later iterations of the surveys we asked about their knowledge of climate change responses and the North Polar (Arctic) Region.

The first figure (on the following page) explores participants’ self-reported pre- and post-course knowledge of climate change science, including things such as carbon cycle, greenhouse gases, and carbon footprints. Specifically, respondents were asked to indicate the extent of their knowledge before and after the course using the following scale to indicate their knowledge level: 1=nothing at all, 2=not much, 3=about the same as most people, 4=a little more than most people, 5=a lot more than most people.

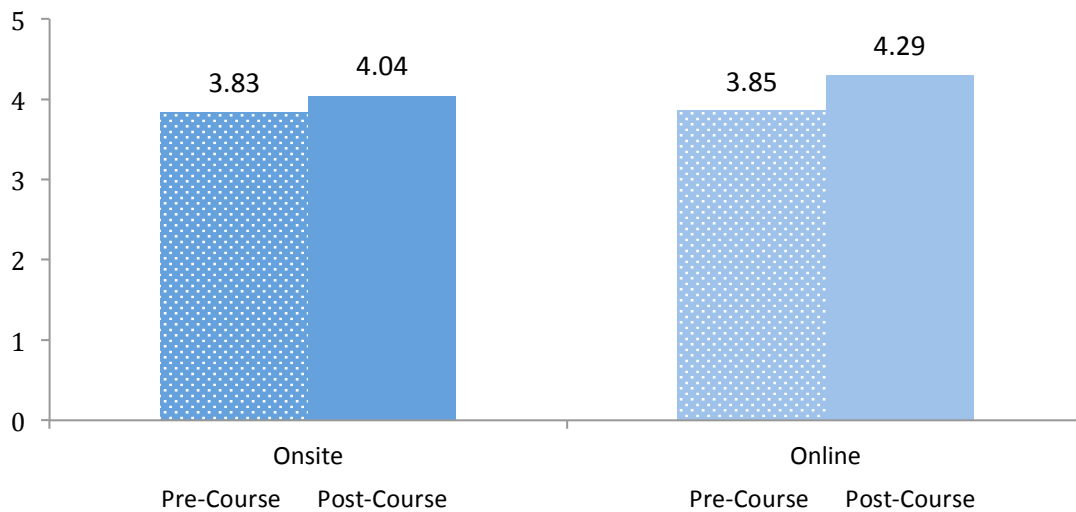
Figure 5: Participant's Knowledge about Climate Change Science



Onsite and online course participants felt similarly about their knowledge of climate change science prior to the course, however, there seemed to be a larger increase in self-reported knowledge levels among online course participants. One possible reason for this trend might be the ability to spend more time watching/re-watching course lectures and reading/re-reading assigned and supporting articles. The online course experience also included quizzes that allowed participants to check their knowledge and understanding of topics at the beginning and end of each course module; receiving feedback of this nature may foster a greater sense of confidence or certainty in one's level of knowledge. An additional explanation for this finding is the fact that onsite participants tended to stick with the course, whether they were grasping all the content or not, whereas it seems more online participants dropped out of each course. Their attrition could be due to a lack of understanding, but more research would be necessary to confirm this finding. None-the-less, it is possible that participants who stuck with the course through the end were more likely to understand the content as they went along.

Next we asked participants to indicate how much they knew about climate change impacts including, for example, rising sea levels, habitat changes, increased severe weather events, and cultural impacts. We found a similar pattern in survey responses, i.e., online course participants rated their knowledge of climate change impacts higher at the end of the course than onsite course participants, perhaps for the same reasons discussed above. The figure below illustrates average, self-rated, pre- and post-course knowledge of climate change impacts.

Figure 6: Participant's Knowledge about Climate Change Impacts



For the onsite courses, we also asked participants to rate their knowledge of climate change solutions (e.g., reduction of energy use), and climate change actions (e.g., carbon/energy assessments). For the online course surveys, participants were instead asked to rate their knowledge of climate change responses (e.g., mitigation and adaption), and the North Polar (Arctic) Region. The following two figures summarize pre- and post-course knowledge ratings for the topics described above.

Figure 7: Onsite Course Participants' Knowledge about Climate Change Solutions and Actions

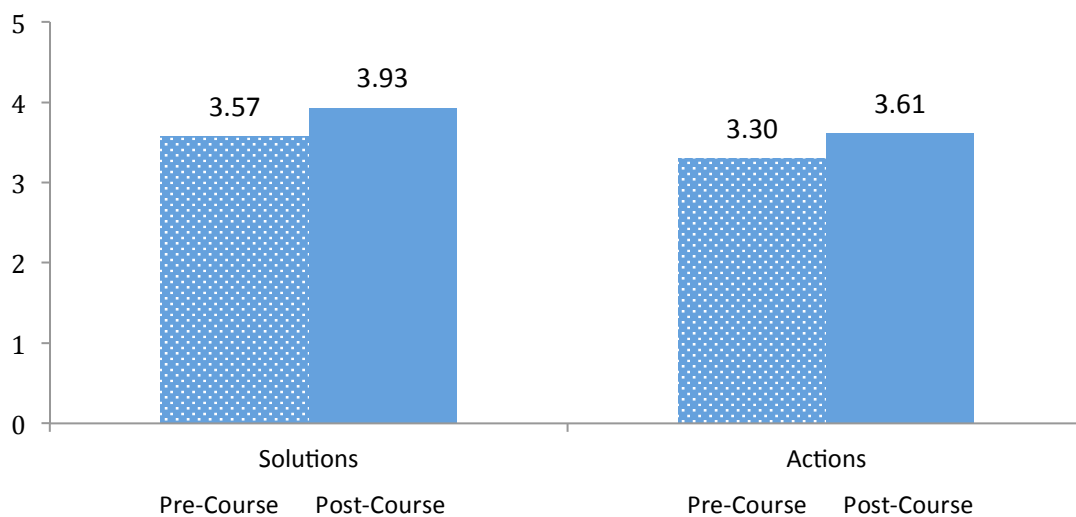
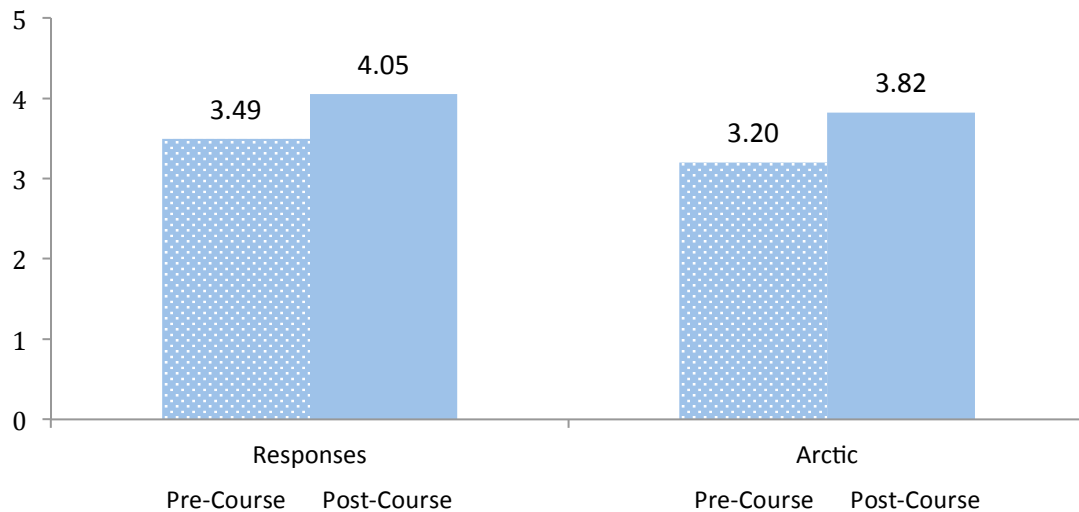


Figure 8: Online Course Participants' Knowledge about Climate Change Responses and the North Polar Region

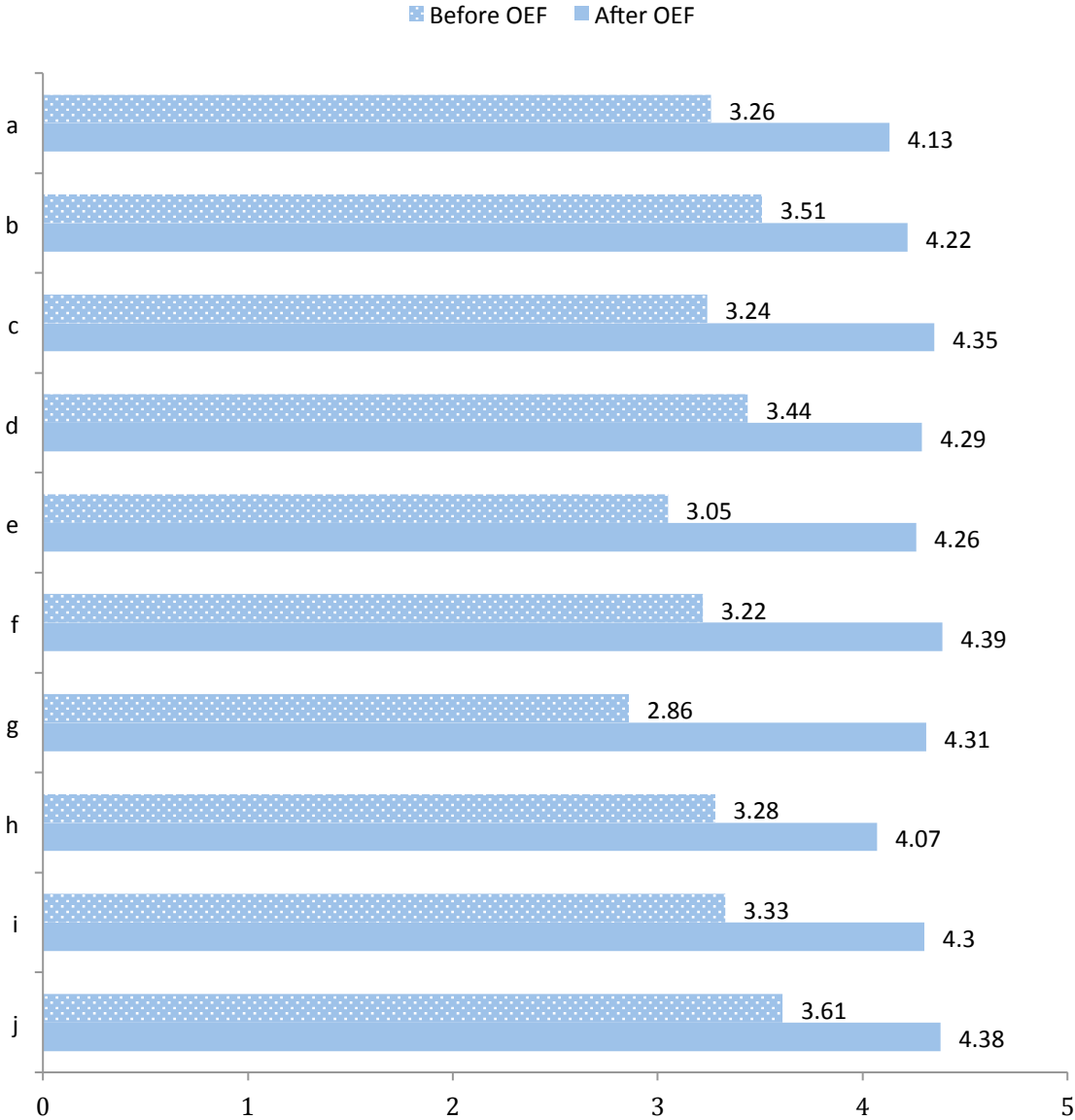


On the online course surveys (starting in 2015), we asked participants a series of additional questions about understanding of topics related to climate change and climate change science. Because these questions were not included on the pre-course survey, participants were asked to indicate their level of understanding before and after the course using a five-point scale where 1="none"/no understanding, 2="very low," 3="moderate," 4="high," and 5="very high." The questions/statements about climate change included the following:

- a. Much of the climate change uncertainty is not in the science – we have a good understanding of how the addition of greenhouse gases will affect the climate. The uncertainty lies in the amount of these gases that will be released into the atmosphere.
- b. With regards to climate change, the costs of mitigating action are probably less than the cost of inaction (i.e., damage repair).
- c. Scientific statements are statements that can be proven to be false.
- d. The greenhouse gases (like water and carbon dioxide) work by absorbing and then re-radiating energy from Earth's surface.
- e. Records from ice cores tell us that climate can change faster than scientists originally predicted.
- f. Earth is heated unevenly because it is a sphere and more solar radiation strikes the equator. This drives the circulation of the ocean and atmosphere.
- g. A positive feedback occurs when a small push in one direction leads to a continuation of the system in the same direction. Our climate system is dominated by positive feedbacks.
- h. Risk depends on the probability of an event occurring combined with the cost (in money and human suffering) if the event occurs.
- i. The climate system contains a committed warming and more warming is in the pipeline.
- j. Climate is the long-term average of weather.

The following figure shows online participants’ self-reported understanding of each topic before and after the “Our Earth’s Future” course that they took. The biggest gains were reported for understanding of positive feedback (item g), ice core records (item e), and the effect of solar radiation on the circulation of the ocean and atmosphere (item f).

Figure 9: Self-Reported Understanding of Climate Change Topics Before and After “Our Earth’s Future” Course



Participants who came into the course with expectations for gaining a better understanding of the basics of climate change science, and the ability to communicate about it to others, felt that their objectives were met. One focus group participant stated “I got out what I came for...I wanted to be able to educate people about the basics of climate change...with confidence.” Participants learned the reason why Sandy was called “Super Storm Sandy” rather than

“Hurricane Sandy” and the difference between weather and climate. “We’ve been given the tools to navigate the information,” noted one focus group participant. Another participant stressed the value of coming away with greater ability and confidence in being able to communicate about climate change: “it’s definitely difficult but [the instructor] gave us different ideas...I really appreciated that.”

Online participants cited the following learning outcomes:

- *Climate change is being experienced universally. It is important to tease out local weather from climate change when talking about global warming to lay people so they better understand the bigger picture.*
- *I learned about the basics of climate science, how climate change is affecting certain peoples, along with how to evaluate scientific claims.*
- *This course really did a great job of using facts to drive the point home about climate change...This is what people need to see--science without politics. The course was eye opening for me, and I'm a person who wholeheartedly gets the concept of climate change. It was really educational, adding details I would not have known otherwise, even as a "believer". I am more passionate about educating others as a result.*

Participants also came away with a better sense of what different scientists do, and how they are using their scientific skills and knowledge to make sense of our world, e.g., “hearing how scientists think in different disciplines...I got a respect for what they do...and I didn’t learn, in depth, the science, but I definitely felt interested in their approach and their view of things.”

EFFECTS ON PARTICIPANTS’ BELIEFS

On the pre- and post-course surveys we asked online participants to indicate which of several statements best identified with their beliefs regarding climate change:

1. Climate change is happening now, caused mainly by human activities
2. Climate change is happening now, caused mainly by natural forces
3. Climate change is not happening now
4. I don't know

On the pre-course survey, 86% of online course participants agreed with the first statement, 7% agreed with the second statement, only 1% of respondents agreed with the third statement and 7% of respondents indicated that they didn’t know. On the post-course survey, 95% of participants agreed with the first statement, 1% agreed with the second statement, 1% agreed with the third statement and 3% said they did not know.

Additionally, participants were asked to provide examples or arguments that supported their belief. The following are examples of comments shared by participants on pre- and post-course surveys. On the pre-survey, participants were slightly more likely to draw upon personal experiences e.g., with Hurricane Sandy or travels to other places. On the post survey, participants referenced to specific sources of literature/information and used some terms (e.g., “forcings”) that were not used at the start of the course.

Table 4: Examples of Comments Regarding Evidence for Climate Change Beliefs

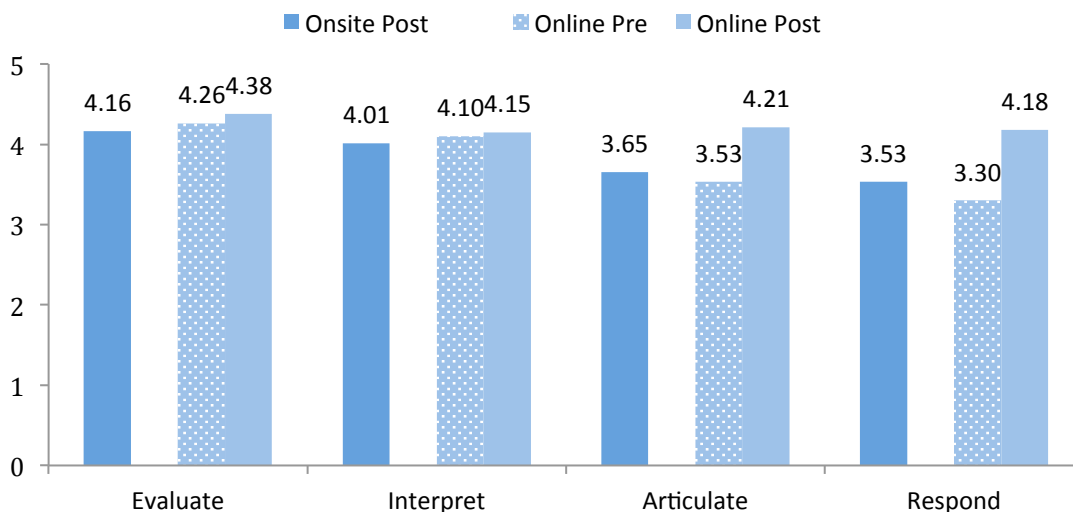
Comments on Pre-Course Survey	Comments on Post-Course Survey
<p>1: My personal connection with climate change are the extreme weather patterns that I am experiencing. I live in New York City, and have noticed the seasons becoming more extreme. For example, the winters and summers seem to be harsher, while the "shoulder" seasons spring and fall seem to be shorter. Also, I am from California and cannot help but notice the extreme drought that is taking place.</p> <p>1: My travels have taken me to many countries with obvious results of pollution caused by human ignorance and or lack of action to change.</p> <p>1. Hurricane Sandy</p> <p>1: Rising sea levels, changes in weather patterns, loss of some animal species</p>	<p>1. Reports by the IPCC, New York City's Plan NYC, Science magazine, Nature magazine, and various climate-related non-profit organizations.</p> <p>1. Science Magazine, Scientific American, The American Museum of Natural History, NASA, along with various environmental writers all support my understanding of contemporary anthropogenic climate change.</p> <p>1. Objective metrics in atmospheric, surface, and ocean temperatures over decades spanning the Industrial Revolution that correspond to greenhouse gas (man-made and otherwise) emissions and concentrations provide irrefutable evidence that climate change on a human timeframe is related to human activity.</p>
<p>2: I view it as a mix of natural forces and human activity. I see humans as having a responsibility to optimize their behavior towards the environment, but I also know the history of the Earth has included major shifts in climate and landscape which were beyond human control.</p> <p>2: Man may have some influence on climate change but, nature dances to its own tune.</p>	<p>1. The information from the ice tubes pulled from the Arctic with layers centuries long showing changes, history, and current increases in "CO2 levels compared to recent past decades. Also, data regarding negative changes in biodiversity and ecosystems as a result of increasing water temperatures. This is the beginning of the domino effect with global proportions.</p>
<p>3: We live on a planet, that we have only been able to keep records for slightly over a century. How do we know if the current climate cycles that appear to offer change, aren't just normal cycles? In addition, I believe we are currently experiencing "global cooling" due to sun spots and not global warming, as is often stated.</p>	<p>1. The rate of change in the particulate matter in the atmosphere and the volume of carbon no longer sequestered in fossil remains both are human interactions with the planet. Natural forcings happen but human involvement has increased the extreme factors of those forcings. Storms and droughts are far more severe than in historic evidence and the speed and intensity appear to be increasing.</p>
<p>4: I believe the climate is changing as a normal course of nature and the geologic record reveals however I wonder if humanity is changing the way this normal climatic cycle occurs.</p>	<p>4. I think there are both elements of natural forces and human activities causing climate change. Being a scientist, I feel the climate isn't understood well enough and there aren't enough years of knowledge to understand exactly what's going on with the Earth.</p>

EFFECTS ON PARTICIPANTS' ABILITIES

Course participants were asked to rate their ability to do a variety of skills related to scientific literacy and the ability to communicate with others in scientifically literate ways. Specifically, survey respondents were asked to assess their ability to do the following using a five-point scale where 1="extremely poor," and 5="extremely strong,"):

- Evaluate information from multiple sources
- Interpret data visualizations
- Clearly articulate the basis of climate change
- Respond to anti-climate change arguments

Figure 10: Participants' Science Literacy-Related Abilities Before and After the Course

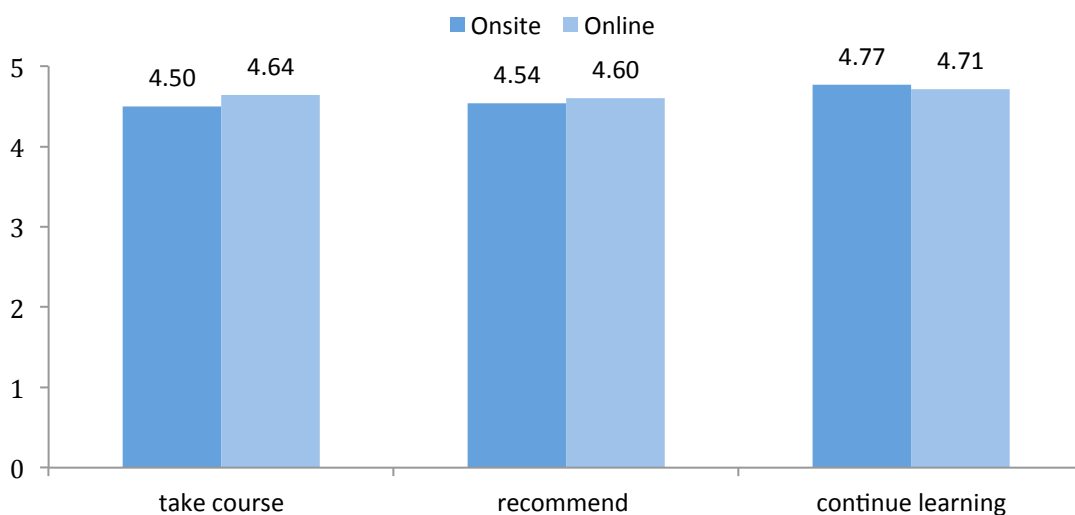


Participants' belief in their ability to evaluate data and interpret visualizations seem fairly consistent between onsite and online participants at the end of the course, and between pre-course and post-course responses for the online participants. There is, however, a more interesting trend regarding participants' belief in their abilities to articulate the basis of climate change and to respond to anti-climate change arguments. Participants in onsite courses had opportunities to practice articulating claims about climate change and responding to anti-climate change arguments in class so, if you assume onsite participants were fairly equivalent to online learners at the onset of their learning experience, you would expect to see either equivalent ratings of their abilities after the course or higher rated ability levels among onsite participants. However, in actuality, we see what appear to be greater increases among the online course participants (if you assume pre-course ability ratings for onsite participants to be roughly equal given trends elsewhere in the data that suggest onsite and online learners to be quite similar at the start of this informal learning experience). Perhaps for the same reasons outlined earlier in this report, i.e., regarding biases/beliefs inherent among the online participants who follow-through to the end of the course, online participants seem to feel stronger in their ability to articulate the basis of climate change and respond to anti-climate change arguments.

EFFECTS ON PARTICIPANTS' BEHAVIORS

Pre- and post-course surveys tracked participants' responses to a series of questions about their certainty of doing various things as a result of taking the "Our Earth's Future" course – possible behaviors we asked about included taking other courses offered by AMNH, recommending this course to a friend, and continuing to learn about climate change. The figure below compares the responses of onsite and online participants who responded to the post-course survey. (Note, response options were coded as follows: "definitely will not"=1, "probably will not"=2, "unsure"=3, "Probably will"=4, and "Definitely will"=5.)

Figure 11: Likelihood of Doing Things After "Our Earth's Future" Course



Responses indicate high levels of satisfaction with the course among onsite and online learners alike.

In addition to the behaviors that we asked about participants in both the online and onsite courses indicated that they had had discussions about things that they had learned with people outside of the course. Some participants had used resources and knowledge they had gained to fuel conversations with climate change doubters, while others were excited about sharing information and resources (e.g., "graphics, charts, and videos) with fellow climate change believers.

BIG TAKE-AWAYS

ROLE OF THE INSTRUCTOR

Clearly, one of the most important factors in any instructional program, formal or informal, is the instructor. His or her ability to organize a coherent path through the topic of study, to assemble a strong set of resources and activities that communicate key themes, and the ability to explain concepts clearly and respond effectively to participants' questions is essential to a successful course. In the case of Our Earth's Future, both online and onsite participants praised the abilities of instructor Debra Tillinger's and, in addition to praising her instructional abilities, they also found her passion for the topic to be engaging and appreciated her openness and approachability.

In addition to the primary instructor, the Our Earth's Future courses also benefited from presentations from experts in a variety of fields that intersect with the topic of climate change. This ability to hear things from the "scientists' mouths, rather than just documentaries and magazine articles" was something that course participants appreciated. Lastly, the value of a strong support team was also noted at various stages during the onsite and online courses. By helping with course logistics, and attending to various participant issues that arouse, these team members helped the overall learning experience to be seamless and flow smoothly from week to week. One of the online participants stated "I was pleasantly surprised at how accessible the instructors were! They answered everyone's questions even when some of them were kind of off the wall. They maintained professionalism at all times."

LINKS BETWEEN FEEDBACK AND CONFIDENCE

There seems to be some evidence from this evaluative study that suggests that even short, informal assessments can potentially have an impact on participants knowing that they have learned (and/or feeling more confident that they have learned something). Online course participants seem to have benefited from the assessments offered as part of that learning experience, and some onsite participants expressed a desire for similar ways to check their understanding of key concepts and identify lingering misconceptions. In the absence of more or more regular assessments, there may also be value in a short statements that summarize the goals of each module and provide a checklist for participants to make sure they've learned or understood all of the key points.

FINDING THE RIGHT FIT FOR ALL PARTICIPANTS

Adult learners have had varied learning experiences, life experiences, and professional experiences, all of which make it far more challenging to create one adult learning experience that “fits all” adult learners. Course participants appreciate the option of having additional resources available if they want to dive deeper into a topic or further their understanding of a concept, but they also warn against making those resources required—acknowledging the varying amounts of available time adult learners have to devote to informal learning pursuits.

DIVERSE RESOURCES

Both onsite and online learning experiences incorporated a variety of learning resources including lectures, or videos of lectures, supplementary videos, articles and essays, interactive simulations, and visualizations of data. Learning opportunities also grew out of small and whole group discussions in the onsite courses, and the discussion forum in the online courses. One of the online course participants stated, “I expected that I would have some papers to read, but was pleasantly surprised that there were so many sources to learn from. The readings were clear and easy to understand, and I really enjoyed the discussion forum. The instructors encouraged thoughtful discussion, and it was great to learn from all of the comments.” Providing a diverse set of resources and formats for interaction help to ensure that a course will be successful in meeting the needs of learners with varied learning styles and interests. The use of a variety of resources also helped to meet the needs of learners at different knowledge/ability levels, as was the case for one of the online course participants who we interviewed who stated: “Some articles and info graphics were more complicated than I was used to, but the videos and on line questions by people helped to clarify.”

EXTENDED LEARNING EXPERIENCES

Many participants were quite passionate about climate change and the environment in general. As further evidence of the perceived value of their learning experiences, several participants in both the onsite and online courses expressed a desire to be alerted to future learning opportunities that tied into these interests. Several participants also expressed a desire to help out with future courses and requested a way to stay connected to their fellow course participants so that they could continue discussions and continue exploring the topic of climate change together. Adult learners came to feel like they had become a part of a learning community and it was their hope that this experience could extend beyond the confines of a 3-10 week online or onsite course.

MUSEUMS AS A SOURCE FOR LEARNING

One of the underlying goals of this project was to better understand the unique value and benefits of museum-based learning experiences. Throughout the project, participants cited examples of what they considered to be the inherent value of museum-based learning opportunities, i.e., access to experts and leaders in their respective fields, a wealth of resources and learning materials including diverse artifacts and exhibits, and most importantly, the fact that museums are a trusted source for unbiased information.

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APPENDICES

Pre Course Survey Questions.....Page 36

Post Course Survey Questions.....Page 38

Onsite Course Focus Group Protocol.....Page 44

Online Course Interview Protoco.....Page 45

Pre-Course Survey

Please rate the **importance** of the following possible reasons for taking this course, using a 5-point scale where **1=not important at all** and **5=very important**.

- a. To learn new things **in general**.
- b. To learn **specific things** about the topic of this course.
- c. I consider myself to be a life-long learner.
- d. Taking this course allowed me to gain credits or knowledge that I could apply to my work.
- e. I appreciate opportunities to socialize with other adults.

Please list any **other** reasons you had for taking this course:

Please indicate your level of **agreement** with the following statements (**Strongly Disagree=1, Disagree=2, Neutral=3, Agree=4, Strongly Agree=5**)

- a. I consider myself to be a life-long learner.
- b. I regularly seek out learning opportunities that are related to my work.
- c. I regularly seek out learning opportunities for reasons **other than** professional advancement (e.g. for personal enjoyment).
- d. I am primarily taking this course because I am interested in the topic.
- e. I would still have signed up for this course even if it were on a different, unrelated topic.
- f. The resources provided by AMNH enhance its value as a source for adult learning programs.
- g. I appreciate opportunities to socialize with other adults.

Please choose the response below that best represents your beliefs about **museums** as a source for online learning experiences in comparison to each of these other sources for online learning: (Response options: **Museums are better, Both are the same, Formal educational institutions are better**)²

- a. Museums vs. formal educational institutions (e.g., colleges or universities)
- b. Museums vs. other informal learning institutions (e.g., libraries or parks)
- c. Museums vs. online learning sites (e.g., Coursera, Khan Academy, edX)

Why do you feel the way you do about museums as providers of online educational resources for adult learners in comparison to other online resources for adult learners?

How much do you know about... (1=nothing at all, 2=not much, 3=about the same as most people, 4=a little more than most people, 5=A lot more than most people.)³

- a. Climate change science? (Carbon cycle, greenhouse gases, carbon footprint, etc.)

² This question was not asked on the 3 week online pre-course surveys.

³ These items were borrowed from the Eco_Schools USA CCC Survey with permission from PEER Associates.

- b. Climate change impacts? (Rising sea levels, habitat changes, increased severe weather events, cultural impacts, etc.)

Onsite:

- c. Climate change solutions? (Reducing energy use, etc.)
- d. Climate change actions (Carbon/energy assessments etc.)⁴

Online:

- c. Climate change responses? (mitigation, adaptation, etc.)
- d. The North Polar (Arctic) Region

Which of the following three statements comes closest to your view? ⁵

- Climate change is happening now, caused mainly by human activities
- Climate change is happening now, caused mainly by natural forces
- Climate change is not happening now
- Don't know

What evidence or examples support your understanding of climate change?⁶

Please rate your ability to do each of the following: (1=extremely poor=1, 5=extremely strong)⁷

- a. Evaluate information from multiple sources
- b. Interpret data visualizations
- c. Clearly articulate the basis of climate change
- d. Respond to anti-climate-change arguments

Please check any of the following learning experiences you have had as an adult:

- A short onsite course at AMNH (one day or less)
- A longer onsite course at AMNH (More than one day or session)
- Short onsite classes at other educational institutions (one day or less)
- Longer onsite classes at other educational institutions (More than one day or session)
- A paid online course
- A free course online
- None of the above

Specifically, how many online courses have you taken prior to this course?⁸

- None
- One (1)
- A few (2-3)
- Several (4-7)
- Many (8 or more)

⁴ The italicized C & D were replaced in 2015 by the ones listed below.

⁵ This question was not asked on the 5-Week Onsite Course Pre-Surveys.

⁶ This question was not asked on the 5-Week Onsite Course Pre-Surveys.

⁷ This question was not asked on the 5-Week Onsite Course Pre-Surveys.

⁸ This question was not asked on the 5-Week Onsite Course Pre-Surveys.

Post-Course Survey

Which of the following best describes your level of participation in this course?⁹

- I participated in the majority of the course, viewing most course resources and engaging in most activities
- I participated in some of the course but only viewed a few of the course resources
- I did not end up participating in the course

Please rate the quality of each class session/module using a 5-point scale where 1=Extremely Low and 5=Extremely High, (check NA if you did not attend that session):

5-Week May 2014 & June 2014:

- a. Week 1: Is Climate Change Happening? Prove it...
- b. Week 2: It All Comes Down to the Ocean
- c. Week 3: Cultural Impact of Climate Change
- d. Week 4: Our Earth's Future: Risk and Resilience
- e. Week 5: Tell it Like it Is

5-Week March 2015 & June 2015:

- a. Week 1: Watching Climate
- b. Week 2: It all comes down to the ocean
- c. Week 3: Living with climate change
- d. Week 4: Risk and Resilience
- e. Week 5: Mitigate, Adapt, or Suffer?

3-Week: Extreme Weather

- a. A Perfect Storm
- b. A Web of Interactions
- c. What's Next?

3-Week: Rising Seas

- a. Living with Climate Change
- b. How does climate work
- c. Past, Present Future

3-Week: Life Responding to Climate Change

- a. Threats to Life on Land
- b. Risks to Global Food Supply
- c. Vulnerabilities of Ocean Life

⁹ Online Course surveys only.

10-Week 2014

- a. Climate Change is Happening: See It
- b. Climate Change is Happening: Model It
- c. It all comes down to the ocean
- d. Living with Climate Change
- e. Mitigate, Adapt or Suffer

10-Week 2015

- a. Climate Change is Happening: See It
- b. It all comes down to the ocean
- c. Climate Change is Happening: Model It
- d. Living with Climate Change
- e. Mitigate, Adapt or Suffer

Please rate the quality of each component of the course using a 5-point scale where 1=Extremely Low and 5=Extremely High

- a. resources available via the course website
- b. use of resources at the museum

Please rate the extent to which the instructor and guest speakers were able to communicate scientific information clearly: 1=not clearly at all, 5=Extremely clearly (check NA if you did not attend that session)

5-Week May 2014

- a. Course Instructor
- b. Michela Biasutti, Guest Speaker
- c. Laura Allen, Guest Speaker
- d. Jenny Newell, Guest Speaker
- e. Ed Mathez, Guest Speaker
- f. Randy Horton, Guest Speaker
- g. Mark Fischetti, Guest Speaker
- h. David Biello, Guest Speaker

Comments:

5-Week June 2014:

- a. Course Instructor
- b. Michela Biasutti, Guest Speaker
- c. Laura Allen, Guest Speaker
- d. Jenny Newell, Guest Speaker
- e. Ed Mathez, Guest Speaker
- f. Radley Horton, Guest Speaker
- g. Gavin Schmidt, Guest Speaker
- h. Phillip Orton and David Biello, Guest Speakers

Comments:

5-Week March 2015:

- a. Course Instructor
- b. Gavin Schmidt, Guest Speaker
- c. Michela Biasutti, Guest Speaker
- d. Jenny Newell, Guest Speaker
- e. Ed Mathez, Guest Speaker
- f. Phillip Orton and David Biello, Guest Speakers

Comments:

For Online Course Surveys:

Please rate the quality of each component of the course using a 5-point scale where 1=Extremely Low and 5=Extremely High (Check NA for not applicable if you did not use or participate in any of the following):

- a. Dr. Tillinger's Lectures
- b. Other Expert Lectures
- c. Supplementary Videos
- d. Essays
- e. Discussion Forum
- f. Quizzes
- g. Interactive Activities
- h. Links to Resource

Given your level of knowledge prior to the course, how challenging did you find this course to be? ¹⁰

- Too easy
- Just right
- Too challenging

Comments – Please use the space below to share specific comments about the amount of work required for this course.

Approximately how many hours per week did you spend on the course?¹¹

- Less than an hour
- 1-2 Hours
- 3-5 hours
- 6-7 hours
- more than 7 hours

¹⁰ Online post-course surveys only.

¹¹ Online post-course surveys only.

How would you describe the pacing of this course?¹²

- Too slow
- Just right
- Too fast
- Other, please specify

What did you like most about the course?

What did you like least about the course (and how could it be improved for the future)?

How likely would you be to sign up for other courses at the American Museum of Natural History (1=Definitely not likely, 5=Definitely)

- a. ...on the same topic?
- b. ...on related topics?
- c. ...offered completely online?
- d.with online and face-to-face components?

Please indicate your level of agreement with the following statements (Strongly Disagree=1, Disagree=2, Neutral=3, Agree=4, Strongly Agree=5)

- a. I consider myself to be a life-long learner.
- b. I regularly seek out learning opportunities that are related to my work.
- c. I regularly seek out learning opportunities for reasons other than professional advancement (e.g. for personal enjoyment).
- d. I am primarily taking this course because I am interested in the topic.
- e. I would still have signed up for this course even if it were on a different, unrelated topic.
- f. The resources provided by AMNH enhance its value as a source for adult learning programs.
- g. I appreciate opportunities to socialize with other adults.

Please choose the response below that best represents your beliefs about museums as a source for online learning experiences in comparison to each of these other sources for online learning: (Response options: Museums are better, Both are the same, Formal educational institutions are better) ¹³

- a. Museums vs. formal educational institutions (e.g., colleges or universities)
- b. Museums vs. other informal learning institutions (e.g., libraries or parks)
- c. Museums vs. online learning sites (e.g., Coursera, Khan Academy, edX)

Instead of the question above, the online post-course surveys asks for respondents' level of agreement with the statement: This course has improved my opinions about museums as a source for online learning opportunities.

¹² Not included on the 3-week online post-course surveys.

¹³ This item was not included on the March or June 2015 5-week post-course surveys.

Why do you feel the way you do about museums as providers of online educational resources for adult learners in comparison to other online resources for adult learners? ¹⁴

How much do you know about... (1=nothing at all, 2=not much, 3=about the same as most people, 4=a little more than most people, 5=A lot more than most people. ¹⁵

- a. Climate change science? (Carbon cycle, greenhouse gases, carbon footprint, etc.)
- b. Climate change impacts? (Rising sea levels, habitat changes, increased severe weather events, cultural impacts, etc.)

Onsite:

- c. Climate change solutions? (Reducing energy use, etc.)
- d. Climate change actions (Carbon/energy assessments etc.)

Online:

- c. Climate change responses (mitigation, adaptation, etc.)
- d. The North Polar (Arctic) Region

Which of the following three statements comes closest to your view?

- Climate change is happening now, caused mainly by human activities
- Climate change is happening now, caused mainly by natural forces
- Climate change is not happening now
- Don't know

What evidence or examples support your understanding of climate change?

How much do you know about... (nothing at all=1, not much=2, about the same as most people=3, a little more than most people=4, a lot more than most people=5)

- a. Climate change science? (carbon cycle, greenhouse gases, carbon footprint, etc.)
- b. Climate change impacts? (rising sea levels, habitat changes, increased severe weather events, cultural impacts, etc.)
- c. Climate change responses? (mitigation, adaptation, etc.)
- d. The North Polar (Arctic) Region

Please rate your ability to do each of the following: (1=extremely poor=1, 5=extremely strong)

- a. Evaluate information from multiple sources
- b. Interpret data visualizations
- c. Clearly articulate the basis of climate change
- d. Respond to anti-climate-change arguments

¹⁴ This item was not included on the March or June 2015 5-week post-course surveys.

¹⁵ These items were borrowed from the Eco_Schools USA CCC Survey with permission from PEER Associates

(Note: on the 3 week post-course surveys, respondents were asked to indicate their skill in doing each of the above before and after the course)

How would you describe your level of understanding of the following? (BEFORE and AFTER the Course (None=1, 2=Very Low, 3=Moderate, 4=High, 5=Very High)¹⁶

- a. Much of the climate change uncertainty is not in the science – we have a good understanding of how the addition of greenhouse gases will affect the climate. The uncertainty lies in the amount of these gases that will be released into the atmosphere.
- b. With regards to climate change, the costs of mitigating action are probably less than the cost of inaction (i.e., damage repair).
- c. Scientific statements are statements that can be proven to be false.
- d. The greenhouse gases (like water and carbon dioxide) work by absorbing and then re-radiating energy from Earth's surface.
- e. Records from ice cores tell us that climate can change faster than scientists originally predicted.
- f. Earth is heated unevenly because it is a sphere and more solar radiation strikes the equator. This drives the circulation of the ocean and atmosphere.
- g. A positive feedback occurs when a small push in one direction leads to a continuation of the system in the same direction. Our climate system is dominated by positive feedbacks
- h. Risk depends on the probability of an event occurring combined with the cost (in money and human suffering) if the event occurs.
- i. The climate system contains a committed warming and more warming is in the pipeline.
- j. Climate is the long-term average of weather.

Based on your experiences in this course, how likely are you to (1=Definitely will not, 2=Probably will not, 3=unsure, 4=Probably will, 5=Definitely will)

Onsite Courses

- a. ...take another course at AMNH
- b. ...recommend this course to a friend
- c. ...tell friends about adult learning opportunities at AMNH
- d. ...continue my learning about climate science

Online Courses (not likely at all, not very likely, neutral/undecided, likely, very likely)

- a. Recommend this course to a friend
- b. Recommend adult learning opportunities at AMNH in general
- c. Recommend online learning opportunities from museums in general
- d. Take another course offered by AMNH on the same topic
- e. Take another course offered by AMNH on a different topic
- f. Participate in online learning opportunities offered by other museums
- g. Continue studying about climate change
- h. Visit a museum

¹⁶ On 2015 Online Post-Course Surveys Only.

Onsite Course Focus Group Protocol

1. Why did you sign up for this course?
 - a. How did you learn about it?
 - b. What did you want to get out of it?
2. To what extent did the course experience meet your expectations?
3. To what extent did the course experience not meet your expectations?
4. Was the pace (is this too technical for group?) of instruction ok? (Too fast, too slow, just right)
5. Was the length of the course okay? (Too long, too short, just right?)
6. Was the level of instruction ok? (Lectures? readings from the online course page? Too hard, too easy, just right?) (can we ask if they found the online course page useful?)
7. What improvements would you would recommend to make future courses better?
8. What did you get out of participating in the course?
 - a. What are the most important things you learned from the course?
 - b. What new knowledge, skills, and perspectives did you gain?
 - c. Do you feel better equipped to explain, discuss and/or argue your viewpoints about climate change?
 - d. What, if anything, are you going to/or plan to do differently? (behavior)
9. Would you recommend this course to others? Who/why?
10. Have you ever taken an online course? Would you be interested in taking an online course from the Museum in the future? Why/why not? (we would be interested to know from those who have taken online courses how they feel the two types of learning experiences compare if possible).

Online Course Participant Interview Protocol

1. Which of the following Our Earth's Future Courses did you participate in?
2. Why did you sign up for the Our Earth's Future course(s)?
3. What were your expectations for the course(s) and to what extent were they met?
4. Which of the following best describes the pacing of the online course(s) from your perspective?
5. Which of the following best describes the length of the online course(s) from your perspective?
6. Which of the following best describes the level of instruction for the online course(s) from your perspective?
7. Did you experience any technological challenges while taking the online course? How were they resolved?
8. What did you like best about the online learning experience?
9. What did you like least about the online learning experience?
10. What improvements would you recommend to make future online courses better?
11. What are the most important things you learned from the course?
12. Did your online learning experience make you feel more equipped to explain, discuss, and/or argue your viewpoints about climate change? How so?
13. If you've taken other online courses, how did the Our Earth's Future course(s) compare?
15. Based on this experience, would you take future online courses offered by AMNH and/or recommend this course to others?
16. If you participated in the face-to-face Our Earth's Future course at AMNH as well, please compare and contrast your online vs. face-to-face experience.
17. How did the Our Earth's Future online course(s) compare to other face-to-face learning experiences that you've had?