THE Generation X Report

A Quarterly Research Report from the Longitudinal Study of American Youth

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How many young adults know their cosmic address?

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ONE OF THE SIGNAL ACHIEVEMENTS OF AMERICAN SCIENCE IN THE LATE 20TH AND EARLY 21ST CENTURIES IS AN EXPANDED UNDERSTANDING OF THE UNIVERSE IN WHICH WE LIVE. Although we have explored only a tiny fraction of the visible universe, American satellites and space telescopes have mapped large tracks of space. It is not uncommon to look at a magazine or a web site and see an image taken from the Hubble Space Telescope or color-enhanced images from x-ray, gamma ray, or other space telescopes operated by the United States or the European Space Agency. As a part of its continuing inquiry into the scientific literacy of Generation X, the Longitudinal Study of American Youth (LSAY) asked a national sample of young Americans aged 37 to 40 to look at an image taken by the Hubble Space Telescope and to identify the object and to share their thoughts about it.

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For additional information about the LSAY, visit **www.lsay.org.**

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Each of the 5,100 young adults in the LSAY national sample received a letter and a photographic quality picture of a spiral galaxy provided by the Hubble Space Telescope. Astrophysicists believe that the spiral galaxy in this image (see front cover) is similar to the spiral galaxy in which planet Earth resides. Planet Earth is a part of a solar system and is in orbit around the Sun, which is a star. Assuming that the image of the spiral galaxy shown previously is a reasonable representation of our own spiral galaxy, our solar system is located about two-thirds of the way out on one of the arms of the spiral galaxy and would be one of the smallest white dots in the image. The spiral galaxy rotates (it takes about 250 million years for our solar system to make one rotation around the galaxy) and the center of the galaxy is a black hole that is gradually pulling matter from the galaxy into itself. The visible universe includes more than 100 billion galaxies.

The 2010 LSAY annual survey asked each young adult to look at the image provided and try to identify it. An open-ended response was collected first, followed by a multiple-choice question that asked if the object in the picture was (1) another solar system that is forming planets, (2) a cosmic dust cloud in which thousands of new stars are forming, (3) a star that has exploded and is collapsing to become a white dwarf, (4) a galaxy similar to our own galaxy, or (5) a comet that is spinning off frozen matter as it moves through space. Forty-three percent of LSAY young adults were able to provide a correct answer that indicated that they recognized the object as a galaxy that is similar to our own galaxy (see Table 1).

This report will examine which young adults were able to identify the image correctly and examine some of the factors that are associated with knowing about this image. This analysis will also examine the sources that Generation X young adults use to learn about the Universe and related scientific questions. And, finally, the report will look at the impact of understanding the nature of the Universe on other attitudes toward science and religion.

THE HUBBLE IMAGE AS AN EXAMPLE OF SCIENCE LEARNING IN GENERATION X

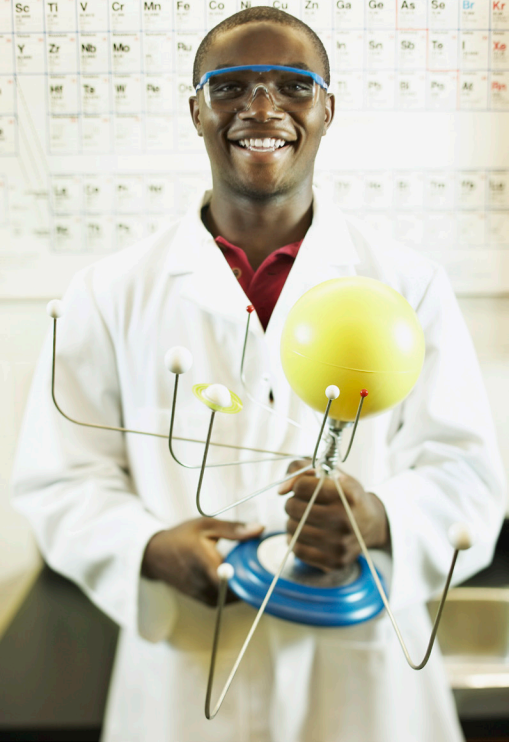
The identification of the Hubble image as a spiral galaxy similar to our own is more than just a scientific version of Trivia. We know from decades of research on adult science learning that adults acquire some basic core scientific concepts from their formal schooling and that exposure to college-level sciences courses is especially influential in this process. We also know that many adults acquire additional science information from stories in the media and from informal learning activities in museums and similar institutions. And more recently, there is evidence that many adults acquire some additional science information from online sources, often as a part of a search related to a need to know (Miller, 2010a, 2010b, 2010c).

But the Hubble image poses a different kind of science information

Table 1: Percentage of LSAY young adults able to correctly identify Hubble image, 2010.

	Correct	N*
All LSAY young adults	43%	3,080
Gender		
Females	32	1,544
Males	53	1,536
Education		
Less than high school	21	87
High school graduate or GED	36	1,308
Associate degree	44	248
Baccalaureate	47	884
Masters degree	50	402
Doctorate or professional degree	63	150
College Science Courses		
No college science courses	31	1,036
1 to 3 college science courses	42	428
4 to 7 college science courses	48	476
8 or more college science courses	55	837
Civic Scientific Literacy Score		
Less than 50	20	508
50 to 69	33	1,059
70 to 89	52	963
90 or higher	81	313
Previous Exposures to Hubble Images		
None	19	685
One	26	368
Two	34	471
Three	49	609
Four	65	645
Five	71	301

* The number of respondents in each row.



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exposure. This image and hundreds of other space telescope images appear in the media, in various entertainment formats, and sometimes as a part of advertising. In contrast to searches for information about a specific disease or medical problem, exposure to a Hubble Telescope image falls more into the realm of curiosity rather than personal or occupational necessity. Images of this kind may provoke feelings of uncertainty or curiosity and may lead some individuals to think about their place in the Universe and related philosophical issues.

WHO GOT IT RIGHT?

It is useful to begin by asking which young adults were most likely to correctly identify the Hubble image as a spiral galaxy similar to our own.

The level of education completed is a strong predictor of recognizing the Hubble image (see Table 1). LSAY young adults with advanced formal education were approximately three times more likely to recognize this Hubble image than were young adults who did not complete high school. One of the factors that contribute to this difference is exposure to college-level science courses. The United States is unique in its requirement that all college students complete one year of college science courses as a part of a general education requirement. Because these courses are often taken during the first or second year of college, students who enter college but do not earn a degree are still exposed to college science courses (and other general education requirements). A separate examination of the impact of college science courses documents that the completion of college science courses increased the likelihood of recognizing the Hubble image as a spiral galaxy.

The combination of high school and college science courses and some engagement with informal science learning after the end of formal schooling increases the likelihood that a young adult will become scientifically literate. I have written about this extensively in various places, but the basic idea is that adults who understand a basic set of scientific ideas – the nature and structure of matter, the organization and functioning of various forms of life, and some basic concepts about the nature of the Universe – will be able to make sense of emerging news about new scientific discoveries and about new information such as the Hubble space telescope images (Miller, 1998, 2000, 2001, 2010a, 2010c). The Index of Civic Scientific Literacy ranges from zero to 100 and a score of 70 or higher is a mark of being scientifically literate. Using this measure, the 2010 LSAY data show that young adults with higher levels of scientific literacy were progressively more likely to recognize and understand the Hubble image (see Table 1). Only one in five young adults with a lower level of scientific literacy were able to identify the image, but four out of five young adults who scored 90 or higher on the scale were able to identify the image correctly.

Young men were significantly more likely to identify the Hubble image correctly than were young women in the LSAY sample (see Table 1). Slightly more than half of young men were able to identify the image as a spiral galaxy similar to our own compared to a third of young women. This relationship remained essentially the same within levels of education and within the number of college science courses completed. This pattern suggests that young men may have an earlier and stronger interest in cosmology – the study of the Universe – than young women.

This quick look at some of the factors that make it possible for some young adults to identify the image correctly points to the importance of a strong formal exposure to scientific ideas in high school and college. This is not surprising, but it should remind the young parents who are participating in the LSAY of the importance of science education for their own children.

THE IMPORTANCE OF CONTINUING ADULT LEARNING ABOUT SCIENCE AND TECHNOLOGY

One of the advantages of more formal education and more college science courses is to provide important conceptual tools for some young adults to locate and use a variety of adult science learning resources available in many communities and online. Most LSAY participants have been out of school for several years, but there is a steady stream of new issues involving science and technology that emerge regularly. In previous ***Generation X Reports***, we

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have looked at how young adults learned about the 2009 influenza epidemic and about how they make sense of conflicting information about organic and genetically modified foods. The responses to our 2010 questions about the Hubble image and related information about the Universe offer additional insights into this process.

Slightly more than 60% of LSAY participants indicated that the Hubble image provided in the 2010 survey was the first time that they had looked carefully at a Hubble or other space telescope image. Some of these young adults reported that they had seen similar images in magazines, books, and online, but that they had not paid a great deal of attention to those images. Other young adults indicated that they had looked carefully at previous Hubble images and thought about the meaning of the images. If our understanding of the process is correct, those young adults who had acquired a minimal level of scientific literacy during the years of formal education should have been exposed to space telescope images in a wider array of settings.

To test this idea, the 2010 LSAY survey asked each participant whether they had previously seen Hubble images or similar space telescope images in various other settings: (1) books or magazines, (2) a planetarium or science museum, (3) science television shows, (4) on the Internet, and (5) in a book that they own. One in five LSAY young adults reported that they had not seen a Hubble or other space telescope image in any of these five places, and 27% indicated that they had seen Hubble or similar images in one or two of the listed places. Forty-one percent said that they had seen Hubble or similar images in three or four of these places, and 10% claimed to have seen similar images in all five places (see Table 2). These results reflect a fair amount of prior exposure to Hubble images similar to the one provided in the 2010 study.

When we look at the relationship of formal education to prior exposure to space telescope images, a reasonably clear pattern emerges (see Table 2). Young adults who completed a baccalaureate were more likely to have seen a similar image in three or more places than were young adults without a baccalaureate. Individuals who had taken college science courses were more likely to have seen space telescope images than other young adults. And young adults who qualified as scientifically literate – the combination of formal and informal science learning – were significantly more likely to have looked at space telescope images prior to the 2010 study. All of these patterns suggest that good early science education provides the tools that make the use of non-school science learning resources – books, magazines, web sites, museums and planetariums, and similar facilities – more attractive and more effective.

Table 2: Factors related to previous exposure to Hubble images, 2010.

	Previous exposure to Hubble images				N*
	None	1 or 2	3 or 4	5 or more	
All LSAY young adults	22%	27%	41%	10%	3,080
Gender					
Female	27	32	36	6	1,544
Male	18	23	46	13	1,536
Education					
Less than high school	36	31	30	3	87
High school graduate or GED	27	30	35	9	1,308
Associate degree	23	22	40	15	248
Baccalaureate	17	26	47	11	884
Masters degree	19	27	45	9	402
Doctorate or professional degree	17	20	49	14	150
College Science Courses					
No college science courses	30	31	31	7	1,036
1 to 3 college science courses	20	26	48	6	428
4 to 7 college science courses	22	26	43	9	475
8 or more college science courses	14	23	49	15	836
Civic Scientific Literacy Score					
Less than 50	44	32	21	3	507
50 to 69	25	30	37	8	1,060
70 to 89	13	26	50	11	962
90 or higher	6	15	58	21	313
Minor Children at Home					
None	20	25	46	9	1,073
Some	24	28	38	10	1,992

* The number of respondents in each row.

One of the important results of the growth of the Internet and the expansion of communication devices and tools in the Electronic Era is that it is easier today to find clearly-written high-quality science information than at any previous time in human history. And, as noted in previous ***Generation X Reports***, a high proportion of these young adults are frequent users of emerging electronic tools. At the same time, we know that all of the available information about science and technology is not of uniform quality and some of it may be incorrect or misleading.

In this context, it is important to inquire about the information sources young adults in Generation X would trust on a subject such as a Hubble image or other information about the Universe. The 2010 LSAY survey asked each respondent to indicate

Table 3: Trust in selected information sources about Hubble or the Universe, 2010.

Trust in Hubble/astronomy Information from …	Mean Score	
	Know Image	Not know
Information on a NASA web site	8.3	7.8
A program/exhibit in a planetarium or museum	7.9	7.4
A PBS/Nova or Discovery Channel science show	7.7	7.1
A lecture from a professor of astronomy	7.5	7.0
A story in a weekly news magazine	6.1	6.0
A report on a cable television newscast	5.9	6.0
A story in the New York Times or WSJ	5.9	5.7
A story on National Public Radio (NPR)	5.9	5.4
A story on nation network television news	5.7	5.9
A story on the Weather Channel	5.6	5.6
A Wikipedia article on the Internet	5.1	5.2
A story on your local television news	5.0	5.1
A story in your local newspaper	4.9	4.8
A lecture by a leader of your church/religious group	3.6	3.9
Number of respondents	1,308	1,764

how much they would trust information about a Hubble image or the nature of the Universe from 14 different sources. The results indicate that many Generation X young adults would trust information from recognized institutions and experts over non-scientific or local authorities (see Table 3). Both young adults who were able to identify the image and those who were not expressed a high level of trust in information from NASA, a planetarium or science museum, a PBS Nova show, or a professor of astronomy. National news reports in a weekly news magazine, a cable television newscast, a major national newspaper, or National Public Radio were also accorded a relatively high level of trust, but somewhat less than the level assigned to NASA and other expert sources. Information found on Wikipedia or in local television or newspapers was trusted far less, and information provided on these questions by a religious leader was the least trusted source of information.

We expected that there might be some difference in the levels of trust between young adults with a history of prior Hubble image viewing and those with less previous exposure, but these differences were minimal (see Table 3). Previous viewers of Hubble images were slightly more likely to trust expert sources than first-time viewers and less likely to trust major media outlets than first-time viewers, but the magnitude of these differences was small.

THE IMPACT OF THE HUBBLE IMAGE ON PERSONAL AND POLICY ATTITUDES

Apart from the impact of formal and informal science learning and trust in major information sources, it is important to look at the attitudes of Generation X young adults on the meaning of these images in their own thinking. It is important to recognize that some of the attitudes that we measured may have been held prior to seeing the Hubble image and we do not mean to claim direct causation. But it is useful to contrast the attitudes of our LSAY participants who correctly identified the image and those who did not.

One of the most common reactions to Hubble images is surprise or awe over the vastness of the Universe. The earliest humans to build telescopes and peer into the sky thought that planet Earth was the center of the solar system and the Universe – that everything rotated around us – but few individuals still hold that view. To assess the attitude of Generation X on this question, the 2010 LSAY survey asked each participant to report the level of their agreement on a zero-to-10 scale with each of several statements. The first statement was "When I see images like this, I am reminded of the vastness of the Universe." Seventy percent of young adults who correctly identified the image strongly agreed with this statement, indicating an agreement level of nine or ten (see Table 4). Only four percent of young adults who correctly identified the image expressed disagreement with the

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statement, compared to 11% of young adults who were unable to identify the image.

A second statement – Images like this show how small and fragile planet Earth is in the context of the Universe – received strong agreement from young adults who identified the image correctly and nearly as strong agreement among young adults who could not identify the image. Three out of four young adults who correctly identified the image agreed with this statement (score of 7 to 10) compared to two out of three individuals who did not identify the image.

For some LSAY participants, the vastness of a galaxy and of the Universe raised doubts about the significance of human beings. Fifty-three percent of young adults who identified the image correctly agreed (score of 7 to 10) with the statement "When I see images like this, I wonder about the significance of humans in the Universe," compared to 43% of young adults who did not identify the Hubble image correctly. One in four young adults disagreed with the statement.

The Hubble image does not appear to provoke a science versus religion reaction. Some young adults viewed the Hubble image as evidence of the "greatness of God's creation," with 55% of young adults who correctly identified the image agreeing with the idea (7 to 10) and 65% of young adults unable to identify the image agreeing with the statement. Other LSAY participants saw the Hubble image as evidence of scientific progress in understanding the Universe, with 63% of young adults who identified the image agreeing with the statement "Images like this show how much progress science has made in understanding the Universe." Nearly 60% of young adults unable to identify the image also agreed with the statement. One in four respondents disagreed that the image reflected scientific progress in understanding the

Table 4: Relationship between Hubble image understanding and selected attitudes, 2010.

	Know Image	Agreement with selected attitudes					Mean Score
		0-1	2-3	4-6	7-8	9-10	
When I see images like this, I am reminded of the vastness of the universe.	N	6%	5%	17%	18%	53%	7.3
	Y	2	2	11	16	70	8.7
Images like this show how small and fragile planet Earth is in the context of the Universe.	N	6	5	25	21	44	6.9
	Y	3	4	17	18	58	8.1
The size and complexity of the Universe proves the greatness of God's creation.	N	13	6	17	14	51	6.7
	Y	21	5	19	10	45	5.7
When I see images like this, I wonder about the significance of humans in the Universe.	N	16	11	30	19	24	5.1
	Y	14	11	22	26	27	5.9
Images like this show how much progress science has made in understanding the Universe.	N	6	5	31	29	29	6.2
	Y	4	7	26	30	33	7.0
It is very likely that there is intelligent life at many places in the Universe.	N	14	10	33	18	26	5.3
	Y	8	7	25	22	39	6.8
Seeing images like this makes me want to learn more about the nature of the Universe.	N	12	13	36	21	19	5.1
	Y	5	11	29	29	27	6.5
The Federal Government spends too much money on projects like the Hubble Telescope.	N	27	19	34	11	8	3.3
	Y	39	21	25	8	6	2.9

Notes: The number of participants who were able to identify the image correctly was 1,311 and the number who were unable to identify it was 1,769. Participants were asked to report their agreement or disagreement with each statement on a zero-to-10 scale. The responses are show both by the categories of response and the mean agreement score on each item is included in the right-most column of this table.

Universe. A direct comparison of the two responses showed that approximately 40% of young adults agreed with both statements, indicating that they did not see any conflict in the two statements.

At a more specific policy level, a majority of Generation X young adults disagreed with the statement "The Federal Government spends too much money on projects like the Hubble Telescope." Fifty-three percent of young adults disagreed (scores of 0 to 3) with this statement, compared to 17% that agreed with it (scores of 7 to 10). Young adults who were able to identify the Hubble image were significantly more likely to reject the statement than young adults who were uncertain about the image (see Table 4). Some analyses of other national surveys in the U.S. have found that adults who were in high school or college at the time of Sputnik in 1957 held stronger positive attitudes toward the space program than other adults, but these results from the Generation X young adults in the LSAY show a generally positive attitude toward space projects such as the Hubble Telescope.

Finally, one of the effects of the Hubble image was to stimulate young adult interest in learning more about the Universe. When asked to agree or disagree with the statement "Seeing images like this makes me want to learn more about the nature of the Universe," 46% of young adults agreed and 21% disagreed. A third of young adults were uncertain about how much the image motivated them to learn more about the Universe. Young adults who correctly identified the image were somewhat more likely to report that the image made them want to learn more about the Universe than young adults who did not identify it (56% to 39%). These responses illustrate – in part – the dynamic of adult science learning. Individuals who see an image or read a story that stimulates their curiosity are more likely to seek additional information about the subject and those young adults who have an initial understanding of the nature of the Hubble image are likely to have the conceptual tools to be able to locate additional information, read and comprehend it, and to integrate new material into their thinking.

ON BALANCE...

We began by asking how many young adults – Generation X – know their cosmic address and the short answer is that about 43% know that they live in a spiral galaxy and are able to identify a Hubble picture as being similar to our own galaxy. Knowing your cosmic address is not a necessary job skill, but it represents an important part of the growth of human knowledge about our Universe and – to some extent – about ourselves. Unlike our distant ancestors who thought that Earth was the center of the Universe, we know that we live on a small planet in a heliosphere surrounding a moderate sized star than is a part of a spiral galaxy. We are increasingly learning that our small planet benefits from a set of fortunate circumstances – a comfortable distance from our star and protected by a thin stratospheric layer that allows the growth of oxygen-using life. There may be important short-term (the next million years) advantages to knowing where we are and something about our cosmic neighborhood.

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A Brief History of the LSAY

Today, the Longitudinal Study of American Youth (LSAY) is the longest and most comprehensive longitudinal study of a national sample of public school students ever conducted in the United States.

To provide a more intensive longitudinal examination of the development of student achievement in middle school and high school (and the relationship of those patterns to career choices), the National Science Foundation (NSF) funded the LSAY in 1986. After a year of pilot testing of instruments, the LSAY began collecting data from a national sample of 7th and 10th grade students in 50 U.S. public school systems in the fall of 1987. During the next seven years, each of approximately 5,900 students in the two national probability cohort samples were given mathematics and science achievement tests (based on the National Assessment of Educational Progress item pools) each fall and were asked to complete attitudinal and self-report questionnaires each fall and spring.

In addition, one parent of each of the LSAY students was interviewed each spring by telephone, and all of the mathematics and science teachers who served one or more LSAY students were asked to complete a questionnaire for each course, including information about the objectives of the course, the textbook used, and the allocation of time and effort in the course to various kinds of instructional activities. The principal of each of the participating schools was asked to complete a school inventory and questionnaire periodically. The initial period of data collection ended in the spring of 1994 when the 7th-grade cohort was one year beyond high school and the 10th-grade cohort was four years beyond high school.

With support from the NSF STEP program in 2005, the LSAY was able to locate or account for more than 95% of the original sample of students. Data collection was resumed in 2007 and four additional cycles of data collection have been completed with NSF support.

The LSAY participants in the two cohorts are now 36 and 39 years of age, respectively. Because of its extraordinary longitudinal record of these young adults – who represent the core of Generation X – the LSAY is committed to continuing an annual program of measurement and analysis in future decades.

During the years in which students were enrolled in middle school and high school, data were collected primarily through the use of printed questionnaires and tests administered in school by a local school staff member employed part-time by the LSAY. Teacher questionnaires were printed and collected by a combination of mail and the use of a local in-school coordinator. During the in-school years, one parent of each participating student was interviewed by telephone once each year. Currently, approximately 75% of participating young adults complete an annual questionnaire online and the remaining 25% use a printed questionnaire and a postage-paid return envelope. Current participants are offered a small payment in appreciation for their time and effort.

All of the data collection and data management procedures used by the LSAY are approved by the University of Michigan Institutional Review Board. In earlier years, LSAY data collection procedures were reviewed and approved by the Institutional Review Boards at Michigan State University, Northwestern University, and Northern Illinois University. The data are deposited (in a blinded format to protect the identity of individuals) in the Inter-university Consortium for Political and Social Research (ICPSR) at the University of Michigan and are available for secondary analysis according to ICPSR rules. Over the last two decades, LSAY data have been used in approximately 40 dissertations and more than 200 articles in refereed journals.

A more comprehensive description of the LSAY is available at www.lsay.org. ◆

The Generation X Report is based primarily on data from the Longitudinal Study of American Youth (LSAY). The LSAY has been funded by the National Science Foundation (NSF) since 1986 (NSF awards MDR-8550085, REC96-27669, RED-9909569, REC-0337487, DUE-0525357, DUE-0712842, DUE-0856695, DRL-0917535, DUE-1118625, DUE-1118626).

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the NSF.

We acknowledge the continuing cooperation and support of the more than 4,000 LSAY participants who have voluntarily completed questionnaires, telephone interviews, and data forms over the last 24 years and thank them for their continuing support. Without their active involvement, the LSAY would not be possible.

We also acknowledge and thank the parents of LSAY students and the teachers, principals, and administrators in public school districts throughout the U.S. who contributed their time and energy to this study.

And, we acknowledge and thank the several hundred staff who have worked on the LSAY over the last two decades to make this study possible.