

The Effects of a Museum of Science Fiction Event on Participant Knowledge and Interest in Science

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The informal learning environment of the Museum of Science Fiction's *Escape Velocity* event offers an integration of science and science fiction in a variety of activities, talks, events, exhibits, and panels to further attendees' interest. This study examined the efficacy of this event as a learning experience through a survey of attendees. Attendees reported increasing their knowledge of STEM, being able to join many STEM activities, feeling empowered to connect with NASA scientists and resources, intending to look for ways to find out more, and wanting to learn more about NASA science. Those who attended NASA-related panels reported statistically significant gains in knowledge and interest as a result of attending panels on Habitable Worlds, Apollo 50th Anniversary, and Weather on Earth/Weather in Space.

Keywords: science fiction, science, STEAM learning, informal learning, community of interest

INTRODUCTION

The Museum of Science Fiction's annual Escape Velocity event combines the worlds of science and science fiction into a weekend of educational fun featuring scientists, artists, engineers, authors, and academics. This celebration of science fiction aims to promote interest in the science, technology, engineering, arts and mathematics (STEAM) educational areas through a diverse range of engaging programming, special guests, gallery exhibits, technology sessions, and hands-on activities. The event has been held annually since 2016.

The event is unlike other comic-con type events due to the large amount of informal STEAM educational programming presented within the context of science fiction. This approach creates a unique futuristic world's fair atmosphere using the fun of comic cons and fascination of science and engineering festivals. Escape Velocity's mission is to make a measurable positive impact to boost informal learning on the more conceptually challenging academic areas and to attract people to science, technology, engineering, art, and math by producing and presenting the most compelling, exciting, educational, and entertaining science festival in the United States using science fiction as its primary engine.

The event's programming provides models for how science fiction can be used to create interest in STEAM and educate students and the general public about the current knowledge in these fields. From expert panels to exhibits and models, gaming, simulations, and costuming, participants are invited to think and dream about what is possible through STEAM.

CONCEPTUAL FRAMEWORK: INFORMAL SCIENCE EDUCATION

Learning Models for Informal Science Events

Escape Velocity is grounded in the literature on productive informal education programs as described by the National Research Council's (2015) recommendations to 1) Provide intellectually and socio-emotionally rich first-hand experiences with STEM; 2) Leverage audience interest, experiences, and cultural resources; and 3) Make explicit connections across set-

tings. Participants have firsthand experiences with scientists, science fiction writers, producers, and actors, and technologies and models. The event makes explicit connections between science and science fiction, stories and film, real life and potential future scenarios (see Figure 1). A learning opportunity is defined by the nature of the learners, the context and the content (Cranton, 2003). *Escape Velocity* is attended by people interested in science fiction and science; the environment is intellectually and socio-emotionally rich, and there are explicit connections between science and science fiction, books and movies, actors and scientists.

Escape Velocity brings together people who like science fiction, who work or act in it, study or teach it. Activities that are free-choice for adults are the strongest predictors of self-reported knowledge of science and technology (Falk, Reinhard, Vernon, Bronnenkant, Heimlich & Deans, 2007). Choosing to engage in informal learning activities is often based on intrinsic motivation – the want or need to know or experience. Intrinsically motivated learners are more likely to pursue similar activities over time based on the enjoyment and value they perceive (Linnenbrink & Pintrich, 2000; Wigfield & Eccles, 1992; 2000).



Figure 1. Participants at *Escape Velocity* 2019 seated in the Millennium Falcon cockpit.

Adults engage in what has been called “life-long learning” in which individuals intentionally take part in different experiences that are cumulative and can be considered learning (Malcolm, Hodkinson, & Colley, 2003). Most adults spend on average 15 hours per week engaged in informal learning (Livingstone, 1999), including events such as *Escape Velocity*. People who come to informal environments with well-developed interests are like-

ly to exert themselves to learn more, supporting their ongoing engagement (Renninger, 2003). The key is to understand what supports people in pursuing their own deeply held interests and, in the case of *Escape Velocity*, to make constant and strong connections to the current knowledge and processes of science.

There is some evidence that families are pursuing a learning agenda when engaging in informal learning experiences, such as museum visits (Hike, 1989). Several families at *Escape Velocity* were observed discussing what sessions they wanted to attend, having their pictures taken together on the bridge of the *Starship Enterprise*, and discussing things they were hearing. Families were observed engaging with scientists as well as science fiction personalities at *Escape Velocity* in much the same way Tisdal (2011) observed them interacting with scientists at museums – listening, asking questions, concentrating, and enjoying themselves.

Using Science Fiction to Engage People in STEAM

The goal of the Museum of Science Fiction is to educate and engage people about STEAM through science fiction. For example, the 2019 *Escape Velocity* theme was “Technology as a Mirror of Humanity.” The question of what makes us human is a prevailing one in many science fiction works, and a key part in attempting to answer that revolves around how man and machine interact. In many cases, technology is a tool that helps humankind expand itself to a greater potential, whether it is through faster than light starships which carry humans to explore distant worlds, or through cybernetic augmentation, empowering humans to be able to perform otherwise physically impossible feats. In other cases, technology has applications harmful to humanity. Genetic engineering can be used to edit human genomes to potentially cure diseases such as cancer, but that same technology could theoretically be applied to produce targeted bioweapons.

Using science fiction as a way to educate event attendees on the kinds of challenges humanity is facing now and will continue to face into the future, and inspiring them to pursue education and careers in STEAM fields in order to help resolve these challenges, is the goal of the Museum of Science Fiction. As shown in Figure 2, *Escape Velocity* provides the Museum team with the opportunity to bring in a wide range of other like-minded individuals and institutions that share an interest in promoting science education so that they can apply their own expertise. The Great Adventure Lab, for instance, a local team of instructors who hold computer programming workshops for children, taught them how to build and operate a Martian rover

using LEGO robotics. Another presenter, Technology and Gaming Labs, taught game development using the same powerful design programs used by professional game developers.



Figure 2. A NASA technology educator at the controls of the Millennium Falcon.

KEY FEATURES

NASA's Contribution to the Content and Excitement

NASA has had a significant presence at every Escape Velocity with exhibits, sessions, and workshops. NASA's space on the exhibit hall floor was home to NASA scientists with a wide variety of specialties who answer any and all attendees' questions about the moon, sun, and other planets and the technology that has been developed to explore them. In one session, specialists explained the importance of spacecraft in tracking weather and detailed the effects upper atmospheric weather phenomena have on technology. Another session explored what has been learned about Mars through the technologies of unmanned exploration and the possibility of past or present life on the Red Planet following the recent discovery of liquid water under its surface. One of the most popular panels celebrated the legacy of the incredible technological accomplishment of the Apollo moon landing which had its 50th anniversary celebration two months after Escape Velocity 2019. Attendees learned that even though astronauts have not set foot on the Moon for five decades, NASA has never stopped studying it with technology such as cameras and sensors on robotic missions, gathering valuable data that is essential for planning a future mission which will return astronauts to the Moon by 2024.

Technology in Science Fiction

In keeping with the 2019 theme of “Technology as a Mirror of Humanity,” the display pieces were selected to evoke questions about what kind of future may lie in store based on the decisions we make on how to apply advances in technology. The Cylon Centurion from *Battlestar Galactica*, with its chrome body and sweeping red eye sensor, or HAL 9000 from *2001: A Space Odyssey* and its sinister voice, are two stylized representations of the real risk some futurists fear of runaway artificial intelligence that becomes a threat to humanity. A *2001: A Space Odyssey* green screen also gave Escape Velocity fans a chance to put themselves in the film (Figure 3).

The centerpiece of the gallery offered a glimpse of a future of hope, cooperation, and fellowship in the form of a one-of-a-kind model of the iconic Enterprise from *Star Trek: The Motion Picture*. This full-scale model is over eight feet long and has an automated light-up sequence from the movie. Attendees who saw these and all the other display objects not only appreciated their craftsmanship and, in the case of original pieces, historical significance, but also were compelled to reflect on how they use technology in their own lives.



Figure 3. Escape Velocity attendees in a green screen photo of *2001: A Space Odyssey*.

Celebrity Guests Share Firsthand Experience

While fans could only look at the display objects in the Museum Gallery, they had the opportunity to speak with and listen to celebrity guests at Escape Velocity, including Dominique Tipper from *The Expanse* and Gigi Edgley from *Farscape*. The opportunity to meet the actresses behind the characters they see on screen, taking a photo together, and hearing them de-

scribe what happens behind the scenes was the highlight of the event for some attendees. Those kinds of interactions, especially for young fans, can create memorable impressions that could inspire them to pursue careers in science, technology, and the creative arts. It's hard to underestimate the impact these interactions have on young students in their formative years as shown in Figure 4.



Figure 4. Escape Velocity attendees posing with character Chewbacca from movie *Star Wars*.

Engaging Themes

Themes that change year to year are a big draw for attendees, exhibitors, panelists, STEAM organizations, and volunteers. The themes from 2016 to 2020 show how the conference connects science and science fiction:

2016: From Imagination to Reality

2017: Robotics, Drones, and Artificial Intelligence

2018: Other Worlds

2019: Technology as a Mirror of Humanity

2020: Quantum Intelligence: AI & Quantum Computing

Participation

Over the past four years during which Escape Velocity was held, participation increased each year from 2,700 attendees in 2016 to 5,300 attendees in 2019. Table 1 identifies the numbers of attendees, exhibitors, panels, STEAM organizations, and volunteers from 2016 - 2019. Table 2 shows the

demographics reported by survey respondents. As shown, there are relatively equal numbers of males and females who attend and the majority of attendees have at least a bachelor's degree.

To increase awareness of the event, many campaigns to reach a broad audience were used. While campaigns included video advertising and website outreach, social media continues to grow in reach. Table 3 indicates that people are engaging through social media channels such as Facebook, Twitter, and Instagram.

Table 1
Participants Over the Past Four Years (2016-2019)

	Attendance	Exhibitors	Panels/ Events	STEAM orgs	Volunteers
2016	2,700	40	95	19	200
2017	4,300	80	165	19	200
2018	4,700	91	205	35	190
2019	5,300	91	196	27	110

Table 2
Demographics of Attendees from 2016 - 2019

	#Surveys	Gender M/F	Age	Education Level	First timers
2016	106	50%/46%	56% 25-54	82% Bachelors+	*
2017	120	55%/45%	64% 25-54	97% Bachelors+	*
2018	140	52%/48%	80% 25-54	92% Bachelors+	73%
2019	281	57%/41%	68% 25-54	87% Bachelors+	68%

* Not collected

Table 3
Social Media Reach from 2018 and 2019

	Total impressions	Total reach	Facebook community	Twitter followers	Instagram followers
2018	1.2M	512,000	22,113	5,933	649
2019	1M	311,000	24,006	6,510	814

Catalysts for Participation: Gallery of Display Objects and Engaging Sessions

Beginning in 2016 and continuing through 2019, Escape Velocity has had a gallery of Museum of Science Fiction artifacts, and sessions on gaming, films, science, technical topics, literature, and ethics. The Museum Gallery houses meticulously curated display objects, costumes, props, artwork, and more, from various genres of Science Fiction, sci-fantasy, and others. The sessions focus on engaging attendees in expanding their interests and giving them ideas for what to pursue next. Examples from the 2019 program are described below.

Gaming

Opportunities include Cosmic Encounter Galactic board game World Championship Tournament, Starship Horizons (a multi-player bridge simulation experience), Ogre Battles in Washington DC (Sci-Fi warfare), Matrix Game (defense department type exploration of future), and STEM-OLGY (promote interest in STEM). Attendees have the opportunity to learn about how to enter the video game industry, including making games, or exploring how to create positive diverse role models and heroes in video games.

Films

Attendees were offered the opportunity to view a variety of films including 1) ANYA (2019) a love story set in contemporary New York City between two different species of humans; 2) Star Wars: A New Hope (1977); 3) Alien (1979); 4) Prospect (2019) a father and teenage girl try prospecting on a remote moon; and 5) selected short films.

Workshops

More in-depth workshop opportunities included designing a superhero, learning what it takes to be a galactic sword master, creating diverse Sci-Fi characters, learning science fiction writing techniques, practice developing stories, and finding out how to publish science fiction literature.

Science Talks

Focused talks ranged from Assistive (Disability) Tech of the Future (sciences of biomechanics and ergonomics) to the NASA panel on Habitable

Worlds, a panel of commercial spaceflight industry leaders on democratizing access to space, how electricity and magnetism discoveries led to the electronic revolution, looking back and looking forward from the 50th anniversary of Apollo, true tales of exploration to Pluto and beyond (New Horizons' Mission), and a discussion of how we study weather on Earth and in space (Figure 5).



Figure 5. A science and science fiction panel featuring Alex Young and Mason Peck (NASA) and Adam Nimoy and Rod Roddenberry - sons of the actor Leonard Nimoy (Mr. Spock) and creator of *Star Trek*, Gene Roddenberry.

Technical Talks

Additional talks featured tracing the evolution of visual effects technology, costuming/cosplay topics like how to get started, make choices, and save time, how to draw characters based on STEM for books, comics or games, author Morgan Gendel talking about Sci-Fi writing for TV, film, novels and stories, D.I.Y. Sci-Fi Filmmaking, Intro to Video Game Programming with Scratch Jr.

Literature

Sessions on literature ranged from military science fiction to cyberpunk fiction, neurodiversity (cognition, alterity, ability) in Sci-Fi literature, women characters in Sci-Fi, worldbuilding as a way to teach science, influential feminist science fiction authors, early African American Sci-Fi, the supernatural in Sci-Fi, and speculative fiction combining Sci-Fi and the intersectional discourses of identity.

Ethics

In the ethics sessions, a panel of legal experts explored questions of privacy, replication, sentient AIs, self-driving cars, and patents. Internet scholars discussed how the internet became embedded in our lives and how its architecture leaves it prone to oligopolic control. A panel discussed the ramifications of a tech future (mind control, surveillance, and big data). In addition, technologists discussed how humans will be affected by AI, molecular engineering and cybernetic augmentation, and widespread networking. Another session explored the ethical and social implications of AI and autonomous robots, while another panel discussed how technological embodiment creates an increasingly cyborg human experience.

Exhibition Hall

Escape Velocity's exhibition hall exists in a festival atmosphere and presents attendees with larger exhibits, artists selling their work, and dozens of merchandise vendors. A large area is set up for educational, hands-on activities, real-life technology – including VR, robotics, and drone demonstrations. Plenty of green screen photo ops are there for selfie fans and feature some of the most iconic film sets – such as the cockpit of the Millennium Falcon and the bridge of the Starship Enterprise. Costumers and makeup artists give non-stop workshops on cosplay, film production, and 3D printing for making more accurate props and full-size weapons. Art programming includes many classes and workshops for both kids and adults on cartooning, anime, character development, and creative writing.

Other STEAM-related programs are presented by world renown scientists and industry experts on the large rear stage. Authors, performers, and filmmakers are also in the hall to share their ideas, answer questions about their work, and inspire a new generation of professionals. Each year the convention also features an eye-popping collection of electric cars and technology, that includes vehicles from Tesla, Local Motors, and General Motors. In 2019, there were 30 electric vehicles and 60 exhibitors for the participants to explore. A few of these exhibitors included: Batmobile, Ghostbusters, BeSTEM summer Camp, DC Anime Club, SC Star Wars Collection Club, DC Stunt Coalition, FIRST Robotics, MOSF Education Station & green screen, NASA, and US Colonial Marines. These activities are depicted in Figures 6 and 7.



Figure 6. The local FIRST Robotics chapter from Maryland displaying their latest projects in the exhibit hall.



Figure 7. A NASA virtual reality demonstration at Escape Velocity's NASA pavilion.

MEASURING IMPACT

An overall measure was developed for 2019 based on prior years' surveys for continuity with additional questions about impact. Year to year questions were about prior attendance, reason for attending, plans to return next year, and the most important sessions to them. Attendees then rated impact statements on a scale of 1-5 (1 = lowest and 5 = highest): was able to increase knowledge of STEM, able to join STEM activities, felt empowered to connect with NASA, intending to look for more ways to learn about STEM, wanting to learn more about NASA science. In 2019, additional BA-

SIK questions (NSF impact categories Behavior, Attitudes, Skills, Interests, and Knowledge, Friedman, 2008; Davis & Scalice, 2015) to measure impact were added.

In addition, three NASA presentations were evaluated with retrospective surveys on knowledge and interest: habitable worlds, Apollo 50th anniversary, and weather. For the habitable worlds panel, attendees were asked about changes in their knowledge of: 1) the search for life in the solar system; 2) habitability requirements for humans; 3) the search for exoplanets; 4) how exoplanets compare with Earth; and 5) extraterrestrial life. Similarly, they were asked to rate their interest before and after the panel through the questions: 1) Are we alone? 2) Is the Earth the only life sustaining planet in the universe? 3) Is extraterrestrial life possible? Could it be intelligent?

For the Apollo 50th panel, attendees were asked to rate their knowledge before (looking back retrospectively from the end of the panel) and after on a scale of 1-10 (1=no knowledge, 10=very knowledgeable) on the Apollo landing 50 years ago. Questions covered how NASA has continued to study the Moon (sensors, robots), what NASA has learned about the Moon in the last 50 years, what new science can be done from the Moon, how NASA is preparing to go back to the Moon, how astronauts will be protected, and how going to the Moon supports going to Mars. Similarly, they were asked to rate their interest in: the Apollo landing, the Moon, and technology for Moon exploration.

For the NASA weather panel, attendees were asked to rate their knowledge before (looking back retrospectively from the end of the panel) and after on a scale of 1-10 (1=no knowledge, 10 = very knowledgeable) on 1) how NASA observes weather, space weather; 2) how NASA tracks it locally; 3) how NASA tracks it globally; 4) how NASA predicts extreme weather events; 5) science and technology of satellite observations; 6) how to access visuals and stories about weather; and 7) how to download mobile apps for weather studies. They were also asked to rate their interest before and after on a scale of 1-10 (1 = not at all interested, 10 = very interested) on 1) space weather; 2) NASA's tracking of Earth weather; and 3) mobile apps.

RESULTS

In the last two years (2018, 2019), the majority of attendees attended all three days and planned to attend again (74%, 92%). Comments from attendees indicate they were excited about the events they experienced. The selected comments listed below show the variety of events along with the impact on the attendees of all ages.

- *My kids were really excited about the Minecraft station, paper rocket, and the exhibit hall. I really liked that my kids were having fun and learning at the same time.*
- *The panels were absolutely fantastic and included more audience participation than I was expecting. Very happy with both the variety and depth of the panels (science and tech to Sci-Fi to fandom to a fusion of all three).*
- *By far my favorite panel was the one about medicine and 3D printing in space.*
- *I most enjoyed the inflatable dome that was showing movies of the solar eclipse and the 3D animated movie about Mars and the Solar System.*
- *I especially appreciated the effort to put women and people of color in prominent positions. Brava!*
- *Love the talks by scientists about futuristic science, such as AI and NASA talks, and education workshops such as robot building.*

Increased Knowledge and Interest

Attendees (N=281) in 2019 were asked to rate their level of interest on a scale of 1-5, with 5 being the highest on their experience of attending Escape Velocity. Participants were invited to complete surveys following their experiences to determine what they learned during the session, whether their interest in the topic changed as well as whether they valued the sessions in which they participated. To get an overall rating about the Escape Velocity experience, participants rated the items listed in Table 4 on a scale of 1 to 5 with 5 being the highest. As shown in Table 4, attendees reported they were able to increase their knowledge, join STEM activities, felt empowered to connect with NASA scientists and resources, will look for ways to find out more about topics, and want to learn more about NASA science.

Table 4
Reported Level of Interest for 2019 Attendees

Rate your interest (1 = lowest and 5 = highest)	Mean	STD
I was able to increase my knowledge of Science, Technology, Engineering, and Math.	4.0	1.2
I was able to join many activities related to STEM.	3.8	1.3
I feel empowered to connect with NASA scientists and resources.	3.5	1.4
I will look for ways to find out more about any of the STEM topics at Escape Velocity.	3.9	1.2
I want to learn more about NASA science.	4.1	1.1

Participants in 2019 were also asked to rate the importance of the different types of sessions (shown in the Appendix). Attendees rated the types of sessions from 2.4 to 4.2, with 5 being the highest rating. Four types of sessions received 4.0 or higher: Science Discussion Panels, Museum Gallery, Science & Technology Demonstrations in the Exhibit Hall, and Educational Activities.

At NASA supported sessions (Apollo 50th, weather, habitable worlds), attendees were asked to rate their knowledge and interest before and after the session retrospectively. As shown in Table 5, the results from the three featured NASA sessions that were evaluated in more depth showed a high value to the participants. In each session, the panels discussed how NASA studies the topic (technology and process), the current state of knowledge, and next steps.

For example, in the habitable worlds session, the panel explored the current state of knowledge surrounding extraterrestrial life and habitability, and what it might suggest about the possibilities for life beyond Earth. They discussed potential life sustaining environments within the solar system and looked further out at extrasolar planets and planetary systems. Participants were asked to rate their knowledge before and after the panel on a scale of 1-10 with 10 as the highest number. Results for this panel are shown in Table 6. While attendees to this session reported they were somewhat knowledgeable before they came, their knowledge increased significantly ($p < 0.05$) on five of the nine items. The high interest before the session indicated how the search for life has engaged people already. While four of the items were not significant increases, they do indicate slight increases in gained knowledge.

Table 5
Reported Value of NASA Sessions to Participants

	Attendees	Respondents	Response Rate	Value (1-10)
Habitable Worlds	43	21	49%	8.0
Apollo 50 th	78	42	54%	8.8
Earth/Space Weather	37	27	73%	8.6

Table 6
Habitable World Panel Session Pre-Post Measures

Rate your knowledge before and after 1-10, 10=highest	Pre	Post	Change	<i>p</i> value
Search for life in the solar system	4.3	6.4	2.1*	< 0.05
Habitability requirements for humans	4.4	6.2	1.8*	< 0.05
Search for exoplanets	4.5	5.7	1.2*	< 0.05
How exoplanets compare with Earth	4.1	5.9	1.8*	< 0.05
Extraterrestrial life	4.2	6.3	2.1*	< 0.05
Are we alone?	8.4	8.9	0.5	< 0.05
Is the Earth the only life sustaining planet in the universe?	8.2	8.7	0.5	< 0.05
Is extraterrestrial life possible?	8.3	8.8	0.5	< 0.05
Could it be intelligent?	8.2	8.7	0.5	< 0.05

Additional information on NASA's work on the search for life in the universe was provided on the Apollo 50th Panel. As the world celebrated the 50th anniversary of humans landing on the Moon, they looked backward at the Apollo's legacy and forward to the Moon to stay. The panel described what cameras and sensors on manned and robotic missions have discovered, what new and exciting science can be done from the Moon, and how scientists and engineers are preparing to go back to the Moon (including protecting astronauts), with an eye to eventually going on to Mars and even beyond. Attendees were asked to complete a survey at the end of the session in which they rated their knowledge before and after the event retrospectively. As shown in Table 7, attendees reported significant increases in their knowledge of basic concepts and interest in the topics. Participants were asked to rate their interest in the topics listed in Table 8 before and after the panel.

Table 7
Apollo 50th Anniversary Panel Retrospective Pre-Post Results

Rate your knowledge before and after this panel 1-10	Pre	Post	Change	<i>p</i> value
Apollo landing 50 years ago	5.6	6.7	1.1*	< 0.05
How NASA has continued to study the Moon (sensors, robots)	3.8	7.1	3.3*	< 0.05
What NASA has learned about the Moon in the last 50 years	3.5	7.3	3.8*	< 0.05
What new science can be done from the Moon	3.6	7.0	3.4*	< 0.05
How NASA is preparing to go back to the Moon	3.6	6.9	3.3*	< 0.05
How astronauts will be protected	3.6	6.4	2.8*	< 0.05
How going to the Moon supports going to Mars	4.3	6.7	2.4*	< 0.05

Table 8
Apollo 50th Anniversary Topic Retrospective Pre-Post Interest

Rate your interest before and after 1-10	Pre	Post	Change	<i>p</i> value
Apollo landing	7.0	7.8	0.8	< 0.05
The Moon	6.9	8.5	1.6	< 0.05
Technology for Moon exploration	6.3	8.1	1.8	< 0.05

The NASA Weather Panel included discussion on how weather affects life and assets not only on Earth, but in space, on other planets in our solar system, and in other stellar systems. The panelists discussed the science and technology of satellite observations, how to access some of the visuals and stories, and download mobile apps that allow users to contribute to earth and space weather studies. Attendees reported increases in their knowledge and interest. Table 9 includes pre-post results from participant knowledge while Table 10 includes items related to interest (N=27). All items increased significantly ($p < .05$) from pre to post test. Table 10 shows the changes in interest as a result of the panel.

Table 9
Retrospective Pre-Post Knowledge Related to Weather on Earth, Weather in Space Panel

Rate your knowledge before and after this panel 1-10	Before	After	Change	<i>p</i> value
How NASA observes weather	3.6	7.0	3.4	< 0.05
Space weather	3.4	6.7	3.3	< 0.05
How NASA tracks it locally	2.8	6.7	3.9	< 0.05
How NASA tracks it globally	3.2	7.0	3.8	< 0.05
How NASA predicts extreme weather events	3.0	6.3	3.3	< 0.05
Science and technology of satellite observations	3.7	7.1	3.4	< 0.05
How to access visuals and stories about weather	3.5	7.7	4.2	< 0.05
How to download mobile apps for weather studies	3.0	6.8	3.8	< 0.05

Table 10
Pre-Post Interest Related to Earth/Space Weather Panel

Rate your interest before and after this panel 1-10	Before	After	Change	<i>p</i> value
Space weather	5.5	8.0	2.5	<0.05
NASA's tracking of Earth weather	5.3	7.8	2.5	<0.05
Mobile apps	4.6	7.2	2.6	<0.05

DISCUSSION

Over the last five years, Escape Velocity has offered engaging, interesting, and valuable informal learning experiences. Each year, the Museum team has fine-tuned the event to make an impact on the attendee interest and knowledge of STEAM through science fiction. The lessons learned include offering sessions with practicing scientists discussing the current, near-future, and distant-future science concepts (like time travel and inhabiting other worlds), showcasing science fiction writers, personalities, showcasing models, and providing interactive experiences.

The Museum's Board of Advisors and Escape Velocity staff are comprised of influencers in the fields of science and technology. These asso-

ciations have led to the identification of three common needs: improving STEAM education, increasing overall student interest in STEAM career areas, and increasing employment of female and minority students in STEAM fields. As referenced from the National Math and Science Initiative website, approximately 56 percent of American students are unprepared for college-level math courses, while more than 64 percent are unprepared for college-level science courses. These deficiencies have led to a reduction in science and technology innovations in the United States. NASA subject matter experts have suggested innovation workshops in the future. The Museum is aware of the underrepresentation of women and minority groups in STEM-related fields. This underrepresentation leads to a lack of opportunity in the job market and restricts upward mobility of women and minority groups. As stated by Tucker, Hanuscin, and Bearnese (2008) in the article "Igniting Girls Interest in Science," girls tend to lose interest in STEM after about sixth grade, which could lead to negative labor market outcomes. According to the authors, "successful programs incorporate hands-on activities, role models, emphasis on practical applications, and practices that promote equitable learning environments." (Tucker et al, 2008, p.1621)

Therefore, the Museum has developed the Escape Velocity program to encourage students, especially underrepresented minorities and women, to engage in STEM-related studies and activities (See Figure 8). Schools, clubs, and informal organizations are invited to attend as groups on the first day. A section of the exhibit floor is devoted to activities for them. By introducing students to scientific and technological accomplishments inspired by ideas and theories posited in science fiction, the Museum hopes that more students will pursue scientific and STEM-related career paths. Students in need are offered free admissions and some schools organize field trips to the event. Through Escape Velocity, the Museum of Science Fiction remains committed to increasing the number of women and minorities in STEM-related research fields and occupations. While Escape Velocity will benefit a wide variety of students, educators, and the future STEM workforce overall, its program is specifically designed to provide informal, hands-on learning to students who are more likely to benefit in a transformational way. The Escape Velocity program itself is informed by educators with experience working with the primary target audience: female and minority high-school students. Escape Velocity places the learner at the center of activities and supports engaging experiences that provide an environment for development of critical thinking and problem solving through a high quality, multi-sensory experiences.



Figure 8. Escape Velocity attendees try to figure out how to escape the room in an exhibit hall game.

SUMMARY AND CONCLUSIONS

By offering learning opportunities across a wide range of ages and grade levels and accommodating different types of learners through a variety of programs, Escape Velocity has demonstrated the Museum's commitment to education and advance its mission of promoting interest in, and pursuit of STEAM educational fields. Through partnership with NASA and other STEAM organizations and institutions, the Museum has an exciting slate of new activities planned for 2020 that builds on the success established at Escape Velocity 2016-2019.

The interest in the events, the effects on attendees' knowledge and interest, and their plans to learn more and to attend again indicate that science fiction is a powerful motivator for engagement and education. The nature and content of the events can be used as a model for local activities in classrooms, out of school activities, and community events.

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APPENDIX

Most Important Types of Sessions

Which Escape Velocity programs are most important to you? 1-5=highest	Mean
Science Discussion Panels	4.2
Museum Gallery	4.1
Science & Technology Demonstrations in the Exhibit Hall	4.1
Educational Activities	4.0
Pop Culture Discussion Panels	3.9
Vendors in the Exhibit Hall	3.9
NASA Scout Workshop	3.6
Bridge Simulator	3.5
Cosplay	3.4
Evening Programs	3.4
Artist Workshops	3.3
Celebrity Appearances & Discussions	3.3
Film Festival	3.3
Sci-Fi Fighting Demonstrations	3.3
Children's Activities	3.1
Board Gaming	2.9
Awards Reception	2.6