

Supplemental Materials for: Formative Experiences in Museums: Influencing STEM Aspirations in Australian Youth

An Interactive Qualifying Project submitted to the Faculty of WORCESTER
POLYTECHNIC INSTITUTE in partial fulfillment of the requirements for
the degree of Bachelor of Science

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Report Submitted to:

Sponsor Organization:
Museums Victoria

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This report represents the work of WPI undergraduate students, submitted to the faculty as evidence of a degree requirement. WPI routinely publishes these reports on its website without editorial or peer review. for more information about the projects program at WPI, see <http://www.wpi.edu/Academics/Projects>

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Supplemental A: Recruitment Flyers



Hey STEM Students!

Help Scienceworks develop inspiring STEM experiences by participating in a focus group at Melbourne Museum.

Selected participants will receive 2 complimentary passes to visit Melbourne Museum and the new LEGO® exhibition, RELICS: A New World Rises*.

Focus groups will take place between Friday 10 November and Wednesday 15 November at Melbourne Museum, refreshments will be provided to participants during the session.

Open to all currently enrolled university students.

Scan to Register



See Museums Victoria website for full terms and conditions relating to tickets.



MUSEUMS
VICTORIA



Hey Uni Students!

Help Scienceworks develop inspiring STEM experiences by participating in a focus group at Melbourne Museum.

Selected participants will receive 2 complimentary passes to visit Melbourne Museum and the new LEGO® exhibition, RELICS: A New World Rises*

Focus groups will be 1 hour and will take place Tuesday 21 November and Wednesday 22 November at the Melbourne Museum. Refreshments will be provided to participants during the session.

Open to all currently enrolled university students.

Scan to Register



See Museums Victoria website for full terms and conditions relating to tickets.



MUSEUMS
VICTORIA

Supplemental B: Focus Group Consent Form

The purpose of this study is to provide Museums Victoria with information regarding what encourages youth to pursue STEM study and careers. The information from this focus group will be used to identify opportunities to enhance Scienceworks offerings. The results of this study will be published to our university website (Worcester Polytechnic Institute) and shared with Museums Victoria. If we use any of your comments from the discussion today in our research, we will not identify you by name but simply a pseudonym (e.g. Student 1). Any responses we quote from the group will not be identified by name.

If at any point during the focus group you do not want to answer questions or want to leave, you are free to. The session should take approximately 60 minutes. Audio will be recorded from the session, but will not be made available to anyone except the primary research team for their reference. Recordings will be destroyed at the conclusion of our project-February 1st, 2024.

If you have any questions about the study or how we will use your data, please contact us by email at gr-melb23-mv@wpi.edu or through our advisors Lorraine Higgins at ldh@wpi.edu or Jonathan Chee at jchee@wpi.edu.

By signing your name below, you indicate you understand the purpose of this study and agree to participate in this focus group. Additionally, you agree to the audio recording of this session.

Signature _____

Date _____

Supplemental C: Focus Group Outline

Materials

Item	Count
Pile Sorting Cards	6 (Sets)
Name Tags	5
Sharpies	6
Thank You Note	5
Tickets	10
Refreshments	N/A

*we want to have extras of things just in case, we only anticipating on having 4 people participate in the groups, but will be inviting up to 5

Before

1. Set up room (desks/tables and chairs in a circle or close group)
2. Have pre-written name tags and place them on each spot. (Number of their card set is written on the back)
 - a. Note-taker keeps track of who was assigned what number
3. Set up refreshments table
4. Set up pile sorting
 - a. Using tape, create the outline for the sorting activity

(Should look like this)

- b. Make sure each station has a complete card set and a sharpie
5. Get audio equipment ready, test to make sure all seats can be heard

Preamble~ 5 mins

1. Escort people in
2. 10-15 minutes before time for participants to grab refreshments should they so choose

3. Introduce ourselves and project

General Script:

“Hi my name is ____ i’ll be running the focus group today. I’m studying _____ at Worcester Polytechnic Institute which is a University in Massachusetts. I am interning for Museums Victoria which is. . .”

I’m _____ i’ll be taking notes during this session and I might jump in with some questions too. I’m also a student at WPI studying _____ and here as an intern for Museums Victoria.

During this focus group you will be asked about any experiences you had as a child that might have influenced your decision to study STEM. Our conversation today will be used to help Scienceworks create meaningful exhibits and programs for children to help encourage them to study STEM in the future.

We will be using some slides during our time today to help guide our discussion.

We will now go over the consent forms for participating in our focus group today. We will also be recording this session to make sure that we don’t miss anything you say.

Please sign the bottom if you agree with the statements. (Notetaker read consent form, make sure everyone signs). Thank you.

As mentioned, this recording will only be used by us and will not be published. Additionally, all recordings will be destroyed when we finish the project. We’re going to turn on the recording device now. We’ll go around the group and when I get to you please state your name and whether or not you consent to being recorded.

For example - ‘My name is Emma Gatti and I consent to being recorded’

Also as a reminder, since this is being recorded we would appreciate it if each of you can speak one at a time. However, feel free to jump in at any point during the conversation if you have something to add.

Great, thank you! Now that the technicalities are out of the way -”

5 mins in

Icebreakers~ 2 mins

Have participants introduce themselves:
Names, school, what they're studying, favorite food

7-10 mins in

Pile Sorting~8 mins

We will now be switching gears to complete a hands-on pile sorting activity.

The goal of this activity is to determine how certain experiences in your youth impacted your motivations and desires to later study STEM or not. In front of you there are notecards labeled with various STEM-related experiences. You will be asked to sort them into four piles by placing the notecards in the tape boxes. The experiences can be from any age during your childhood, meaning before starting university.

The piles are as follows:

1. Experiences that Strongly Encouraged You

I had this type of this experience when younger, and it strongly affected my desire to engage more with STEM

2. Experiences that Somewhat Encouraged You

I had these experiences as a kid and remember them positively; they had some affect on my desire to pursue STEM

3. Experiences with No Impact

I did not have these types of experiences when younger or if I did, they did not influence my desire to pursue STEM.

4. Experiences that Discouraged you

I had this experience as a kid and it made me think STEM wasn't for me

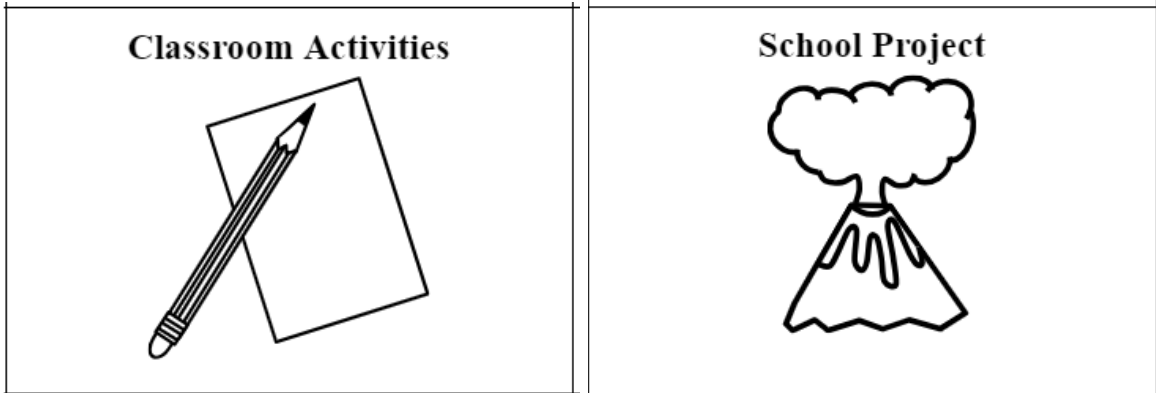
There are also two blank cards that you can fill in if there are any experiences you want to add. It is not required to use the blank cards, but please feel free if you would like.

You will be given approximately 5 minutes to complete this activity.

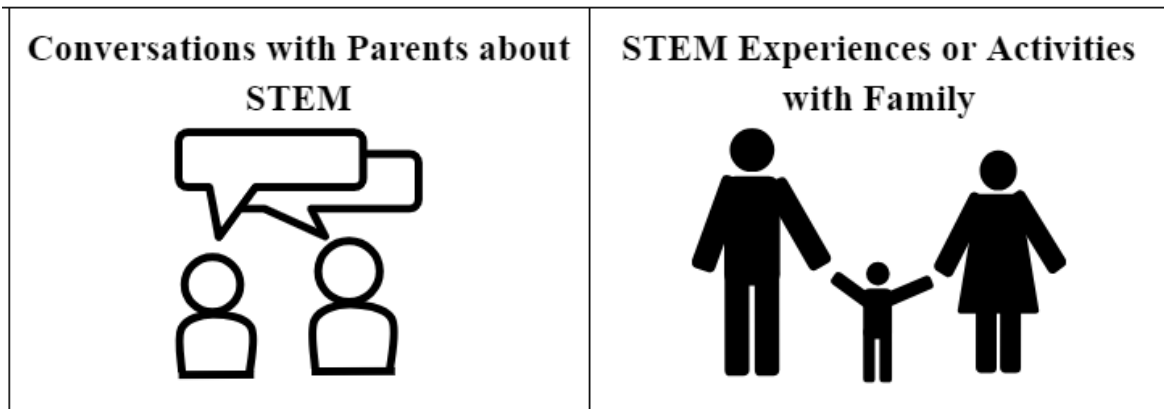
Please leave the cards in the separate piles as they will be collected at the end of the focus group. However, if you recall a certain experience you can change which pile a card may be in. Please let us know if you have any questions during the activity or if you need clarification on the meaning of any of the cards.

Clarifications:

There are four cards we would like to clarify before beginning: the first two are School Projects vs. Classroom Activities. A school project consists of a project or activity you receive from school, but may work on at home as well. A classroom activity consists of an activity that was completed during a school day.



The second two cards are Conversations with Parents About STEM vs. STEM Experiences or Activities with Family. Conversations with Parents About STEM include discussions about STEM careers, STEM in school, other STEM activities etc. STEM Experiences or Activities with Family consist of your family physically doing or bringing you to something STEM-related.



Allow approximately 5 minutes for activity completion. Announce the 30 seconds remaining mark. Ask if anyone needs more time

15-18 mins in

Post Activity Questions~30-40 mins

Transition to discussion from pile sorting activity, let students know they can feel free to share whenever

Objective 1- To figure out which experiences specifically stood out establishes what their formative experiences might be both for positive and negative influences.

1. When looking at the experiences that strongly encouraged you to pursue STEM studies, can you share one with the group?
 - a. What age were you?
2. Are there any other experiences from any of the piles that stand out to you?
3. We discussed positive experiences that have influenced your choice to study STEM. We will now turn to experiences or factors that may have discouraged you at times. Have you ever been discouraged from pursuing STEM studies? If so, tell us about that– then to others
 - a. Would anyone else like to share other discouraging experiences?
4. Are there any types of experiences that were not on these cards that you feel have influenced your desire to pursue stem? If so, what?
5. Have any of you switched any of the cards to a different pile during our discussion?

Objective 2 - To establish the role of science museums in formative experiences

6. How many of you have visited Scienceworks when you were younger? (general count)
 - a. Other science museums? (general count)
7. Out of those who have, were there any exhibits or programs that particularly excited you?
 - a. Tell us about those and how they made you feel
8. What do you think would make museums more likely to inspire students to pursue STEM subjects/careers?

50-55 mins in

Conclusion~5-10 mins

1. When getting close to an hour; remind participants that we're almost done and get final comments
2. Tell them they can leave everything exactly where it is and grab any snacks that remain
3. Thank them for their time and invite them to presentation
4. Hand out tickets as they exit the room

END at 1 hour

General Notes:

- It's ok to have some awkward silence, may encourage people to talk
- Remind people of the question or move on if getting off topic
- Reference objectives for each question
- "Why is that?" if need deeper info especially if they say vague words like "love" or "inspired"

Supplemental D: Staff Interview Consent Forms

Oral Consent:

The purpose of this study is to provide Museums Victoria with information on the types of experiences that encourage youth to pursue STEM. The information from this interview will be used to identify opportunities to enhance Scienceworks offerings. The results will be published to our university website (WPI) and shared with Museums Victoria. If we use any of your comments from the discussion today in our research, we will give the choice to be identified by name or a pseudonym (e.g. Employee 1).

If at any point during the interview you do not want to answer questions or want to leave, you are free to. The session should take approximately 30 minutes. Audio will be recorded from the session, but will not be made available to anyone except the primary research team for their reference.

If you have any questions about the study or how we will use information from the interview, please contact us by email at gr-melb23-mv@wpi.edu or through our advisors Lorraine Higgins at ldh@wpi.edu or Jonathan Chee at jchee@wpi.edu.

By stating 'yes' you indicate you understand the purpose of this study and agree to participate in this interview. Do you agree to participate?

Written Consent:

The purpose of this study is to provide Museums Victoria with information on the types of experiences that encourage youth to pursue STEM. The information from this interview will be used to identify opportunities to enhance Scienceworks offerings. The results will be published to our university website (WPI) and shared with Museums Victoria. If we use any of your comments from the discussion today in our research, we will identify you by your name.

If at any point during the interview you do not want to answer questions or want to leave, you are free to. The session should take approximately 30 minutes. Audio will be recorded from the session, but will not be made available to anyone except the primary research team for their reference.

If you have any questions about the study or how we will use information from the interview, please contact us by email at gr-melb23-mv@wpi.edu or through our advisors Lorraine Higgins at ldh@wpi.edu or Jonathan Chee at jchee@wpi.edu.

By signing your name below, you indicate you understand the purpose of this study and agree to participate in this interview. Additionally, you agree to the audio recording of this session, and the use of your name in our final materials.

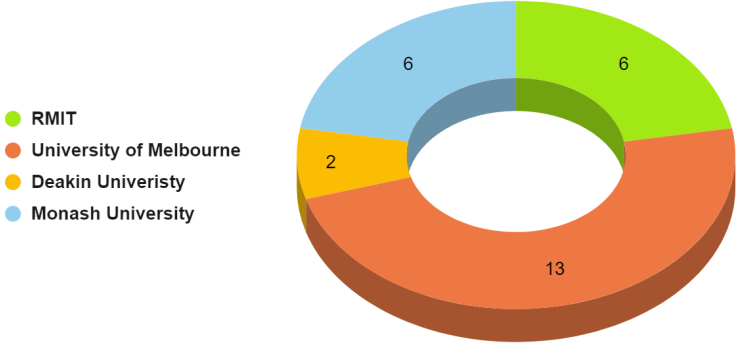
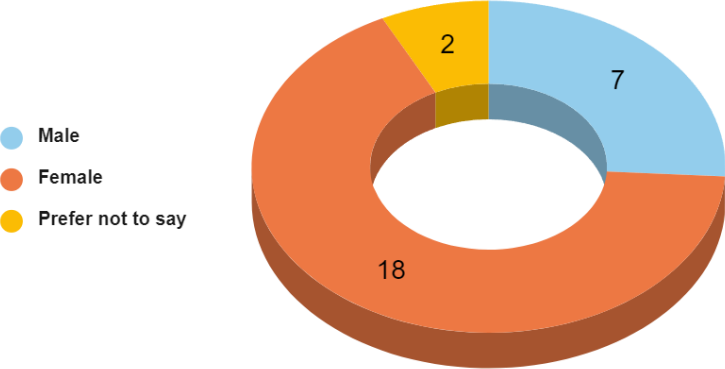
Signature _____

Date _____

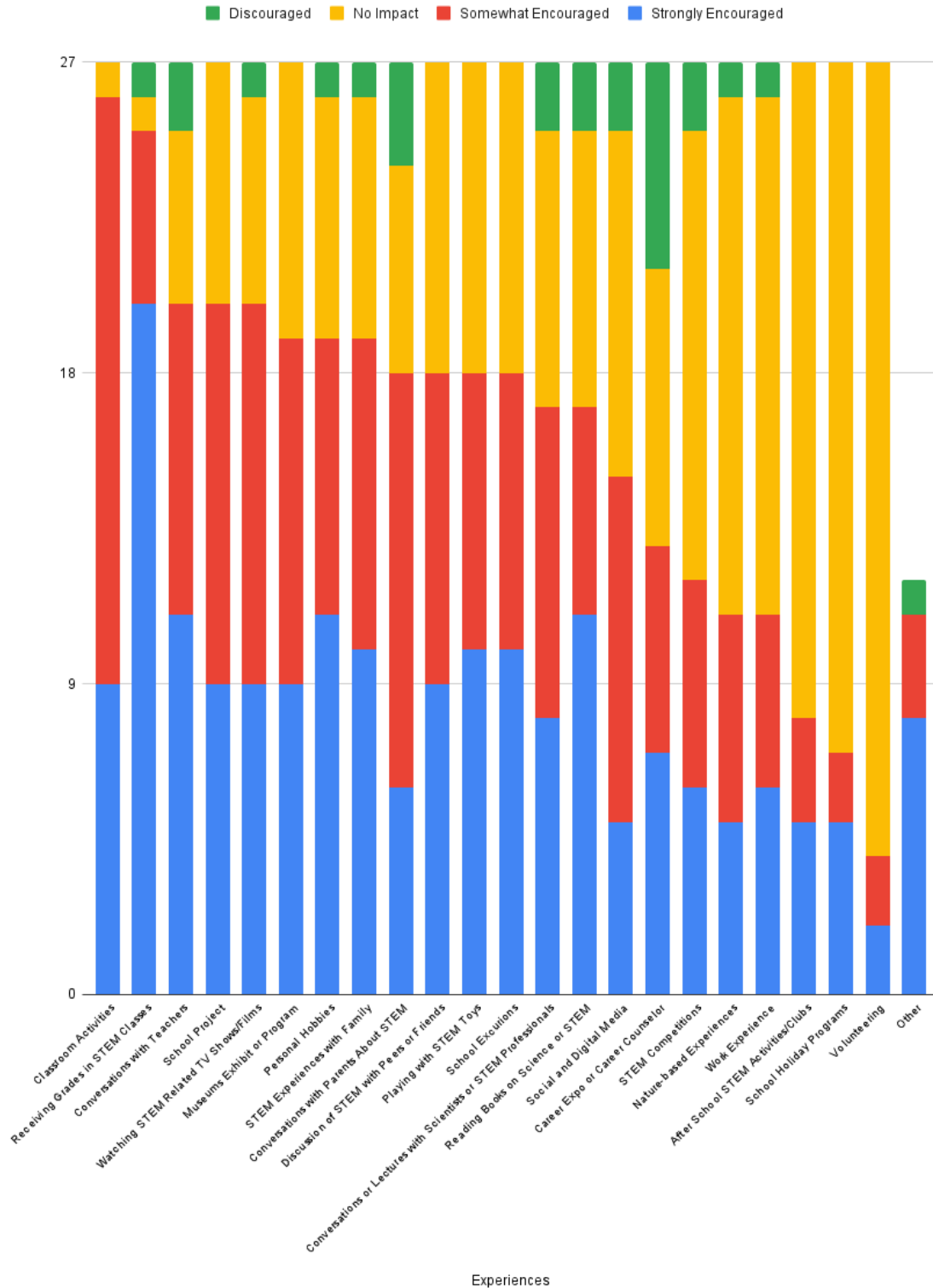
Supplemental E: Museum Victoria Staff Interview Outline

1. Preamble
 - a. Consent (See Supplemental D)
 - b. Reiterate project goals
 - c. Briefly state current findings about factors that influence children to pursue STEM
 - d. Ask if they have questions about our project/findings
2. Ice breakers
 - a. How long have you worked for Scienceworks (or Museums Victoria)?
 - b. Which, if any, offerings in Scienceworks that you have worked with have been successful in getting kids engaged? (Get them to elaborate)
3. Brainstorming
 - a. Discuss the factors we find that encourage children to pursue STEM one-by-one, and talk about what the museum has done, or could do to address these:
 - i. Experiences for girls
 - ii. Experience Involving Parents
 - iii. Exhibits/programs that relate STEM to everyday life
 - iv. Attempts to combat STEM stereotypes or show that all kinds of people work in STEM
 - v. Exhibits/programs that teach kids about the activities engineers and scientists engage in at work?
 - vi. Mentoring programs
4. Conclusion

Supplemental F: Focus Group Demographics



Supplemental G: Complete Pile Sorting Data and Graphs



Supplemental H: Coding Terms for Encouraging Characteristics with Definitions and Examples

Characteristic	Definition	Example
Amazement	The student felt impressed, or shocked. They remembered the experience as “cool,” “interesting,” or “fascinating.”	“I learned about maglev trains and how they work. It just blew my mind, I loved it.”
Inquiry	The experience was open-ended and encouraged freedom, curiosity, or new learning.	“...it was always like wanting to know how things work. So I always liked asking questions and trying to find the answers.”
Positive Reinforcement	The experience reaffirmed, reinforced, or supported the student’s pursuit of STEM.	<p>“I went and told like my mom and she was like, ‘Don't listen to her. You're going to do it. Yeah, you can do what you want.’ I was like, ok!”</p> <p>“I got good grades in everything. So that kind of cemented that I was doing the right thing for me.”</p>
Enjoyment	The experience was notable because of how fun or enjoyable it was.	“when I was young, when I had, you had those like little, like science experiments for kids books, those were like really fun.”
Real-Life Connection	The experience showed the student how STEM concepts apply to real-life, including the applications and careers involved in STEM work.	<p>“And I think it just helps you to visualize what the science looks like in real life rather than just like equations or like whatever in your books. It's more like practical.”</p> <p>[at Ford] they were talking about engines ... and it was really cool to see the knowledge I was learning [in school] being applied.</p>
Hands-On	The experience allowed the	“There was lots of like mixing stuff together.

	student to touch, play, tinker, manipulate, or build with their hands. The experience was engaging and active.	And I just remember finding it really exciting, like the hands on stuff. . .”
Relationships	The experience was memorable because the student felt connected to another person (e.g. Family, friends).	“Like my dad's mechanical engineer so I would like talk about random concepts and stuff with him. So I think, um, those sorts of conversation to spark interest...”
Utility	The student perceived STEM as valuable to their future education or career path.	“The fact that you have the STEM set, this like skill set, but then you bring it into another field that you find yourself...”
Repetition	The student had similar experiences in STEM on multiple occasions.	“...I started on like Duplo when I was like four, and then I was really into Lego to like maybe 14. And then after that I got into more like, like RC cars and like technical things and like building, like electronics and like, maybe like detailed model airplanes.”
Structure	The student liked how STEM work is structured. This includes the formulaic and objective nature of the STEM process.	“So I think being able to like being able to have a right answer and there are rules and if you follow them and you know there's a structure to it and there's an order and you can it just feels very like.”
Identity	An experience where the student felt they “fit” into the STEM community.	“I resonated with the doctors because they were really open and kind. That's like, I could be one of these people and I could fit in there without feeling like I'm from a different world altogether.”
Collaboration	The experience allowed the student to discuss or collaborate with others.	“ I enjoyed some competitions, the ones that were in groups... I enjoyed working with other people towards the same thing.”
Pride	The student felt pride or ownership for something they made or experienced.	“...in primary school, and we created the science club to just like, do you know, making towers out of marshmallows and toothpicks and in lunchtimes and stuff...we made a science club and that's pretty cool.”
Personal	The experience was	“Okay, I want to do something that can help

Connection	memorable because it related STEM topics to the student's personal values or own life.	the environment. And that kind of cemented it in. I was like, Okay, I need to do something for myself that will make an impact, a positive impact on that.”
Others' Expectations	The expectations of others' encouraged the students' pursuit of STEM. (e.g. family, friends, etc...)	“I can remember all of my STEM teachers um, being like, you know, you need to do STEM, you need to do this, you need to do that.”
Proving Yourself	An experience made the student want to prove their capabilities in STEM to others.	“...I was more determined to do better. Just be better than all of them. Was my goal.”
Sensory	The experience immersed the student in a STEM environment through sensory experiences (visual, auditory, tactile).	“So I grew up in Dandenong ranges... [s]o I became really fond of the environment I was just like living in and surrounding it...”
Competitive	The experience had a competitive element. This could be an individual or group based experience.	“... I naturally went into STEM because I wanted to be better than my sister.”

Supplemental I: Coding Terms for Discouraging Characteristics with Definitions and Examples

Characteristic	Definition	Example
Criticism	The student faced criticism or negative evaluation <i>from others</i> that discouraged their pursuit of STEM.	“...I had teachers that would openly and directly tell students that, ‘you know, maybe you're not actually cut for this’...I think that maybe over time I started to actually believe that maybe I was no good at it.”
Self-Doubt	The student’s difficulty with STEM tasks led them to doubt themselves, and this discouraged them.	“...[my STEM grades] kind of like tanked... that kind of really discouraged me in math, first of all, which is why I refuse to study anything related to math at uni.”
Pressure/Expectations	Pressure or low expectations from others turned the student away from STEM.	“It felt like a pressure, like I have to get into cancer research or something because everyone's like, like 'you're smart'. . . And there was this big thing about like if you want to get a good score, you got to keep up all the STEM classes.”
Too Structured	The student felt discouraged by a lack of freedom in their STEM activities.	“...when you're a kid, you have all the possibilities of like, I can do this and that. And then you go to high school and this structure is now so hard, like it just comes down to hard core facts.”

Negative Identity	The student had an experience in which they determined they did not want to become like their (often negative) image of a STEM person.	“Because if you don't like the type of people that are working in that field, you really feel super discouraged to go into the field.”
Discomfort/Environment	A STEM environment felt uncomfortable or unwelcoming to a participant.	“Yeah, it was also like the environment of it because it was super loud and I wasn't really learning anything, ...then you argue with the people on your table and no one listens to you.”
Negative Utility	A lack of job prospects or real world applications discouraged a student.	“You don't get to see where the maths or the physics is going to lead to because you're just learning like all these laws.”
Social Isolation	The student felt isolated from others during a STEM experience.	“...[in] high school... [I was] the only girl in the class or that sort of thing... it felt very isolating because like I know I want to do this, but you can't see yourself reflected in the environment around you.”
Lack of Exposure	The student experienced little exposure to an area of STEM.	“...until I entered high school... I pretty much I wasn't exposed to like engineering as a career before then. “
Boring	A STEM experience was dull or uninteresting.	“I was like, oh my gosh, finally I'm going to be doing science. And then I ended up disappointed for like the next 2 to 3 years because the lab classes were... very unengaging”
Lack of Structure	The student disliked STEM because there was not enough structure.	“... I didn't feel like there was much structure, and structure was really comforting and easier to find”

Formative Experiences in Museums: Characteristic Checklist

This checklist is intended for internal use by museums to aid in their experience development process so that they can inspire current and future generations to pursue STEM through their offerings. A “formative STEM experience” within this context is defined as an influential childhood event, experience, or realization that fosters positive thoughts about STEM careers or studies (Bradford, 2020). There are nine identified characteristics that help foster formative experiences, followed by the “experience goal” which describes what each characteristic includes, and the “visitor feeling” which details how the visitor should feel during and after the experience to meet each characteristic.

The checklist was designed to be used in the follow scenarios:

Experience Design: Aid in brainstorming and audience outcomes determination.

While all of the characteristics are important, not all characteristics need to be included for an offering to nurture formative experiences. With that in mind, the checklist could be used to help the design team determine which characteristics they would like to include.

Reevaluation: The checklist can then be used again retrospectively to reevaluate chosen characteristics and their implementation. Think of this as a “check-in” to see if the characteristics chosen are still the characteristics that the experience supports.

Analysis: The checklist could be used on a wider scale to gain a general indication of which characteristics are most and least frequently seen within the museum’s experiences.

This checklist was developed by a WPI student team for a university research project in collaboration with Museums Victoria and was formed through the literature review, focus groups, and staff interviews they conducted. If you would like to read the student’s full report, *Formative Experiences in Museums: Influencing STEM Aspirations in Australian Youth*, it can be found by searching the title in Worcester Polytechnic Institute’s *Digital WPI* website (<https://digital.wpi.edu/>).

Created By : Emma Gatti, Sarah Tozier, Isaac Levine, Erik Breiling

Bradford, B. C. (2020). Examining STEM Formative Experiences and College STEM Outcomes from a Social Cognitive Career Theory Perspective [Rice University]. <https://www.proquest.com/docview/2568282140/fulltextPDF/911F26D1EF264A0FPQ/1?parentSessionId=HvBgWOrwhxrupHoutYd%2FT7PomgjH82j%2FvFRi5NCnXlY%3D>

Characteristic	Experience Goal	Visitor Feeling	Present?	Notes
Amazement	The offering intends to awe and inspire visitors with cool, interesting, or mind-blowing material.	Visitors should feel amazed, impressed, or shocked. Visitors should remember the experience as “cool,” “interesting,” or “fascinating.”		
Real-Life Connection	The offering is designed to show how STEM concepts apply to real life. It should also demonstrate the applications and careers involved in STEM work	Visitors should leave the offering believing that STEM concepts apply to their own life and that there are many possibilities for their future		
Exploration and Inquiry	The offering provokes curiosity and allows exploration of STEM topics in a fun and safe way. Open-ended experiences or questions should be provided, but balanced with defined answers and structure.	Visitors should feel supported in their exploration, and leave curious and inclined to “keep sciencing”		
Hands-On	The offering involves activities where children can touch, play, tinker, manipulate, and build with their hands.	Visitors should feel engaged, active, and involved in the STEM process or activity.		
Positive Reinforcement	The offering helps build confidence and positive feelings in STEM through positive reinforcement and staff support	Visitors should feel confident, supported, and proud of their ability		
Enjoyment	The experience is designed to be fun and enjoyable.	the visitor should leave with a general sense of enjoyment and feeling joyful.		
Social Interaction	The offering is designed to allow multiple participants at once. This can be physically or mentally, with bystanders offering advice and encouragement. The focus should be on involving close friends and family in learning.	Visitors should feel involved and connected with others.		
Sensory	The offering is designed to immerse visitors in a STEM environment through sensory experiences (visual, auditory, tactile).	The visitor should feel immersed or surrounded in experience.		
STEM Identity	The offering helps break down STEM stereotypes and makes science more accessible.	The visitor should feel that they are included in the STEM community. STEM work should feel approachable		

Formative Experiences in Museums: Pile Sorting Activity

Included Materials:

22 Experience Cards
2 “Other” Cards
5 Category/Pile Cards
1 Name Card

Instructions:

Each participant should have a deck of 24 cards. The categories should be set up as follows -

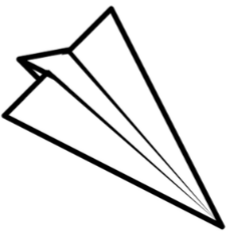
Strongly Encouraged	Somewhat Encouraged	No Impact	Discouraged	Did Not Experience

Additionally, the number of the deck should be written on the back of each card, and each participant should be given a pen or marker to fill in the “Other” card if they so choose.

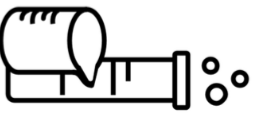
This “Pile Sorting Activity” was developed by a WPI student team for a university research project in collaboration with Museums Victoria. The content and purpose of these cards is intended for use within a focus group setting to prompt discussion. If you would like to read the student’s full report, please enter *Formative Experiences in Museums: Influencing STEM Aspirations in Australian Youth* in the search bar on Worcester Polytechnic Institute’s *Digital WPI* website (<https://digital.wpi.edu/>).

Created by : Emma Gatti Sarah Tozier, Isaac Levine, Erik Breiling
Graphics by: Emma Gatti

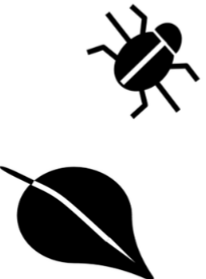
Personal Hobbies (e.g. model airplanes, collecting specimens)



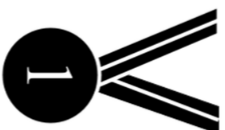
Work Experience



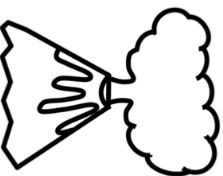
Nature-Based Experiences



STEM Competitions



School Project



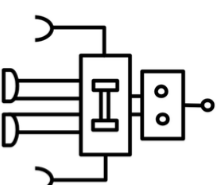
Playing with STEM Toys



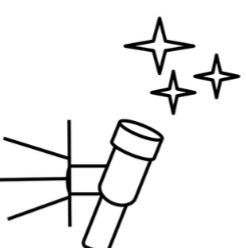
Career Expo or Career Counselor



After School STEM Activities/Clubs



School Holiday Programs



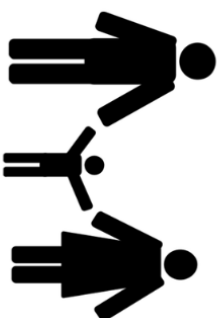
Conversations with Teachers



Museum Exhibit or Program



STEM Experiences or Activities
with Family



Discussions of STEM with
Peers or Friends



Reading Books on Science or
STEM



Receiving Grades in STEM
Classes



Conversations or Lectures
with Scientists or STEM



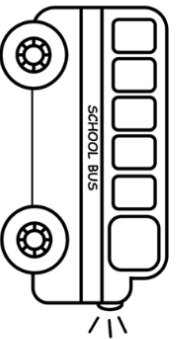
Watching STEM-Related TV
Shows/Films



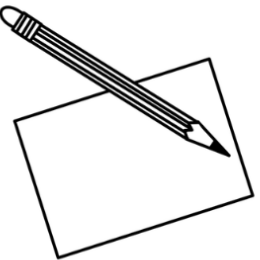
Conversations with Parents
about STEM



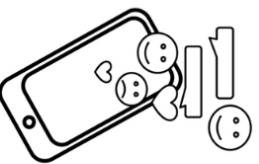
School Excursion



Classroom Activities



Social and Digital Media



Volunteering



Other
(Fill in)

Other
(Fill in)

Somewhat Encouraged

Discouraged

Strongly Encouraged

No Impact

<p>Did Not Experience</p>	<p>Name:</p> <hr/>
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Blank card to write card set number: