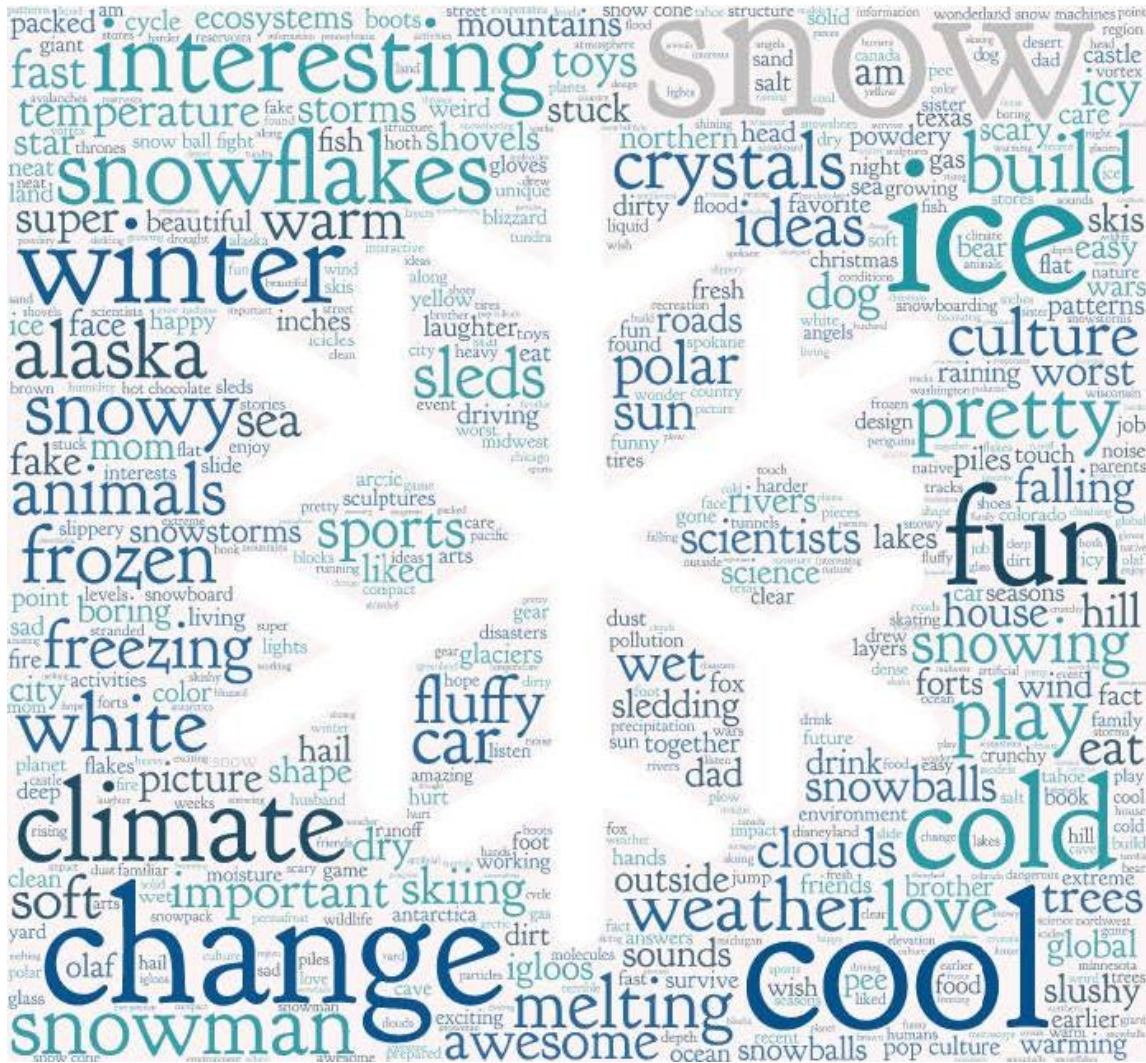


Winter Worlds



Snow in Climate, Culture, and Learning

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Executive Summary

As part of the **Winter Worlds: Snow in Climate, Culture and Learning** Informal Science Learning project funded by the National Science Foundation, Goldstream Group conducted a front-end evaluation to assess adults' and children's 1) attitudes about snow, 2) knowledge of snow concepts and the role snow plays in the global climate system, and 3) interest in learning more about snow through a museum exhibition. This evaluation found that adults and children alike find snow fun, exciting, and pretty; that people know very little about the science of snow; and that people are most interested in learning about snow topics that are unfamiliar to them, particularly how snow forms.

Attitudes About Snow



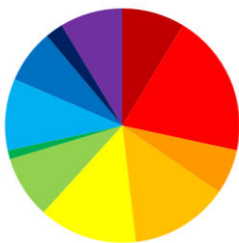
- **Positive associations to snow shared in 73%** of interviews
- **Remembered** building a tunnel, a fort, a cave, a snowman, a hill (43%), huge weather event (36%), sledding (27%), epic sledding stories (12%), skiing or snowboarding (17%), snowball fights (15%)
- **Family and friends mentioned in 27%** of interviews
- **Snow Days was equated with fun** in 52% of interviews
- **“Pretty”** used 234 times to describe snow or snowflakes
- **Adults had mixed emotions about snow**

Knowledge of Snow Concepts



- **Know that snow is ice crystals**
- Unsure why snow is white
- Know that snow texture, snow on the ground based on weather conditions and temperature
- Unsure how snow forms or how snowflakes get their shape
- Know where, when, and how much it is snowing is changing, unsure of impacts
- Know that snow contributes to water supply, most unsure how changes in snow will impact water supply

Exhibition Interests



- **Winter Worlds described as cold, snowy, icy winter wonderland with trees, mountains, ice castles and snowmen**
 - **64% want to know how snow forms and want to observe and manipulate the process**
 - **19% want to learn more about snow characteristics**
 - **10% want to learn about different types of snow**
 - **20% want to learn how snow changes on the ground**
 - **35% want to learn about climate change and its impacts**
 - **56% want to see representations of real objects**
 - Snow art, snow crystals, snowy ecosystems, and snowflakes most popular; popular culture least popular
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To collect this data, Goldstream Group and the Oregon Museum of Science and Industry (OMSI) conducted 81 interviews and a card sorting activity with groups of adults and children that included 64 adults and 93 children between the ages of six and sixteen. Although the interviews were conducted in Portland, Oregon, Fairbanks, Alaska, and Bethel, Alaska the majority of the adults interviewed were transplants from another part of the country or another country or they were visitors, and therefore we did not attempt to compare responses from those interviewed in Oregon to those interviewed in Alaska. We did attempt to compare people by where they reported growing up when this information was available, but because this data was inconsistently reported and because interview groups included people who grew up in more than one location, this comparison was not possible. We did however compare the responses of adults and children when there were clear differences in their answers.

Attitudes toward Snow

The first question guiding the front-end evaluation is about how respondents' relate to snow. Both adults and children shared strong memories of sledding, sometimes with epic crashes, building snow forts and tunnels, throwing snowballs at their friends, and sometimes being hit with snowballs, making snow angels, eating snow, and skiing. They talked about "snowpocalyse" and "snowmaggeden" to describe significant weather events that left piles of snow behind and closed schools for days. For some, driving in the snow was an adventure, for others it was their worst memory. For many, memories of their snow adventures included important family members, learning to ski with a parent, building a snowcave with dad, and playing with a brother or sister.

- 73% of the 81 interviews included at least one explicitly positive reference, emotion, or association to snow
- Respondents had strong memories related to snow:
 - 43% of the interviews included a memory of building something from snow – a tunnel, a fort, a cave, a snowman, a hill.
 - 36% of interviews included a memory related to a snow weather event, about 11% of the interviews included a reference to a snow weather event as a "worst memory."
 - 27% of the interviews included a strong memory about sledding and 12% of the sledding memories were "epic" stories of crashing.
 - 17% of the interviews included a memory of skiing or snowboarding.
 - 15% of interviews included snowball fights as both a "strong" memory and 9% of interviews included snowball fights as a "worst" memory
- More than half (52%) of the interviews included a reference to playing or having fun on "snow days."
- Snow days were also unplanned family time.

Even though adults had positive memories of snow from their childhood, and many continued to ski or take part in other outdoor activities, adults reported finding snow challenging, inconvenient, and sometimes dangerous. “Snow days” for many working parents means missing work, driving in dangerous conditions, and shoveling a driveway. Adults talked about snow losing its “magic” when they grew up.

Knowledge of Snow

The second evaluation question address the extent to which respondents are knowledgeable about snow concepts and of the role snow plays in the global climate system. We looked at responses in relationship to several aspects of snow science described in snow research literature (LaChapelle 2001, LaChapelle 1969, National Snow and Ice Data Center) and by Project Principal Investigator Matthew Sturm, including snow characteristics (e.g., color, texture), how snow forms, factors that affect snow, snow on the ground, snow in the global climate system, and climate change impact on snow. Children and adults interviewed for the Winter Worlds front-end evaluation at OMSI and in Alaska were knowledgeable about some aspects of snow, although many of their answers were tentative.

- All of the interviews reflect the respondents’ basic knowledge that snow is ice crystals or at least frozen water.
- Respondents know that snow is white, but none of the respondents described that the color is a function of reflection, that snow is white because most all of the visible light striking the snow or ice surface is reflected back (National Snow and Ice Data Center). Further, none of the respondents connected the reflective properties of snow to snow’s albedo effect to cool the planet.
- Respondents implicitly seemed to know that snow texture is different based on weather conditions and temperature and that snow on the ground can change. Interviews indirectly referenced various types of snowpack, including new snow (recent snow deposit in which the original form of ice crystals can be recognized), powder snow (dry new snow, which is composed of loose, fresh ice crystals), neve (young, granular snow that has been partially melted, refrozen and compacted), as well as snow formations, particularly a crust. None explicitly named any type of snowpack or snow formation.
- Very few of the interview respondents were able to fully describe how snow forms, but both children and adults had a generally vague idea of the process. For example, many touched on the parts of the process, mentioning ideas like, “snow forms high in the atmosphere,” without describing that snow forms when the atmospheric temperature is at or below freezing, even if the ground temperature is not below freezing (National Snow and Ice Data Center). Others described ice particles or water particles freezing and growing to become snow. However, in describing how snow forms none of the interviews included a reference to the supply of water vapor. Later in the interviews however when asked what can affect snow what snow is like humidity was referenced in 22% of the interviews, indicating that some respondents had a sense of how water vapor is important to the formation of snow. Only three of

the interviews included a reference to dust or crystals of sea salt included in the formation of snowflakes.

- About 12% of the interviews included a reference to the shape of snowflakes as a “star,” “six-sided,” or a hexagon. Other descriptions of snowflakes included “a piece of snow” (20% of interviews), a “crystal,” (10% of interviews), or a “frozen drop of water” (10% of interviews). None of the interviews referenced the molecular structure responsible for the shape of a snowflake.
- Most respondents were aware that snow is affected by several factors, including the typical range of winter temperatures, the humidity, the amount of wind, and the altitude above sea level (LaChapelle 2001). None of the interviews included reference to the fact that snow is affected by the total amount of snowfall (both annually and by individual storms) or the relation to timberline (LaChapelle 2001).
- 75% of the interviews referenced changing patterns in how much snow falls each year. Interview respondents talked about less snow falling than in previous years, snow falling at different times of the year than it has in the past, and/or snow falling in different locations (more in some places and less in other places) than it has in the past (the National Snow and Ice Data Center¹ has identified these effects of climate change as well).
- Most of the interview respondents understood that seasonal snow provides water for many regions in the world, but none mentioned any of the other important roles that seasonal snow plays in the Earth’s climate system. The interview respondents talked about snow’s connection to water supplies that people use in two primary ways.
 - 44% of the interviews included a reference to snow or snowpack melting and adding to the groundwater or filling reservoirs, lakes, or rivers. Several of the interviews included references to negative effects when snow cover is not adequate, like wildfires. Often, but not always, it was one of the adults in the group who talked about this relationship between snow and the water supplies that people use.
 - 36% of the interviews included a comment about snow melting and becoming drinking water, but did not include a reference to snow’s storage capacity or a reference to snow filling a reservoir or river or lake.
 - 12% of interviews included a comment indicating the respondent(s) were unsure about the connection between snow and their water supply.

Museum Exhibit Interest

The third evaluation question addressed the extent to which respondents were interested in a museum exhibition about snow and what they would like to learn about snow. We looked at this question in several ways, including asking respondents’ to reflect on the term “winter worlds,” asking respondents to describe what they would see in an exhibit about

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snow, to describe what they would like to learn about snow, and to sort images related to snow by their level of interest.

Winter Worlds

The idea of “Winter Worlds” reflected respondents’ general positive attitudes toward snow described above. “Winter Worlds” were described as a “winter wonderland,” beautiful, snowy, with majestic mountains and snow covered pine trees, as Christmassy, with candy canes and Santa Claus, as places with ice castles and igloos. The same mixed feeling about snow that were evident in adult respondents’ attitudes about snow were evident in their perspective of “Winter Worlds.” Integrated into positive descriptions of winter wonderlands were descriptions of cold, icy places like Alaska, Greenland, and Antarctica.

- 47% of the interviews included a reference to a “winter wonderland,” to “Disneyland” or “Frozen,” to Christmas or a Christmas theme, or to play/fun activities.
- 51% of the interviews included a reference to the weather in a “Winter World.” Respondents described it as snowy, icy, and cold.
- 37% of the interviews included a reference to characteristics of a “Winter World.” Respondents talked about Native people living there, natural characteristics, like trees, mountains, and ice skating ponds, and they talked about objects or structures that would occur there, like ice castles, snow castles, and snowmen.
- 27% included a reference to a northern country or location. Respondents talked about locations in “northern latitudes,” Greenland, Iceland, Scandinavia, Antarctica, Denmark, Alaska, Norway, and North Pole.
- Less than 10% of the respondents had an explicitly negative reaction to “Winter Worlds.” In these cases, respondents only talked about icy, cold places and several referenced popular culture images of cold climates that were inhospitable.

Interests

Respondents were primarily interested in learning about topics that were unfamiliar to them (e.g., how snow forms) and uninterested in learning about topics with which they were familiar (e.g., popular culture references to snow, snow pastimes). In the sorting activity, four topics in particular rose to the top: snow art, snow crystals, snowy ecosystems, and snowflakes. Respondents’ descriptions of what they would like to learn about snow echoed, but did not exactly match the topics selected as most interesting in the sorting activity. The disconnect between the interviews and the sorting activity may simply be a reflection of respondents’ limited knowledge about the sorting activity topics; for example, prior to seeing the pictures of snow art respondents were unaware of snow art, so did not know to talk about it as a learning topic.

- 64% of interviews included a reference to the respondents’ interest in how snow crystals and snowflakes form. Interview respondents talked about their interests in the process of snow formation, how snowflakes get their shape, chemical composition of snowflakes, the molecular structure of snowflakes, and how snow crystals form under different temperatures.

- Many wanted to look at the process as a snowflake formed or to look at snowflakes under a microscope.
- Others talked about manipulating the formation of a snowflake, controlling for the temperature and humidity to see how different crystals grow.
- 19% of interviews included a reference to learning more about snow characteristics, such as why snow is white or sparkly, how much water is in snow, how snow insulates plants from freezing.
- 10% of the interviews also included a reference to learning about different types of snow.
- 20% of interviews included a reference to learning about how snow changes on the ground. These respondents talked about their interest in different types of snow, snow layers and glaciers, and the process of how snow melts and changes on the ground.
- Although snowy ecosystems ranked second in the sorting activity (Table 1 and Figure 2) only 14% of interviews included a reference related to snowy ecosystems. Children made most of these references.
- Snow scientists had an average ranking of 6.58. Those who explained why they were interested in the topic of snow scientists (27% of interviews), referenced their curiosity about the science – what were the scientists studying and what were they learning, the scientists’ “cool” factor, lack of knowledge about snow science in general, or general interest in science.
- On the other side, those who ranked snow scientists low and explained their ranking (17% of interviews), did so because they felt that science is boring, what the scientists in the picture were doing looked boring, or they simply were not interested in science.
- 35% of the interviews included a reference to learning more about climate change and its impact on snow and the water supply. Respondents were interested in the future of snow, how snow is changing, how snow benefits the climate, and about the water cycle and water supply in relation to snow. However, water supply ranked tenth most interesting in the sorting activity, just after weather events.
- 5% of interviews referenced snow art, such as ice or snow sculptures or pictures of snowflakes (6% of interviews) as something they would be interested in seeing or learning about at a museum exhibit.

Table 1: Respondents’ average ranking of 11 snow topics

Sorting Activity Topic	Average Rank
Snow Art	3.91
Snow Crystals	4.47
Snowy Ecosystems	4.48
Snowflakes	5.15
Snow Forms	5.90
Snow Sports	6.10
Life in Snowy Regions	6.32
Snow Scientists	6.58
Weather Events	7.04
Water Supply	7.67
Snow in Popular Culture	7.90

- Respondents referenced snow in popular culture throughout the interviews (e.g., 14% of interviews used a popular culture reference to describe the idea “winter worlds”), but popular culture was ranked last in the sorting activity primarily because popular culture is everywhere; as one child said, “Everyone is sick of Frozen” (13:23).
- Very few people wanted to learn more about weather events, which was reflected both in the sorting activity (Table 1 and Figure 2) and in the interview. On average weather events was ninth out of eleven choices sorted and just 7% of interviews included a respondent indicating interest in learning more about weather events. Interview respondents may not be interested in learning more about weather events because they are already familiar with the topic: when asked about snow in the news, more than 53% of interviews included a reference to weather events that they learned about on the news.
- 12% of the interviews included a reference to interest in learning something about snow pastimes or sports at a museum exhibit, these included references to items like snow machines, winter activities, and snowballs. In the sorting activity, snow sports/pastimes received an average ranking of 6.3 (Table 1 and Figure 2). One child interviewed explained her choice related to snow sports/pastimes as something familiar, but not a topic she is interested in learning more about.
- Even though respondents ranked their interest level in “Life in Snow” eighth, 25% of interviews included a reference to people and snow. These included wanting to know about words for snow in various languages, how to survive in snow, how people historically survived in cold climates, and how cities are preparing for snow.

Several themes emerged that did not have a direct parallel to the sorting activity.

- 56% of the interviews referenced an interest in seeing representations of real objects, including snow structures like an igloo, a snow cave, a tunnel or a snowman (15%), fake snow (15%), and replicas of snowflakes (10%).
- 22% of the interviews included a reference to including hands-on activities in a museum exhibit about snow. Respondents offered a variety of activities from simply wanting to have objects to touch and making paper snowflakes to feeling different types of snow and 3D printing snowflakes.

Introduction

The **Winter Worlds: Snow in Climate, Culture and Learning** is designed to produce 1) a better understanding of the role of culture in mediating informal science learning while 2) creating opportunities for the public (children and adults alike) to learn about the vital role that snow plays in our global climate system and in providing two billion people essential water resources. The focus of the project is on snow because it is a) a fascinating and widely under-appreciated part of the Earth system, and b) because through snow an extensive and heterogeneous population with many cultural overlays can be accessed and tested in a study of how culture affects learning outcomes. The two project goals will be pursued through two major complementary activities. The first is an outreach program in Alaska that will visit over 30 remote villages during the four-year life of the project. In each village science activities for adults and children will be conducted that focus on snow in their daily lives and on the climate, with the latter in the form of a dialog that gives “voice” to people in these largely native villages. Due to the close association of Alaskans and nature, the resulting stories on snow and climate are likely to be evocative and will directly inform and enrich the museum exhibit that we will develop. The second activity is to develop a traveling museum exhibit on snow that spans from snowflakes and how they formed, to snow cover and how it impacts climate, ecosystems, and people in their everyday lives. The exhibit will also include material on snow in culture and art. The overarching goal of the exhibit will be to provide fun window on a critical but familiar piece of the Earth’s climate system at a time when the climate change debate has become too polarized (Winter Worlds: Snow, Climate, Culture and Learning Grant Application).

Methods

Objectives

The purpose of the front-end evaluation is to provide information about visitors’ knowledge, interests, and experiences related to snow topics to inform and provide direction for the Winter Worlds exhibition and outreach development process. In particular, the front-end evaluation will assess visitors’ a) attitudes and emotions related to snow, b) prior knowledge of snow concepts, c) prior knowledge of the role snow plays in the global climate system, and d) interest in learning more about snow through a museum exhibition.

Methods

Data collection included an interview and an illustrated card sort to assess knowledge, emotional responses, and interest. Front-end evaluation data collection took place January 26 to March 15, 2019 at the Oregon Museum of Science and Industry (OMSI) located in Portland Oregon and at several locations in Fairbanks and Bethel Alaska, including at the University of Alaska Museum of the North, in public locations, and at community events, like the Fairbanks Folk Festival. Participating families received a \$10 gift card to Fred

Meyer, a regional grocery store chain. Consent for participation was received for all family groups.

Interviews: Interviews focused on the family group and included questions about a) visitors' prior knowledge of snow concepts, b) visitors' prior knowledge and understanding of the role snow plays in the global climate system, c) visitors' emotional responses to snow, and d) visitors' interest in learning more about snow through a museum exhibition.

Illustrated Card Sort: We also asked family groups to look at and sort from most interesting to least interesting 11 illustrated cards with topical photographs. Topics included the following:

Code	Card
1	Snowflakes
2	Snow forms
3	Snow crystals
4	Weather events
5	Snow art
6	Snow scientists at work
7	Life in snow regions
8	Snow sports/pastimes
9	Water supply
10	Snow in popular culture
11	Snowy ecosystems

Sample

The front-end evaluation used a convenience sample of adults and children in the age range nine to 14. In total 81 interviews were completed, 40 interviews were completed at OMSI and 41 interviews were completed in Fairbanks Alaska at the University of Alaska Museum of the North, the Fairbanks Children's Museum, at other local events, and during initial outreach activities in rural communities. Interview groups included 64 adults and 93 children between the ages of six and sixteen.

While we did not ask people directly where they were from or where they grew up, we did ask where remembered events took place. This question often led to interview participants sharing information about where they were from. Using this information, we estimated that 51 (63%) of the interviewed groups included individuals who were originally from, or grew up in a location that received regular snow (e.g., Alaska, Minnesota, Wisconsin, New Jersey, Connecticut, Colorado), 13 (16%) included individuals who were from a place with some snow, but not regular snow (e.g., western Washington and Oregon), and 16 (20%) included individuals who were from a place with no or very rare snow (e.g., Florida, California, Arizona).

Analysis

Interviews and card sorting activities were recorded and transcribed for analysis using ATLAS.ti. The unit of analysis we used in the analysis was each interview. Therefore, percentages represent the number of interviews that included a given theme. We attempted to identify speakers as adults and children in the example quotes provided to provide illustration of the different and similar ways adults and children talked about snow. We compared the responses of adults and children when strong differences were evident. Although the interviews were conducted in Portland, Oregon, Fairbanks, Alaska, and Bethel, Alaska the majority of the adults interviewed were transplants from another part of the country or another country or they visitors and therefore, we did not attempt to compare responses from those interviewed in Oregon to those interviewed in Alaska. We did attempt to compare people by where they reported growing up when this information was available, but because this data was inconsistently reported and because interview groups included people who grew up in more than one location, this comparison was not possible. We did however compare the responses of adults and children when there were clear differences in their answers.

For each quote, several identifiers are included. For example, Child 79: [Quote] (79:34). We have identified each speaker as a child, adult, or interviewer. An interview number identifies each child or adult. After each quote are two numbers separated by a colon. The first number again indicates the interview and the second number indicates the specific quote within the interview.

IRB Review and ongoing oversight

The University of Alaska Fairbanks IRB reviewed the evaluation plan as part of its reviews of the research and evaluation plan for the NSF-funded project: *Collaborative Research: Winter Worlds – Snow in Climate, Culture, and Learning*.

Attitudes and Emotions Related to Snow

Positive Perceptions

In general, the adults and children interviewed had a positive perception of snow, with 73% of the 81 interviews including at least one positive reference, emotion, or association to snow. Children unabashedly loved snow.

Interviewer: What do you think when someone says snow day?

Child 78: Yay.

Interviewer: Yay, is that a good thing?

Child 78: Yeah.

Interviewer: Yeah. Why is that?

Child 78: I love snow (78:6)

Many of the adults also reported strong positive memories.

Adult 20: I have one when I was very young. I lived in Sault Ste Marie, which is further north. And I remember playing outside, and I was just laying in the snow, and it was dark. And it was just very cozy, and I was looking at the sky. It felt very nice to me. I was in a snowsuit, mind you. I was well dressed for it. But, I just remember that (20:1).

Even when pressed to share a negative memory of snow, many of the adults were unable to come up with a negative memory.

Interviewer: So, if what you shared was a positive memory of snow, what is your worst memory of snow? What's a negative memory?

Adult 39: Oh, I don't know. I don't have any negative memories of snow really, I don't think. **I always think of snow as a good thing.** Even skiing and doing some of that, it's always been nice. I kind of miss it 'cause now it's just ice and wind and wet (39:8).

Others remembered even negative memories as a positive event.

Interviewer: Okay. And you can't think of one negative memory of snow. All of your memories have been positive.

Adult 29: Okay. You're going to put me on the spot. Okay. One time at Barrington Elementary in Upper Arlington, Ohio where I grew up, we were having an ice fight. And my friend, Thomas Wesley, in fourth grade nailed me between the eyes with a chunk of ice that looking back on it was at least six inches in diameter. And I got about a two-inch gash that required stitches. But, honestly, I wouldn't even say that was

really a negative memory 'cause it was a really great ice fight. And I remember – it's memorable. I remember it to this day. I don't really remember it negatively (29:2).

However, where children unabashedly loved snow, some adults had mixed feelings. On the one hand, they “loved” snow, because it is beautiful, or they ski, or they do another outside activity, but on the other hand, they have to drive in snow, shovel or snowplow when it snows, or miss work when there is a snow day. The following woman, for example, described driving in snow as a “worst” memory, but later, when asked to describe snow, talked about how beautiful snow is and that she “loves” it when it snows.

Adult 69: Oh, we lived in Lupine or Gilcrest for seven years and there was like lots and lots and lots of snow. And so, I would have to sometimes plow. I drove 21 miles to work in my car and there would be like a one lane and so if somebody would have been coming at me, I would have, I don't even know what we would have done. And then, to get to the lake, I'd have to plow it with my car and I got stuck a couple times doing that (69:3).

Interviewer: Can you describe snow for me?

Adult 69: Beautiful. [Snow] cleans everything up. It makes everything clean to me I love it when it snows (69:8).

Adults also talked about snow losing its “magic” when they grew up.

Adult 68: I think when you grow up with it, it's just not as, um, kind of it loses maybe some of its luster after a while (68:18).

Interviewer: Do you like [snow]?

Adult 66: I liked it more when I was, I loved it when I was a kid.

Interviewer: Yeah, not now?

Adult 66: When you get older, no. Unless it's something like an event that I plan to like drive to that's when I like it (66:29).

The following adult’s comment further illustrates the mixed feeling about snow many adults reported.

Interviewer: Do you have any strong memories of snow?

Adult 78: Blizzards back in the Midwest, Chicago winters.

Interviewer: Is it a good memory or not so good?

Adult 78: Both. When I was younger they were great memories because it's just play but when you're older trying to get to work not so. (78:3)

More than one adult characterized this ambivalence to snow when talking about “snow days.”

Interviewer: Is it a good thing for you a snow day?

Adult 68: Oh, it's great. Trying to work from home with two kids running around. No, I mean it's usually fine. And I think having grown up with a lot of snow and snow days like it's a little bit of a rite of passage for kids, I think, to have that off and go out and play and run around. And it's about like the safest time to be able to go out and play 'cause nobody's driving, right, so you can walk down the middle of the road for the most part, you know.

Interviewer: That's true, I didn't think about that.

Adult 68: Yeah, going out and sledding like I have such a fond memory of it as a kid there is something to be said for the kids to have it too. So sometimes like yesterday was a little disappointing when we woke up and there was no snow (68:6).

Another mom echoed this ambivalence:

Interviewer: What do you think when someone says snow day?

Child 70: No school.

Interviewer: Is it a good thing?

Child 70: Usually.

Interviewer: What do you think is it also a good thing?

Adult 70: Yes, it's usually a good thing. Just unless I have to work and find care for them (70:6).

Many of the adults' negative feelings about snow related to driving in the snow. One woman who lives in Vancouver, Washington, but is originally from Canada talked about the challenges of driving and then how much fun snow is for the kids. Later she described skiing over Christmas break as a regular family event.

Adult 77: I mean ended up getting like really light snow but towards the end because of the – being cumbersome in driving, I do not like snow.

Interviewer: Yeah, yeah.

Adult 77: But otherwise, you know, it's fun for the kids. Like, they can go sledding over hills and at school as well, during recess, they can go play in the snow (, 77:3).

Interviewer: Do you do that a lot? Do you go skiing and snowboarding?

Adult 77: We usually [go skiing] during Christmas break. So he goes to a snow school [to learn to ski] (77: 20).

Strong Memories about Snow

Snow elicited strong memories from almost all of the interview participants, many of which reflected fun, excitement, adventure, and even danger. Thirty-six percent (36%) of interviews included a memory related to a weather event, and about 11% of the interviews included a reference to a snow event as a “worst memory.” People used words like “snowpocalypse” and “snowmageddon” to describe weather events. Others talked about “piles” of snow, missing days of school, and getting stuck in the snow.

Child 55: I remember when I was little, we had a lot of snow one year, and it piled up, and I was only three at the time, four, maybe, so of course, it was up to my shoulders almost. But I thought we were snowed in (55:10).

Child 77: My strongest memory that I have is when I was like in I think grade 3 we had lots of snow and then like school was closed for like three or four days in a row and yeah, we had to make up for those days (77:1).

Adult 14: Probably in Nebraska. We moved there January of 2004 and they were closing I-84 right as we were driving passed. So it was a ton of snow here, and then when we arrived in Omaha there was just piles and piles of snow on either side of the street. The mall parking lots had all the plowed snow. I didn't think it would melt until June or July, it was so big [...] It was kinda fun. We went sledding. I actually went sledding with my husband probably for the first time in a long time [...] But just, I think I had never seen snow like that (14:3).

Adult 21: When I was a kid, we traveled through a certain part of Oregon, and snow was piled up almost to the top of houses in some areas because it had drifted. So, I remember getting out of the car and trying to run over to a certain area that was open. And I fell down through the snow and my shoe got lost, and we never could get the shoe out 'cause it was just – it was just funny. Just a fleeting memory.[...] That would have been in about 1972 (21:2).

Adult 38: There was a high school snowpocalypse and then like four years later there was a college one. [...] In high school it was all positive it was just no school but the first three days of the college one was cool and then it was like all right, I would to get back to my regular life now. I would like to go places and enjoy things (38:9).

While many people remembered big weather events, most of the memories shared during interviews related to activities, such as building forts, sledding, having snowball fights, and

skiing. Forty-three percent of the interviews included a memory of building something from snow – a tunnel, a fort, a cave, a snowman, a hill. Twenty-eight percent of the interviews included a reference to snow forts as an object related to snow. Both adults and children recalled building something as a strong and positive memory.

Child 5: Well, about a year or two ago, me and my brother built a large snow tunnel in the back yard between the trampoline and the play structure (5:1).

Child 6: Well, once my friend stayed the night, and it snowed, and we made a really cool fort. And that's a really good memory of snow (6:1).

Child 9: Building snowmen in our hard. Yeah, building snowmen, or trying to build other snow creatures (9:1).

Child 15: When me and my sister making, like, something out of sticks and we made a castle thing. And then what we did was we made a snowman next to it (15:1).

Child 55: I remember when I was really little, me and my brother would go outside and build a snowman. We thought it was a really big snowman, but it was only that big. And we couldn't lift it up, and we had to come have our dad lift it up (55:11).

Adult 13: I grew up in the snow, so I remember – when I think of snow, I think of it being over my head and digging tunnels in the snow. Of course, I was only two and three, four at the time (Interview13:1).

Adult 35: So I'm from Pennsylvania like upper state and we were in the blizzard of '78. And so, I remember out of school. A week. But I remember that [the snow] was so deep that we dug snow tunnels to the point that my dad fell in as he was walking to the car. He was not happy with us. We loved playing in the snow (35:1).

Almost a third (27%) of the interviews included a strong memory about sledding and 74% of the interviews included a sled or an inner tube as an object related to snow. Many (12%) of the sledding memories were “epic” stories of crashing.

Adult 3: Up on Mount Hood we pulled this giant tire up the hill and then we slid down in the tire, inner tube, and slid down the hill together. And the leader of our group, he saw us all stacking ourselves and he ran and he jumped on top, and we went flying down the hill on the big inner tube. And we went over one of the jumps and all crashed. All I

remember is we were in a big jumble and I was at the bottom and I had snow up my nose, felt like all the way into my brain. And I couldn't move, and then pretty soon – it seemed like forever, and they were talking so I was like stuck in an avalanche. And they're like, "Where's Rhonda?" And they grabbed me by my back of the head and pulled my head out of the snow, and it was terrible. I couldn't move (3:5).

Adult 4: We did inner-tubing, and we were pulled by a friend's quad in his grass field, where my parents live. And we were going back and forth and back and forth, and this is another – I mean, I always have – I get hurt. So the inner tube went flying up over and landed in the ditch, and that's where I was. That was the end of that winter as well (4:9).

A handful (5%) of the interviews also included a “worst memory” related to sledding.

Child 45: I was at my grandparents' friends' house. We were sledding. There was a little hole in the ground. We were on a really fast sled and went whoop, boom. And then I got snow all over my face and a little cut up here from a tree branch... just burning, and then we went inside and we had cookies and hot chocolate (45:9).

Adult 14: Well, that same winter when we went sledding, it was perfect snow one day. We went sledding again the next day and overnight it had melted a little bit and then refrozen, so it was kind of a layer of ice. And it was a lot harder. And because I was riding on the same sled as my husband we took off down the hill pretty fast and we caught air and we landed and I landed on my face. And I remember thinking I hope I have all my teeth 'cause it was such a hard fall. Yeah, but I didn't, I have all my teeth. But I had a scar, like a mustache on my upper lip for a – or a scab for a while. So that wasn't fun (14:4).

Snowball fights were also included as both a “strong” positive memory (15% of interviews) and a “worst” memory (9% of interviews). Additionally, 30% of the interviews included “snowball” as an object related to snow. Seventeen percent of the interviews included a memory of skiing or snowboarding. Eighty percent of the interviews included “skis” and 28% included “snowboard” as an object related to snow.

Memories of snow storms, digging tunnels, or learning to ski, often (27% of interviews) included important family members – brothers, sisters, parents, and grandparents.

Adult 67: Yeah, skiing with my dad when I was a kid. I think going inside and getting hot chocolate after snow is a good memory (67:3).

- Child 1: When I was really little, going skiing with my dad (1:1).*
- Child 56: I have a strong memory of when me and my father and my older brother, we were having a snow fight and at the end of it, we – our dad, we all made an igloo, and then me and my brother were inside, and we made – it was like a chicken we made. And then Mom thought we were stuck in there when she got home, and then we bursted out the door. There's a door that we built and packed it in, and then we just bursted out of it. And then, the next day it rained, though (56:5).*
- Child 58: When we built a snowman with my dad, my brother, my mom and my dog, who was there, and we started playing with the snow (58:16).*
- Adult 58: Well, with the children, making the snowman. And when they showed me how to make the [snow]balls (58:19)*
- Child 82: My dad once built us a snow fort in the backyard. It was a total underground tunnel of snow. It was really incredible. Yeah. We had a snowman that lasted for two months once, and then slowly, slowly melted in the backyard (82:2).*

Snow Day

This sense of play and sharing special time with family members were reiterated by respondents' perceptions of "snow day." More than half (52%) of the interviews included a reference to playing or having fun on "snow days."

- Child 1: Sledding. Skiing. Snowball fights. Building a snowman. Hot chocolate. Soup (1:12).*
- Child 3: Let's go build a snowman and go sledding (3:10).*
- Child 4: Excitement, having fun (4:11).*
- Child 14: Epic-ness 'cause a) there's no school, b) sledding and c) possibility of snowball fights. Chill by the fire with hot cocoa (14: 7).*
- Child 19-1: Happiness. Panic.*
- Child 19-2: Best day ever.*
- Child 19-3: You get to stay home from school 'cause sometimes you don't like school, and sometimes you get tired.*
- Interviewer: Are you excited when you hear snow day?*
- Child 19-3: Yeah.*

Interviewer: How about you?

Child 19-2: I'm excited, and I get to play Fortnite all day (19:5).

Child 28: You're out of school, and you're having fun with your friends, mega snowballs and each other (28:4).

Adult 29: That was the best. Yeah. Probably just running over to our friend's house. I was at the perfect age, so we didn't quite have cell phones, and the Internet was still AIM chat rooms. So, it was still faster just to run to someone's house to go like a little merry band of pranksters and just go see all your friends and go do wild stuff, like sledding, huge snowball fights, just going exploring in the snow, like going hiking. Definitely as I got older it was more about going snowboarding and stuff (29:5).

Child 42: Well, in our backyard we used to have a huge mountain...well, hill. We used to make it our castle (42:5).

Child 66: Pretty much the same thing, no school, playing outside, snowball fights, stuff like that (66:6).

Child 72: We had a snow day this year and it was our first snow day in seven years.

Interviewer: Wow.

Child 72: And I went skiing and there was a lot of powder, like this much powder. And me and my friend tried to go on this run, but we couldn't and it took us like 30 minutes because we got stuck in the powder. We have to take off our skis and drag all of our stuff through all of the powder (72:4).

Interviewer: Yeah, what do you think when someone says snow day? I

Adult 72: I think of happy children (72:5).

Child 74: I think hurray!

Interviewer: Why hurray?

Child 74: Because I love snow (74:4).

Snow days also echoed the theme of family time, and coziness.

Adult 26: But snow days as a kid was like yeah cool. That meant we got to play in it, so that's always been. And then snow days now, if we do get to stay home usually it's a warm thought. I think winter is warm, because I like sweaters and I like the fire. I like to bundle up (26:4).

Adult 33: Make snow ice cream, go play in the snow with my kids. That kind of thing (33:5)

Interviewer: And then, what do you think of when someone says "Snow day"?

Child 51: A day to chill, relax, watch movies, fuzzy socks (51:6)

Child 65: I think I don't have to go to school.

Interviewer: Anything else come to mind?

Child 65: I will go and play outside with my brother so I think like yay, I can spend time with my brother and play outside (65:4).

Child 80: The first one, sure. Yeah, this will be fun. We get to play in the snow.

Adult 80: And we also get to have some family time (80:8).

One family even reported pretending to have “snow days” to spend time together as a family.

Adult 62: So actually, there hasn't been a lot of snow sometimes like we'll just say snow day. We just don't go to work and don't go to school. And we'll stay in the house and pretend it's snowing.

Interviewer: That's wonderful. So someone just decides like today's a snow day?

Adult 62: Yes. And my husband goes with it. We're self-employed so we can do that. So everybody stays home and drink hot chocolate and we just pretend it's a blizzard outside and we can't go anywhere. Yay (62:5).

Objects Related to Snow

The objects that respondents related to snow further indicate that many of the people interviewed perceive snow as fun. Of the 358 times respondents named specific objects, 61% of the time they named an object related to play or snow activities, like skis, sleds, snowballs, and snowboards, 27% of the time they named a utilitarian object, like outdoor clothing or a shovel, and 12% of the time they named an outdoor snow feature, like a snow fort or snow angel.

Table 2: Count and percent of interviews that referenced snow objects by type of object

Objects	Count of Interviews that Include Response	Percent of Interviews that Include Response
Objects Related to Play or Snow Activities		
Skis	65	80%
Sled	61	75%

Snowballs	24	30%
Snowboard	23	28%
Snowmachine	21	26%
Snowshoes	7	9%
Ice skates	6	7%
Ice picks	2	2%
Bucket	1	1%
Objects for snowmen	1	1%
Toys	1	1%
Wagon	1	1%
Climbing gear	1	1%
Four-wheeler	1	1%
Utilitarian Objects Related to Snow		
Shovel	44	54%
Outdoor clothing	34	42%
Snowplow	4	5%
Snow blower	3	4%
Axe	2	2%
Snow tires	2	2%
Blankets	1	1%
Hammer	1	1%
Ice scraper	1	1%
Saw	1	1%
SUV	1	1%
Tire chains	1	1%
Snow features		
Snow fort	23	28%
Snowmen	14	17%
Snowflake	3	4%
Snow angel	2	2%
Drifts	1	1%
Ice sculpture	1	1%

Knowledge of Snow

Children and adults interviewed for the Winter Worlds front-end evaluation at OMSI and in Alaska were knowledgeable about some aspects of snow, although many of their answers were tentative.

Snow Characteristics

According to the National Snow and Ice Data Center, “snow is an accumulation of packed ice crystals and the condition of the snowpack determines a variety of qualities, such as color, temperature, and water equivalent. As weather conditions change, the snowpack can change as well, and this affects the characteristics of the snow.” Most interview respondents seemed to know these basic characteristics, but without conviction.

All of the interviews included a reference to snow as water and/or as ice. Many also included a reference to accumulation of ice crystals.

Adult 8: It's like water and ice [...] Cold [...]White (8:7).

Adult 9: Like little pieces of ice. But it's softer than ice and everything. It's like water (9:8).

Adult 10: It's, I don't know, crystals of frozen water, I guess (10:13).

Child 15: Snow is like – it's not really cold 'cause if it was frozen it would be ice but if it – but it's like really cold rain bunched together that's why it's so white (15:6).

Child 29: Yeah. It's like frozen water. It accumulates. That's kind of the difference versus rain. Rain kind of doesn't hang around as much as snow. But, snow hangs around a bit. There's different kinds of snow. I don't know that's tough (29:7).

Adult 39: I don't know. It seems like frozen water. White, fluffy, cold stuff. [Laughs] That's impressionistic touchy-feely stuff. Never thought that way about snow, I guess (39:13).

Sixty-seven percent of the interviews included a description of snow as “white.” However, while a few interviews included references to snow’s reflective characteristics, none of the respondents described snow being white because most all of the visible light striking the snow or ice surface is reflected back (National Snow and Ice Data Center). The child below is one example of a theory posited for why snow is white; most people did not try to explain the color of snow unless referring to yellow snow.

Child 16: But then the reason snowflakes are white is because – that when snowflakes, like glass, when it piles up, like white glass, it turns to not a clear color. Like snowflakes, they're clear if there is one snowflake on your piece of paper it would look clear but if there is a bunch of 'em piled up it's white (16:14).

Sixty-one percent of the interviews included a reference to the texture of snow. The most common texture was “fluffy” or “hard” or “slushy.” Many of these descriptions implicitly referenced the ideas that snow texture is different based on temperature and humidity and that snow texture can change.

Child 11: So it can be like packed and hard, or it could be soft and fluffy. It could be slushy (11:28).

Adult 13: There's a lot of different types of snow. But, when a lot of people hear snow, they usually think fluffy, white, cold. Fluffy snow (13:10).

Child 20: It's almost like cold, light sand. 'Cause sand can be a little bit heavy depending on how wet or dry it is. But, it looks very heavy, but it can be very fluffy, very light, and it's soft. Unless it's a snowball, then it's hard. Or they rub it on your face, it's very rough. But, yeah. Very light, fluffy, little soft crystals (20:28).

Adult 20: Depending how humid it is, how much moisture is in it will say how heavy it is. If it's a big drier, it's light, and it's fluffy. But, when it gets very humid outside, if there's a lot of snow, a lot of mist or rain, then it can be very heavy (20:29).

Child 26: ...so you got dry snow and you got wet snow and you got fluffy snow. You got snow you can make snowballs with and you got too dry snow that you can't make snowballs with or snowmen with. Really dry so it gets grainy (26:10).

Adult 75: Cold, fluffy, and white (75:10)

Child 76: Powdery kind of, sometimes it's powdery, sometimes it's kinda sticky. (76:8).

Other interviews referenced temperature in relation to snow and its differences.

Child 34: Depends on where you're at 'cause in lower 48 a lot of it is like wet and cold. There's a difference between Alaska snow and like lower 48 snow.

Interviewer: Can you describe that for me?

Child 34: The lower 48 snow is like a different cold and it forms differently. I can't really put it into words, it's not my specialty. But it's just more of a like a wet type snow than like here it's harder to build snowman it seems like. I've tried and snowballs but it doesn't seem to work. That's really the differences and the cold down there it's like it gets in your bones more than even when it's negative 40 here it doesn't feel like it does down there when it's 32 degrees (34:6).

The child's quote below encapsulated how the condition of the snowpack determines both the color and texture of snow as well as how snow can change.

Interviewer: And if I'd never seen snow what would you tell me what its like?

Child 68: So depending on where it lands, usually it's very white, totally white.

Adult 68: Soft.

Child 68: And squishable. But then it's hard after you squish it.

Adult 68: Yeah, I mean it's a unique texture. I mean it can be falling and it can be like cotton balls falling and then, you know, just impressive how it adds up very quickly (68:8).

How Snow Forms

According to leading snow scientist, LaChapelle (1969), "All precipitation starts as water vapor in the atmosphere and snow crystals begin as minute ice particles, which have formed around condensation nuclei in the atmosphere, such as dust particles or minute crystals of sea salt. If there is enough supply of water vapor, they will continue to grow until they are heavy enough to fall. The atmospheric factors determining the growth rates are the temperature and the amount of water vapor available."

Very few of the interview respondents were able to fully describe how snow forms, but both children and adults had a generally vague idea of the process. For example, many touched on the parts of the process, mentioning ideas like, "snow forms high in the atmosphere," without describing that snow forms when the atmospheric temperature is at or below freezing, even if the ground temperature is not below freezing (National Snow and Ice Data Center). Others described ice particles or water particles freezing and growing to become snow. However, in describing how snow forms none of the interviews included a reference to the supply of water vapor. Later in the interviews however when asked what can affect what snow is like humidity was referenced in 22% of the interviews, indicating that some respondents had a sense of how water vapor is important to the formation of snow, or at least in the end product. Only three of the interviews included a reference to dust or crystals of sea salt included in the formation of snowflakes.

Interviewer: What is snow made from?

Child 6-2: I don't know. Water and coldness.

Child 6-1: Snowflakes have dust or dirt in them too. Remember we studied that.

Child 6-2: Do they?

Child 6-1: I think so (6:10).

Child 13-2: I think a snowflake is just a bunch of water particles, right?

Child 13-1: I don't really know. I think it's actually a piece of dirt that – I don't know.

Interviewer: A piece of dirt with –

Child 13-1: In the clouds, it has frozen, but I'm not sure that explains it. But, that what I always thought (13:13).

Child 20: Snow is water that has become so cold that it freezes into these tiny little particles that gather and sometimes freeze together (20:8).

Interviewer: How does [snow] form?

Child 65: It goes up into the clouds and if it's cold enough the water molecules will freeze and then, comes back down and that's snow. Doesn't it actually, sorry, doesn't it actually like freeze in the air? It comes down rain and then freezes in the air? (65:8).

Interviewer: What is it made of, snow?

Child 67: Well, a little piece of dust in a raindrop.

Interviewer: Is that how it forms from a little piece of dust or how does it form?

Child 67: It forms – so I don't know how dust gets in the sky. So the dust and the raindrop form together and then it makes snow and then, it falls out of the cloud (67:11).

Interviewer: How does [snow] form?

Adult 68: Isn't it the clouds like it has to turn to snow in the upper atmosphere and then it falls to the ground otherwise, it's freezing rain (68:10).

Child 76: Evaporated water that went into the clouds and then it got cold and then it turned into snow (76:10).

Adult 79: But it's like rain that freezes on the way down, and so I guess it's different from hail. Not sure why is it different from hail or any sort of ice formation. I think a snowflake, you know, is kind of like, spread out. It's not compact, so it's like light comes in. It's iridescent. Yeah (79:13).

Adult 19: And how each molecule forms in the variance between the temperatures. Because that's something that's fascinating for us because we'll have it 34, 35 and there'll be these big, white, fluffy flakes. You're like, okay, freezing's 32, so how is that possible. So,

Reagan explains to me that coming down the way that it could be. It could be really cold up here, and by the time that it hits, it's a big fluffy – it's still okay. Or up there it's a little bit warmer, and by the time it hits, it is freezing still, but then it falls. Just examining that a little bit more to know more about how the temperature (19:34).

Hexagonal Shape

LaChappelle (1969) also explained in his book *Field Guide to Snow Crystals* how the hexagonal shape of snowflakes occurs:

“Water molecules consist of one oxygen and two hydrogen atoms and when water freezes, the molecules assume an orderly arrangement with fixed positions for the oxygen atoms. The hydrogen atoms provide the bonds that hold together this structure called the “crystal lattice.” Perfectly symmetrical snow crystals are in the minority—most are irregular, often unsymmetrical, and are modified by complicated growth processes.”

About 12% of the interviews included a reference to the shape of snowflakes as a “star,” “six-sided,” or a hexagon. Other descriptions of snowflakes included “a piece of snow” (20% of interviews), a “crystal,” (10% of interviews), or a “frozen drop of water” (10% of interviews).

Adult 7: A snowflake is a frozen drop of water that usually has six points and it has a very unique shape and no two are the same (7:11).

Of the interviews, 21% included a description of snowflakes as unique – many of these also referenced the shape of a snowflake.

Interviewer: What is a snowflake?

Child 66-2: A snowflake is like a piece of snow that has a different type of look in it, I guess.

Child 66-1: It's like an ice little particle thingamajigger. It has like a design in it.

Adult 66: Unique, right?

Interviewer: Unique?

Adult 66: 'Cause they're not all the same. Everyone is different (66:11).

Factors that Affect Snow

Snow is affected by several factors, including the total amount of snowfall (both annually and by individual storms), the typical range of winter temperatures, the frequency of supercooled water clouds, the amount of wind, the altitude above sea level and the relation to timberline (LaChapelle 2001). These were concepts that most of the interview participants understood. Interview participants clearly understood that the typical range of winter temperatures affects what snow is like. Seventy-five percent of the interviews clearly included a reference to temperature as something that affects the character of snow. Another 22% included a reference to humidity. Only 10% mentioned wind, 7% mentioned altitude, and 1% referenced to the total amount of snowfall as a factor that affects snow. In addition, interview respondents noted that pollution (12% of interviews), location (12% of interviews), ground temperature (9% of interviews), and climate change (9% of interviews) affect what snow is like as well.

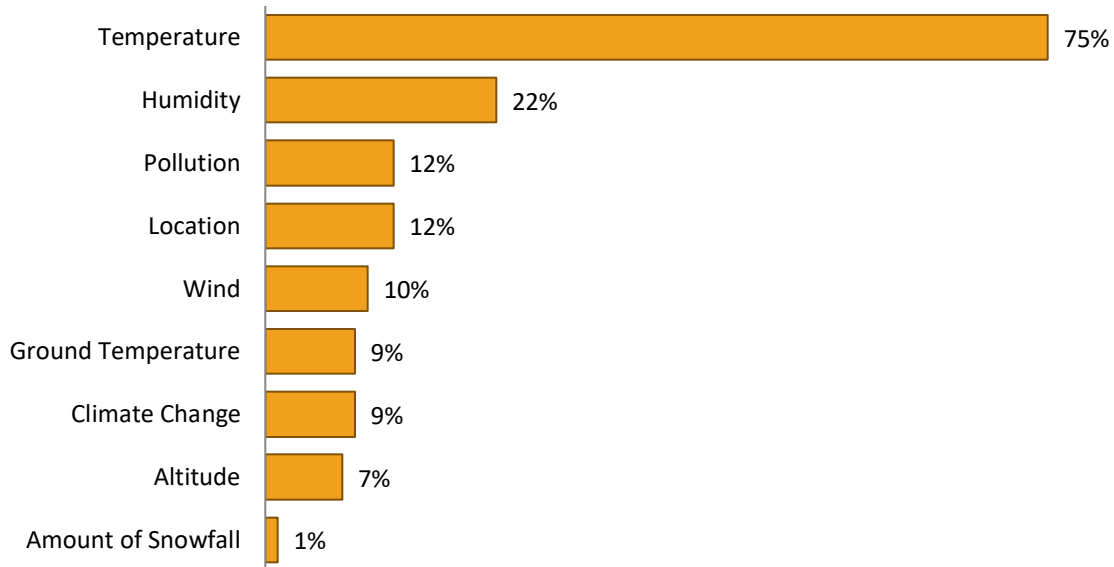


Figure 1: Percent of interviews that included factors that affect snow

Snow on the Ground

There are various types of snowpack – the total of all the snow and ice on the ground, including both new and previous snow and ice that has not melted. Once on the ground, snow is subject to various weather conditions that change the shape of the snow surface. The most common of these new shapes are overhanging snow (a cornice) and a hard snow surface (a crust) (National Snow and Ice Data Center). LaChapelle (1969) described how snow crystals change to create these shapes. Over time, snow crystals lose their shape and become rounded particles of ice. When the layers of snow are at different temperatures, these particles of ice grow new snow crystals. These new crystals are more likely to break

under pressure, which has many undesirable practical effects on snow, including avalanches.

Interview respondents clearly knew that snow changes on the ground. Interviews indirectly referenced various types of snowpack (National Snow and Ice Data Center), including new snow (recent snow deposit in which the original form of ice crystals can be recognized), powder snow (dry new snow, which is composed of loose, fresh ice crystals), neve (young, granular snow that has been partially melted, refrozen and compacted) as well as snow formations, particularly a crust. None explicitly named any type of snowpack or snow formation.

Child 16: If the snow gets too cold it can turn into ice and if it gets too – if it rains a little bit the snow can stick together and make an icy form, like sometimes when people don't make any snowballs and it's a snowball that means it rained for a little bit or tiny particles of hail connected together. And if it rains or hails when it's snows it can gather up and then when it rains it can glue the snow together which can hold the flakes together which is creating a snowball that will be easily to break (16:19).

Adult 13: So, say it snowed on the ground, then it might be light and fluffy, but after a night if it rains again and then it'll make a hard coating on it. And it'll be slippery and more packed in (13:30).

Child 18: It could be fluffy and soft and no one's touched it, and there can be snow on the roads that's pretty much just ice, because it's also close together. Stepped on snow, tree snow (18:1).

Child 68: It depends; sometimes like if the top layer melts and then it refreezes it can be very icy. But other times it can be almost like a cushion (68:8).

One child captured how snow crystals change on the ground.

Child 16: Snow can stay or change, like snow can change over the years and melt but sometimes they can grow crystals on them when it's one snowflake it can grow crystals out of it and reborn itself with crystals.

Interviewer: Okay.

Child 16: That can melt better, ice crystals. And then those crystals melt off and then when it gets cold again, if that one tiny snowflake still survives it can grow more crystals again (16:15).

Very few of the interviews included a description of windblown snow.

Child 21: It actually was like sand when we got it at our school. It was really powdery and sandy. Probably the wind blew it. Like, the wind blew it and it moved across the ground like sand. That was weird. It was really powdery that day. It wasn't hard and condensed. It was more powdery when it came down. You could kick it. Not, like, slushy (21:17).

Snow in the Global Climate System

Seasonal snow is an important part of the Earth's climate system, regulating the Earth's surface temperature, reflecting incoming sunlight, insulating the ground, and providing water in many regions of the world (National Snow and Ice Data Center). Most of the interview respondents understood that seasonal snow provides water for many regions in the world, but none mentioned any of the other important roles that seasonal snow plays in the Earth's climate system.

Adult 10: But yeah, you know, it's holding our water up there. And, how it all affects us and how much water we're going to have. Of course in Portland I don't know how likely we are to really run out of water, but in a lot of other places it's very – it's a big deal for them if all their snow melts at once. You know, California it affects them more. If it all melts at once and they can't hold it in reservoirs, then they may not have enough throughout the year. And so yeah, it's very interesting to me that their drinking water and their irrigation water, all their water isn't necessarily just stored in reservoirs, manmade lakes and all that, but a lot of it's sitting up there in the mountain, and they don't really have any control over how fast that stuff gets release (10:24).

Child 11-1: I think it's very important because the snowpack is what ends up melting and contributing to our – you know, the runoff is essentially what becomes everyone's water. So really important. We need a lot of snow.

Child 11-2: Yeah. And also not just everyone's water, but also the fish's water and all the animal's water too, plants (11:13).

Adult 20: And I see water. I keep seeing it as liquid gold because as we warm up, water's going to be the biggest commodity. So, I'll guard my bottle from you (20:17).

Adult 51: Water supply, probably because a lot of people don't have access to clean water (51:19).

Adult 67: I guess, I assume if it snowed more it would contribute to the water supply. Like you said, you'd have more water but maybe if there's, I

don't know, it's like, I mean on the flip side, if there's less evaporation I wonder if there's less water. I don't know. I don't really know much about that (67:16).

Adult 72: So in Portland it's really important to get a good snowpack, because it will ensure more water and more lower temperature water during the summer, which is important for the fish. It's important for the farmers (72:16).

Climate Change Impact on Snow

Overall, 85% of the interviews referenced climate change. Respondents talked about the climate becoming warmer (54% of the interviews), effects of climate change on animals (15% of interviews), different weather patterns occurring with climate change (17% of interviews), economic and social costs of climate change (7% of interviews), and consequences of climate change, like melting glaciers or droughts (35% of interviews). In addition, 15% of the interviews included a reference to a fearful or negative emotion related to climate change and 15% of the interviews referred to the political status of climate change as controversial. Only a very small handful of interviews (7.4%) included a reference that indicated skepticism of climate change, but none of the respondents outright denied climate change (e.g., “natural cycles”).

Almost 75% of the interviews referenced changing patterns in how much snow falls each year. Specifically, interview respondents talked about less snow falling than in previous years, snow falling at different times of the year than it has in the past, and/or snow falling in different locations (more in some places and less in other places) than it has in the past (the National Snow and Ice Data Center has identified these effects of climate change as well).

Adults were more likely to compare the present to “when they were younger” and children were more likely to talk about “something they heard about” when describing changes in the climate and/or snow.

Child 3-1: Well, [snow] is going away.

Interviewer: It's going away. Uh-huh.

Child 3-2: ...we've noticed a difference as we can see Mount Hood up from where we're at, and you can see the shape of it. The top of the mountain, since when we were younger, definitely looks different, you know. You can tell where the snow, that glacier or whatever is lower or smaller or whatever (3:21).

Adult 4: ...as a kid, I don't remember having these [periods where] the whole entire world shuts down for a week or two situations living here, and

that's happened, what, at least three times in the last ten years. And it seems to be happening earlier in the year, where we're getting snow, and then it's happening still later in the year. My sister lives in Flagstaff, Arizona, and there was one year they had snow in April or May. It's getting really inconsistent (4:26).

Adult 6: I think that it's snowing in places that it shouldn't, and it's not snowing in places that it usually does. That affects polar ice caps and all that good stuff (6:17).

Adult 20: I've heard of some of the older people I know of told me of storms where they couldn't get out. They couldn't even clear the roads 'cause the snow would be over their heads. I think that even though we have a lot of snow, but it's still significantly less, so maybe that warming is affecting it that way that we're having less snow as a result of less water, precipitation is falling. That's what I would say (20:16).

Adult 27: Yeah, well we don't get a lot of snow as we used to get a long time ago. Back in the days at the height, at the middle of the winter, you know, at the height of the snow season we'd get these drifts (27:5).

Adult 39: Oh, yeah. There's no doubt about it. That's even in Bethel, the winters are completely different. Like, my experience with doing field work since I came up here the first summer, 1983, to do archeology. And every field season we were getting blowing snow first week in September. So, it's usually the time everybody started coming in from the field. And the last several years we have a least a month, six weeks of extra summer field season than what we used to have just several years ago. It's a big difference (39:7).

Interviewer: And why do you think these snow changes are happening? Why do you think it's changing?

Child 65: Due to climate change. I can't really think of another reason (65:13).

Interviewer: How do you think snow is being affected by climate change?

Child 65: Less of it's falling because it's getting warmer in certain areas than over in other areas. For us, less has fallen.

Interviewer: So for us less is falling and other places more is falling?

Child 65: From what I've heard because it might be getting colder in other areas but I could have that totally wrong (65:16).

Adult 68: I mean I think it's one of those things where places where you have it less frequently like Portland we're starting to have it more frequently. Places where we've had it consistently, they're having it less frequently

so I mean I really do believe there's an impact of climate change on just the precipitation that we see here in Portland than really anybody sees (68:16).

Adult 83: It's different nowadays than when I was growing up. There was a little snow in specific areas of the country, and now even in the last week, we've had snow in the Bay Area, which is very rare. Obviously, it's the high peaks, but to drive them to school, and look up, and see snow is just like, yeah, nothing that I remember as a kid (83:17).

In turn, these climate changes affect the amount of snow covering the ground, and changes in how the snow melts in the spring affect the water supplies that people use (National Snow and Ice Data Center). The interview respondents talked about snow's connection to water supplies that people use in two primary ways. First, 44% of the interviews included a reference to snow or snowpack melting and adding to the groundwater or filling reservoirs, lakes, or rivers. Several of the interviews included references to negative effects when snow cover isn't adequate, like wildfires. Often, but not always, it was one of the adults in the group who talked about this relationship between snow and the water supplies that people use.

Adult 1: I think it's important because it's our reservoir water for the summer living in sort of the Northwest or really anywhere in the West. As it melts, we're gonna continue to up our water for the dry months. Without snowpack, we're gonna have a problem (1:30).

Adult 3-1: Because our snowpack on the mountains makes a big difference in how much water is in the reservoirs and rivers and stuff.

Adult 3-2: Don't really think about the snowpack, but that's a major contributor to the water source (3:19).

Adult 4: Snow contributes to our reserves, and we have a good snow year, there's less likely going to be a drought in the summer, 'cause we have a source to draw from to turn to water. Your turn. How do you think snow relates to water?

Child 4-1: I would be curious if it cleans it better [...] Yeah. Like a filter.

Child 4-2: Well, I guess it might be more fresh water or – snow can be more fresh water, 'cause it comes from the sky (4:24).

Child 5: Because when it melts into the Bull Run, that's going to our water.

Adult 5: Yeah, melts into the Bull Run, or in the really high mountains it melts into the Columbia. So they have more water in the summer in the Columbia, even though it's not snowing or not raining. If enough

snowpack built up, it'd have water in the summer that the salmon can use (5:19).

Adult 7: Oh, well. It's key to making – it keeps our water – like here, it keeps our water on the mountain. And so, as it melts off slowly, as the reservoirs can fill we can get fresh water for whatever needs we have. In the Midwest, the snow pack is incredibly important for the farmers, so they don't get rain, washes things away. The snow comes, it blankets the fields, and then it slowly melts in and nourishes the soil and replenishes the ground water, and it doesn't just run away (7:16).

Interviewer: How do you think snow relates to your water supply or to the water supply of others?

Adult 10: Well, it's where a lot of our water supply is stored.

Interviewer: You mean in Oregon or in other places too?

Adult 10: Well, sure, Oregon. That's what the Columbia River – I mean, unless it just rains and washes into the river. A lot of it is melting snowpack. So it stores up in the winter, frozen, and keeps melting throughout the year, keeps the rivers flowing. Some more than others (10:19).

Adult 11: I think it's very important because the snowpack is what ends up melting and contributing to our – you know, the runoff is essentially what becomes everyone's water. So really important. We need a lot of snow (11:13).

Interviewer: And how does snow relate to your water supply?

Adult 16: No snow, no water (16:17).

Interviewer: How do you think the snow relates to your water supply?

Adult 19: Completely. That's how we get our water supply, and they always talk about it on our weather channels and things, if we don't get our snow pack, then our water levels are really stressed. And it mean during that summer there'll be shortages (19:15).

Interviewer: How do you think snow relates to your water supply?

Adult 26: Oh yeah, we definitely have had drier summers and more tinder fires out here because I think the water table is lower.

Interviewer: So the water table is lower because of?

Adult 26: Lack of snow. So the amount of snow that piles up on the tundra goes down and that's what gives the plants the initial water and everything. So if they are drying out then it's more likely to have earlier fires, but just we have been having more of them (26:13).

- Interviewer:* And how do you think snow relates to your water supply or the water supply of others?
- Adult 29:* I mean, the snow is ground water. It's gotta go somewhere. It's going to be a real hassle.
- Interviewer:* A real hassle if?
- Adult 29:* I mean, during breakup up here or just anywhere where you have a lot of snow accumulation you've got a lot of water. But, it's really important 'cause that's still – the water that's accumulated in the water that's still part of the overall climate of that area. So, the trees are probably used to having snow or snow melting as they start to blossom in the spring and come back up. You know what I'm saying? With the animals, like the bears and stuff that hibernate. So, I don't know, snow plays a pretty unique part of the ecosystem or the water system, right? Yeah. The water system (29:13).
- Adult 35:* So I do think that [snow] is needed especially in the higher elevations so that when it melts it kind of refills the streams and the rivers and even the oceans and kind of keeping that up. So if we don't have a good snowfall or a good precipitation then we have less and it creates more fires, wildlife fires and all that in the summertime and in the spring (35:9).
- Interviewer:* How do you think snow relates to your water supply?
- Adult 39:* Well, it's a huge issue. In the Kuskokwim River it's probably the major reason that barges aren't probably moving up the river quite as well as they were. Because the Kuskokwim's been much shallower in many areas. Because they haven't had a lot of snow pack. So, the spring snow melts really different now (39:21)
- Interviewer:* How do you think snow relates to your water supply?
- Adult 61:* Ground water, I mean the more snow we have the water table goes up. Ground water is important for forest fires. Just in general having an adequate water supply for plants, animals, people (61:17).
- Interviewer:* How do you think snow relates to your water supply and the water supply of others?
- Child 62:* Well, snow is just a bunch of water so a lot of water. I don't know.
- Adult 62:* So the more snow you have would you get more water?
- Child 62:* Yeah.
- Adult 62:* So if we're not getting as much snow anymore what's happening to the water?
- Child 62:* It's going downhill. Getting dried up.
- Adult 62:* We have droughts.

Child 62: Dried up and the weeds are taking them all (62:12).

Secondly, interview respondents simply talked about the fact that snow is water. Approximately 36% of the interviews included a comment about snow melting and becoming drinking water, but did not include a reference to snow's storage capacity or a reference to snow filling a reservoir or river or lake. The respondents who talked only about snow being water were primarily children. Children also talked about snow's impact on freezing pipes; 7.4% of interviews included a comment, such as "I eat snow I guess. It can freeze our pipes sometimes, which I guess [is related to the] water supply" (Interview 65:14). Nevertheless, for the most part children simply talked about snow melting to drinkable water.

Child 7: If you didn't have any water with you when you were stranded, you could eat it to get enough hydration because it's just fresh water that fell. It's frozen fresh water (7:15).

Interviewer: How do you think snow relates to your water supply and the water supply of others?

Child 50: Water turns into ice, and then ice turns into snow. Snow is basically from – well, rain comes from the ground 'cause it goes up into the clouds, and then it comes back down. But for snow, it does the same thing, and then it freezes and then it comes back down. If you melt that snow, there's gonna be dirty stuff like – there could be leaf parts and stuff like that. There could also be some dangerous, toxic things in there that can actually make some people very sick (50:36).

Interviewer: How do you think snow relates to your water supply? Do you think there's a relationship?

Child 67: So snow melts in water because it is water and it melts into water. So snow is water so it melts into the water. So snow is water so it can melt into the water. It doesn't stay like that because water it is water so it melts.

Interviewer: So when it snows a lot what would happen then?

Child 67: Well, I think it would if it snowed so much, I think it would probably like, maybe like if it snowed so much that the water couldn't melt it, I think it would be like there would be like –

Adult 67: Would it help the water supply, buddy? Do you think 'cause there's more snow falling?

Child 67: I don't really know that one (67:16).

Interviewer: How do you think snow relates to your water supply?

Child 82: Because it gets dried off. Then it goes into the clouds, and then it forms into raindrops and comes down.

Interviewer: And how would that affect your water supply?

Child 82: Because the snow and water are basically the same thing, because it's – one's colder than the other (82:15).

Another 12% of interviews included a comment indicating the respondent(s) were unsure about the connection between snow and their water supply. Many of these responses included a statement like, “I’ve never thought about [how snow relates to my water supply] before.”

Interviewer: And how do you think snow relates to your water supply or the water supply of others?

Adult 28: I never thought about it too much to my water supply. I can definitely see how it can affect the water supply of others, especially the more north you go. I mean, if everything's frozen, obviously, it's a hard way to make some water, heat it up and everything, basically make your water. But, I don't know too much about how that works. So, I don't know (28:15).

Interviewer: And how do you think snow relates to your water supply or the water supply of others?

Adult 30: I guess certain cultures rely on that maybe as a source of water. Maybe that melting snow, I'm not sure (30:12).

Child 79: Bay Area, so maybe in cold areas. Maybe, you know, instead of rain, maybe they could turn the snow into something, winter, you know, where you – what do you call it when you have the dam for rain? Maybe snow turns into water that they can use, so not to my knowledge. I don't know how snow is being used (79:16).

Museum Exhibit Interest

Winter Worlds

“Winter Worlds” elicited positive responses from interview respondents. Forty-seven percent of the interviews included a reference to “winter wonderland,” “Disneyland,” “Frozen,” Christmas or a Christmas theme, or to play/fun activities. Intermixed with the positive perspectives – reflecting the mixed feelings many adults have related to snow – were negative connotations, like “icy”, “cold”, and even “annoying.”

- Adult 6:* *Yes [white everywhere]. Lots of snow on the trees, and I think of the song Winter Wonderland. Snow's on the trees and rolling hills with snow. A sunny day though, I don't know why you want to go out in the sun when you go out in the snow (6:7).*
- Adult 21:* *It's enchanting. 'Jack Winter wonderland.' It's enchanting. It really is. It cleans the whole surface. It changes what the entire landscape looks like. It's pretty thrilling actually (21:9).*
- Adult 25:* *Winter worlds? I feel like that would be a Disney attraction, actually, like where – it's like a Small World After All, except it's all in ice and snow, and it's really annoying (25:5).*
- Adult 26:* *Or Nutcracker, there is a good winter scene in Nutcracker too (26:5).*
- Adult 28:* *Right now, my time in Alaska. I feel like I'm in a winter wonderland.*
Interviewer: *So, when you close your eyes, what do you imagine when you see winter worlds?*
- Adult 28:* *Mountains, big snowy mountains, I don't know. It's just majestic look (28:5).*
- Adult 32:* *Winter worlds, I don't know. Beautiful sceneries, Christmastime, looking at the snow and all the decorations in and around the area where I live (32:4)*
- Child 50:* *I think when it's snowing, it looks super beautiful outside. It's really bright.*
Interviewer: *What other things are super beautiful about that day, would you say?*
Child 50: *The snow. The trees. The snow is glistening. Or a sunrise or a sunset (50:28).*
- Child 62:* *Disneyland (62:6).*

Interviewer: And what does the phrase winter world make you think about?

Child 66-2: Frozen.

Child 66-1: Like winter wonderland-ish kind of (66:7).

Child 71: Magical worlds of snow (71:6).

Adult 80: Fresh fallen snow that's undisturbed, before people get out to it.

Child 80: We like to call it powdered sugar snow.

Adult 80: That is just magical.

Child 80: When it's first like that, powdered sugar. Because when you throw it onto something, and it spreads out, it looks like powdered sugar (80:10).

Fifty-one percent of the interviews included a reference to the weather in a “Winter World.” Respondents described it as snowy, icy, and cold. For the most part these descriptions did not necessarily carry a negative perception, although some did.

Adult 7: I see a forest with pine trees and a foot of snow.

Interviewer: Okay. How about –

Child 7: And a little white winter rabbit (7:8).

Child 10: Land of snow. Land of snow. Land of snow (10:11).

Child 20: Like the time when it's really snowy, but it's not really that cold. So, it's just fun in giant snow mounds. All that stuff.

Adult 20: That's what it means to you. To me it means the north. Very cold. I even see igloos. I'm talking Alaska where they're just brutal sub-zero.

Interviewer: Is it like a negative image?

Adult 20: Yeah. So cold I shiver thinking about it. Yeah (20:7).

Child 24: [Winter World] means there's snow. It's almost like hail, except for it's not hard, but it comes. It's snow that's flat. It picks up. The snow picks up the wind and then it blows. (24:8).

Adult 31: Snow falling from the sky and there being lots of snow everywhere, kind of like a snow globe. That's what that phrase means to me (31:5).

Adult 33: Lots of snow, lots of outside activities in snow, building a snowman. Up here the World Ice Championships, so looking at all the ice carvings. Santa Clause, Christmas that kind of thing (33:6).

Adult 36: I guess just like a blizzard like a lot of snow coming down on me...just like a little bit more wintertime, you know, less daylight, and then, just continuous snowfall and colder temperatures. (36:5).

Child 42: [Winter World makes me think of] a huge snow day. I picture lots of snow and then the trees are just covered in snow (42:6).

Child 49: Big snowflakes and snowflakes falling down on a park or something (49:13).

Adult 75: A world where it only snows.

Interviewer: Uh-huh. Is it a good world or a bad world?

Adult 75: A good world. (75:8).

Thirty-seven percent of the interviews included a reference to characteristics of a “Winter World.” Respondents talked about Native people living there, natural characteristics, like trees, mountains, and ice skating ponds, and they talked about objects or structures that would occur there, like ice castles, snow castles, and snowmen.

Almost a third of the interviews (27%) included a reference to a northern country or location. Respondents talked about locations in “northern latitudes,” Greenland, Iceland, Scandinavia, Antarctica, Denmark, Alaska, Norway, and North Pole. The quote below from a woman in Bethel, Alaska imagines the world divided in two when she thinks of “winter world.”

Adult 27: Winter worlds. Yeah. See, there is a [story they] used to say that about winter worlds, you know. They used to say that one part of the globe will warm up and turn into summers while, you know, that the area of the globe where it usually winters. And then the area where the world stays warm and sunny and all the time, and then the globe will sit to where those areas will start seeing more snow and get colder while us here are warming up. So that's what make me think about winter worlds. And I'm even hearing [this story] from the Native people in Greenland, the Inuit. Yeah (27:7).

Less than 10% of the respondents had an explicitly negative reaction to “Winter Worlds.” In these cases, respondents only talked about icy, cold places and several referenced popular culture images of cold climates that were inhospitable.

Adult 38: We going to back to Star Wars again I'm seeing a frozen tundra planet. Yeah, you know a spacey thing. Gonna be a fantasy type and now I'm thinking Game of Thrones you've got the white walkers, you know. Maybe an amusement park with abominable snowman type rides. I don't know, just throwing some ideas out there (38:17).

Interests

Interview respondents were most interested in learning about topics that were unfamiliar to them. When asked directly what they are interested in learning, how snow crystals and snowflakes form was the most common response (64% of the interviews). None of the interview respondents had a detailed, clear understanding of how snow forms or why a snowflake has six sides. Interview respondents talked about their interests in the process of snow formation, how snowflakes get their shape, chemical composition of snowflakes, the molecular structure of snowflakes, and how snow crystals form under different temperatures.

Adult 13: I think for me, honestly, maybe a bunch of other people would like it, but to see how other types of snow form, like from fluffy to hard. I kind of know a little about it, but it would be cool to be like, "Oh, that's cool."

Child 13-1: That's why we end up with – and like freezing rain. That's good.

Child 13-2: Yeah. Like when it's freezing rain and when it's sleet and when it's hail in the snow, the conditions. I know some of that, but that would be interesting to see exactly what (13:22).

Adult 19: And how each molecule forms in the variance between the temperatures. Because that's something that's fascinating for us because we'll have it 34, 35 and there'll be these big, white, fluffy flakes. You're like, okay, freezing's 32, so how is that possible. So, Reagan explains to me that coming down the way that it could be. It could be really cold up here, and by the time that it hits, it's a big fluffy – it's still okay. Or up there it's a little bit warmer, and by the time it hits, it is freezing still, but then it falls. Just examining that a little bit more to know more about how the temperature (19:19).

Interviewer: So you'd want to learn about like the snowflakes themselves?

Adult 26: Yeah. And what temperatures make certain crystals and what temperatures creates different ones, or what kind of, what do you need to do for all that? It's like with the kids and we make them with the paper snowflakes. I've got some on my windows, because they're all different (26:17).

Interviewer: What do you want to learn about snow?

Child 65: Like how the shape how it is 'cause obviously, it starts out as like water droplets.

Interviewer: So like the shape and how it forms?

Child 65: Yeah, how it forms (65:17).

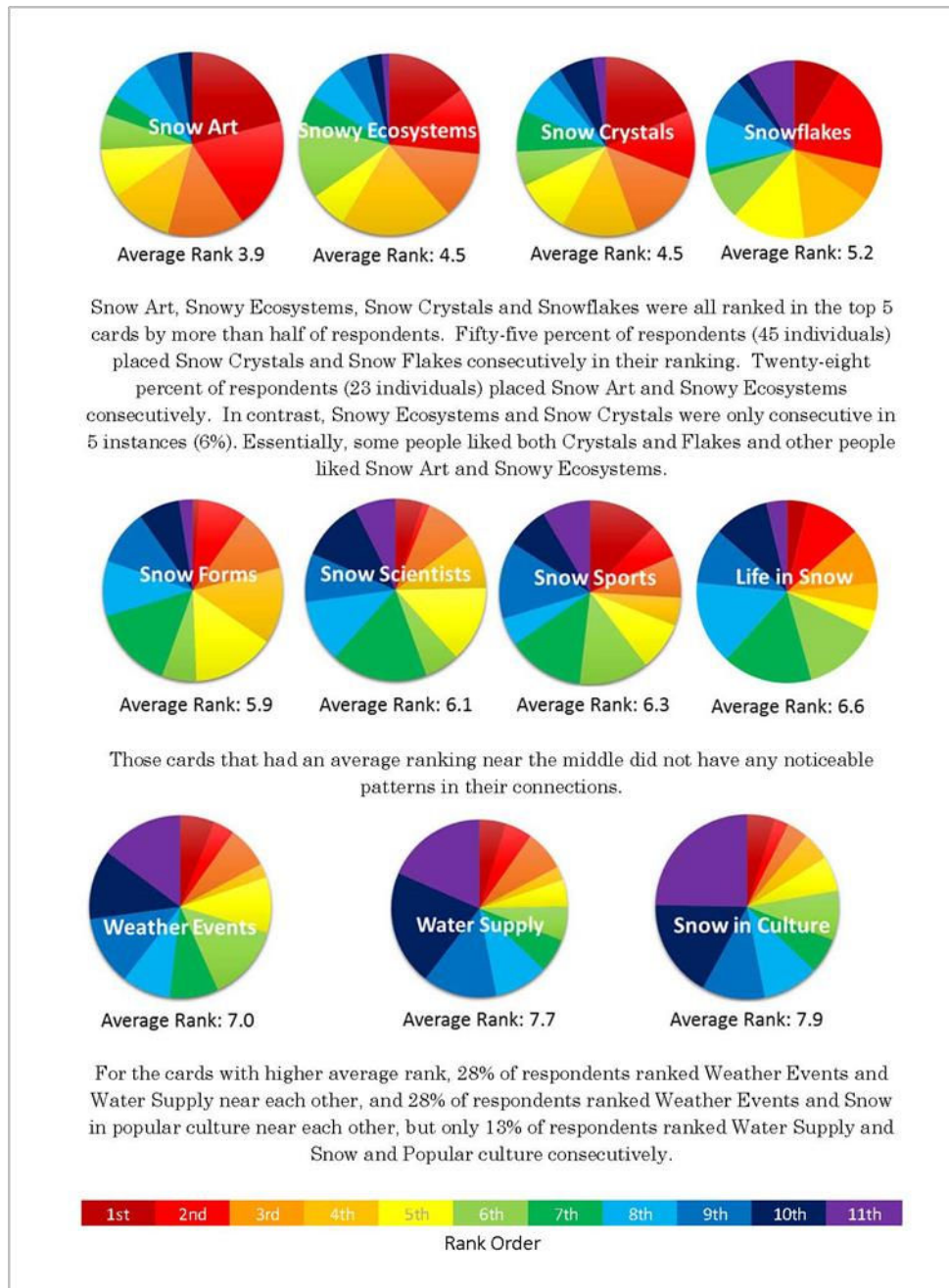


Figure 2: Card Sorting Activity Topic Ranking

Adult 78: Time lapse formation of snow crystals would be cool (78:21).

Adult 36: I guess I would be more interested in the actual like chemical composition and molecular structure and that sort of thing. For my brain, I guess that's the first thing that would come to mind (36:16).

Adult 68: I just think like how the weather and how it has to be like really like this perfect the cold has to come together with precipitation and it has

to be at a certain altitude for it to be snow. I think the real science of it is pretty interesting (68:20).

Adult 69: I mean how do they make it the shapes. How does snowflakes become the beautiful shapes? I'd like to know that.

Child 69: And why is there no same snowflake why are they all different (69:11)?

Many wanted to look at the process as a snowflake formed or to look at snowflakes under a microscope.

Adult 2: I don't know. Maybe something where you could actually – microscopic, maybe you could see it or see something that's crystalizing and changing. Like maybe something like an animated sculpture that was always changing to different types of snowflakes, or maybe a big screen. You could probably do that and watch it grow. You know, watch a snowflake grow (2:20).

Adult 10: I don't know actually how easy that would be to do, but to be able to have the crystals forming somehow. You'd have to magnify it to see it (10:24).

Child 19: I always think it's cool when you learn about how the individual snowflakes form and how they're unique and see them under a microscope [to] see the individual snowflakes and see just how cool they look (19:19).

The idea of manipulating the formation of a snowflake came up several times as well.

Adult 2: Yeah. Yeah, really. Can you control the way a snowflake – can you order up one and say I want it to be, you know, a plate or branched one? I mean, can you control the way it grows around like a wire or something. I don't know. Like, I don't know (2:23).

Adult 4: To be able to make [snow]. I mean the actual concept of being able to have a kid be in a position where they can start [snow] from scratch (4:35).

Adult 21: I would love to see how snow forms? I would like to see some kind of environment, enclosed environment that we could look and watch how it's happening. We need magnetic glass around it or what –

Interviewer You mean live like –

Adult 21: Yes. Live. Create that small world where snow is forming and falling. I don't know how that would be possible, but that would be so cool. And

then I'd like to see that – I don't know. I wish we could just have snow more often, be able to count on it. But, I don't want to make it predictable either. 'Cause it's magical in its own way. But, I would definitely vote for more snow (21:23).

Adult 67: I think it'd be cool you know how like are snowflakes actually all individual something where you could see one being created and form your own shapes of them. I think it would be cool. I think kids would be interested in it. Like they have their own snowflakes or something, you know (67:4).

Adult 75: I think it would be amazing to see an exhibit where you could actually change the temperature in a column and introduce moisture and actually have it snow, rain, or freezing rain based on how you're setting up that (75:29).

Respondents were also interested in learning more about snow characteristics (19% of interviews), such as why snow is white or sparkly, how much water is in snow, how snow insulates plants from freezing.

Child 20: One thing I don't exactly understand is why snow is white. Because, like I said, it's freezing. So, I don't understand why – wouldn't it be clear? And snowflakes are clear too. So, yeah (20:18).

Interviewer: What would make you more interested in seeing an exhibit about snow?

Child 78: Probably – well, I love snow so much so I bet I'd be just amazed at all of it. But I bet I'd really, really like to see what makes snow sparkly without the sunlight (78:22).

About 10% of the interviews also included a reference to learning about different types of snow.

Child 45: How there's different types of snow. Like stickier snow to make snowmen or snow that doesn't make snowmen. Like what's the difference (45:24)

Adult 75: I'd like to know how hoar frost [deposition of ice crystals on a surface when the temperature of the surface is lower than the frost point of the surrounding air] is formed on a surface of snow (75:26).

Interviewer: What would you like to learn about snow?

Adult 80: Maybe a little bit more about the different forms, because I know all the forms she said earlier, like slush, ice, and powdered sugar, and

compact, but I'm wondering if there's more forms of snow than that (80:25).

How snow changes on the ground was interesting to about 20% of the respondents as well. These respondents talked about their interest in different types of snow, snow layers and glaciers, and the process of how snow melts and changes on the ground.

Interviewer: What do you imagine you would see in an exhibit about snow?

Child 27: Artificial layers of snow with different types of layers. Like in the avalanche prone areas of the mountain, those scientists are digging along like that, and they're telling us that okay, so part of that snow layer is kind of frozen over, and then the top portion is kind of loose, and it's something like that (27:21).

Adult 37: I would like to know the snow here [Bethel] 'cause the snow here is so different, I think. It's light and fluffy and I feel like right now it's evaporating. It's not really melting, I can see it melt some, but like in Missouri you would see it all turn smooth and icy when it's melted. And here it's like little holes are forming like is it evaporating? Is the air that dry (37:27)?

Child 75: I'd like to know how hoarfrost is formed on a surface of snow. I'd like to know how the different layers of snow are formed and how that affects snow's stability or safety (75:25).

Child 80: I also wanna know if they keep their shape.

Interviewer: If they keep their shape?

Child 80: Like after you play in it, and after you move it all around and shake it all up, does it keep the shape that it was in when it fell from the sky, or is it a different shape (80:27)?

Interviewer: And what do you imagine you would see in an exhibit about snow?

Adult 34: Probably like just a history of the like the patterns and stuff over the years. Like in Greenland they had the big iceberg, the ice caps, or the ice shelves that I think is what they call them. That kind of stuff cause they say that was snow from the land years ago and it's just compacted over the years. So I'd expect to see something like that 'cause I know they're doing like drilling and stuff into those and trying to date them and do all sorts of testing trying to figure out whether or not we had an ice age or if we're going to repeat an ice age down the road. That type of stuff (34:16).

Adult 65: [interested in]...snow forms because again, there's quite a few different types and I feel like it's going to be pretty high up because I think when people think of snow, they think of like just the light and fluffy stuff. They don't really think of like more packed down (65:19).

Although snowy ecosystems ranked second in the sorting activity (Figure 2), only 14% of interviews included a reference related to snowy ecosystems. Most of these references were made by children.

Child 7: I think that in the winter, weasel's coats turn white so they can blend into the snow just like rabbits and owls. And there's some rodents or maybe squirrels or something, they burrow under the snow, so the white snowy owls don't eat them. And then once they've dug themselves a tunnel, during the spring they store up food. So, then they hibernate. So, then their body basically almost shuts down. And then once during the winter, they wake up, eat something and then go back into hibernation until next spring 7:27).

Child 12: And how to help the polar bears.

Interviewer: And how to help the polar bears.

Child 12: That's right. That's really important (12:19).

Adult 31: I guess how [snow] affects plants and animals in springtime. That would be important to know, I guess. I know that when snow is really heavy and deep sometimes moose and bears and stuff will go hungry (31:17).

Interviewer: If you went to a snow museum what would you see?

Child 61: A polar bear.

Interviewer: If the polar bear was in the museum? Would it be a snow polar bear or a real one?

Child 61: Real one (61:23)

Child 78: Oh, I want to learn how some animals survive without hibernation in snow (78:19).

Child 81: Yeah, I would like to see some tracks, right? And learn about the tracks in the snow, like what they were doing and when, because I was actually just in the snow. And there were interesting tracks making interesting patterns. I was like, "What did this animal do right here?" And we saw these bunny tracks that were hopping across a trail. Then they hopped up into the soft snow like three feet. I'm like, "How did a

bunny hop in the snow?" because if I stepped there, I would sink to the bottom. How did the bunny not go all the way down three feet (81:23)?

Interview respondents ranked snow scientists sixth overall (Figure 2). Some of the reasons for respondents' ranking included curiosity, the scientists' "cool" factor, lack of knowledge about snow science in general, general interest in science, or a general interest in what the scientist(s) are doing in the picture. In total, 27% of interviews included an explanation of respondents' ranking of snow scientists. Again, many of the interview respondents chose snow scientists primarily because they do not know anything about snow science.

Adult 20: We want to see the scientists because I want to know what they're doing with it (20:94).

Adult 28: I think it would be interesting to see – I've never heard of science being done on actual snow, not in relation to climate change. I've always seen it in relation to climate change or something like that. I've never seen too much actual scientific facts on snow itself, how it forms, how the snowflakes differ. That type of information would probably be cool (28:19).

Child 31: I did. I think [snow scientists at work is] most interesting because I have no idea what they do. And I just love science in general. So, for me to be able to know what they're doing, what's their everyday life? What's the purpose of exactly what they're doing? What are the experiments that they do is super interesting to me (31:20).

Adult 34: Scientists at work is mainly just because I'm curious about like just the effects of like the global warming and that type of stuff and what they're doing in Antarctica and to kind of see what they can do. I'm sure there's no reversing global warming (34:33).

Adult 37: Because I want to know what they're researching, what are they looking into for what? What are you studying to find out what, is any of this helping or you know what I mean (37:32)?

Child 42: Because I like science fairs and science (42:20).

Child 51: Scientists at work, because they're different, I don't know the word for it. They're different things they do – there are different things they do to do what they do, and to get successful results (51:21).

Child 65: Snow scientists at work because scientists are important and they're the ones who are going to figure out how and why (65:37).

Child 68: And then, this scientist it's really interesting. They just pick up different samples of snow and look at them under microscopes (68:43).

On the other side, those who ranked snow scientists low did so because they felt that science is boring, what the scientists in the picture were doing was boring, or they simply were not interested in science. In total, 17% of the interviews included an explanation of respondents' negative ranking of snow scientists.

Child 21: Science isn't interesting, Mom (21:75).

Interviewer: And then snow scientists at work.

Adult 29: That's boring (29:64).

Adult 30: How snow scientists work that kind of sounds boring, so I put that last (30:45).

Adult 33: I think if we could see more of the impact that the scientists have on us and stuff. I mean, you don't really hear too much about snow scientists and what they're discovering and what they're looking at and what they're trying to do to help society kind of thing. So, I think if more attention was brought to them and what they do it would be more exciting. But, I just kind of look at it like, "Yeah. I don't know what they do for us," kind of thing (33:20).

Interviewer: And then Snow Scientists at Work? You find that almost –

Child 45: Boring-ish.

Interviewer: Boring. Okay. What's boring about Snow Scientists at work?

Child 45: It's just a lot of explanations I guess. And I don't really like science.

Child 57: Scientists work was a little lower, 'cause I'm not really that much of a sciency person. I'm more like reading, but I think it's pretty interesting and important, just not as interesting to me, personally (57:43).

Adult 83: Scientists working on snow? I mean it's kind of not as interesting, only because it's kind of like, "Okay. So how does this impact us? And what would be our interaction with this?" (83:32)

The three lowest ranked themes – weather events, water supply, and snow in pop culture received very few mentions during the interviews. Snow in pop culture was not interesting to most interview respondents primarily because popular culture is everywhere, as one child said, “Everyone is sick of Frozen” (Interview 13:23).

Thirty-five percent of the interviews included a reference to learning more about climate change and its impact on snow and the water supply. Respondents were interested in the future of snow, how snow is changing, how snow benefits the climate, and about the water cycle and water supply in relation to snow. However, water supply ranked tenth most interesting in the sorting activity, just after weather events (Figure 2).

Adult 1: Well, maybe like how climate change is affecting how much snow and how it's affecting the animals that live in climates where there's a lot of snow or like cold weather, things like that (1:38)

Adult 11: I would be really interested in learning about the future of snow. So if it was an exhibit that discussed, you know, like a hypothesis about where snow will be at or what snow's life will be in the next 50 years, I would be really interested in learning about that (11:20).

Adult 36: I think it would be important if there are studies that are ongoing to talk about how we can help ensure that what we're doing with our lifetime is helping to prevent from ultimately going away. I guess my question is could you imagine if you never had snow in your life or you never saw it because maybe 50 years from now, we don't have snow in the world (36:18).

Adult 69: How the weather, the climate change is going to affect our snow and what that means to us, I guess (69:25).

Adult 65: [I am interested in]...water supply because I know that it's depleting in some areas. Snow scientists at work because scientists are important and they're the ones who are going to figure out how and why (65:18).

Adult 70: I would be interested in learning a lot about where climate change is taking 'cause we generally think of like Canada and the north as like our snowy places. But yeah, I would like to know what climate change is bringing (70:22).

Adult 79: Is snow endangered? 'Can we run out of snow?' I guess is one question (79:22).

Adult 83: I think kids would really benefit from learning what we talked about earlier, how snow in the mountains impacts our water supply. Just have a map, or like a little table diagram, or something that shows, okay, here's the snow. This is what happens. And then it goes down into the rivers, and into the reservoirs, and then it goes into your – into

the pipes, and then into the – into your water stream, or whatever. Like if you took a shower, you know, that kind of thing (83:26).

Very few people wanted to learn more about weather events, which was reflected both in the sorting activity (Figure 2) and in the interview. On average weather events was ninth out of eleven choices sorted and just 7% of interviews included a respondent indicating interest in learning more about weather events. Interview respondents may not be interested in learning more about weather events because they are already familiar with the topic: when asked about snow in the news, more than 53% of interviews included a reference to weather events that they learned about on the news.

However, one respondent had an interesting idea for the exhibit related to weather events:

Interviewer: Is there anything in your background that makes you particularly interested in wanting to know more about climate change, snow?

Adult 38: I don't know, I work at the university and I teach so yes. It's on the lips of a lot of academic. I've used it in my classroom [...] We do like a news, they have a project where they have to pretend to be a news outlet and so, that's a topic that they can research and write about if they want to as a news outlet. And a lot of them choose [climate change] 'cause [they live in] Fairbanks. (38:31).

Another interview included a reference to her interest in learning more about predicting weather events,

Adult 80: One thing I would like to learn is how they get accurate predictions. And how to find out. Is it really gonna snow (80:29)?

Just 12% of the interviews included a reference to interest in learning something about snow pastimes or sports at a museum exhibit, these included references to items like snow machines, winter activities, and snowballs. In the sorting activity, snow sports/pastimes received an average ranking of 6.3 (Figure 2). One child interviewed explained her choice related to snow sports/pastimes as something familiar, but it is not a topic she is interested in learning more about.

Child 11: I think snow sports and pastimes I think is interesting. We do a lot of those things, but it's not really something that I, like, want to spend a lot of time learning about I guess (11:21).

Even though respondents ranked their interest level in “Life in Snow” eighth, 25% of interviews included a reference to people and snow. These included words in various languages for snow, how to survive in snow, how people historically survived in cold climates, and how cities are preparing for snow.

- Adult 1: I want to learn some different words for snow like the Eskimo have so many different words for snow. So being able to understand maybe and be able to relate it back to that piece of culture, it could be kind of interesting (1:45).*
- Adult 4: And the different type of clothing that people have utilized to survive in the snow throughout history and, interestingly, how technology has advanced a lot of that but then, on the other hand, really hasn't at the same time. I mean, Eskimos existed for a really, really, really, really, really long time (4:36).*
- Adult 14: Yeah, and maybe what they're doing in Portland to prepare for the snow. Is there anything different that they're doing? So a lot of places they don't salt the roads because of the runoff into the streams and the rivers, what that does for the environment and for the animals. Are they doing at different these days with the amount of snow that we're getting (14:21)?*
- Adult 30: The different effects the snow can have. As a soldier we talk about frostbite and all the different effects that cold weather injuries can have. Also, from a healthcare standpoint those also interest me (30:19).*
- Adult 38: Cool snow stories like lots of fun snow stories from real people. Not that they have to be there but like maybe some sort of room where you watch a little video and you can come in and go out and people are just talking about snow stuff (38:29).*

Several themes emerged that did not have a direct parallel to the sorting activity. For example, 56% of the interviews referenced an interest in seeing representations of real objects, including snow structures like an igloo, a snow cave, a tunnel or a snowman (15%), fake snow (15%), and replicas of snowflakes (10%).

- Adult 3: I'd love to see some scale like a, maybe like enlarged replicas of snowflakes (3:30).*
- Adult 1: Pictures of places that it has snowed, examples of how deep snow can get when there's blizzards and – obviously, that's not here, but sometimes feet of snow when you live in a place that doesn't snow is hard to imagine. So, that would be kind of neat to walk through. Here's a house, and here's the snow up to the door of the house. Something like that. That would be kind of neat (6:23).*

Interviewer: You said about the snowflakes hanging on the ceiling?

Child 10: Yeah, that's what's kind of cool.

Interviewer: What else would be really cool to see?

Child 10: Well, fake snow on the ground (10:16).

Interviewer: What do you imagine you would see in an exhibit about snow?

Adult 39: Well, it's all the things you talked about here probably. I like the – you'd see models, maybe the hands-on activities kids could do. I think those are great. Even that idea, kind of the ice cave is a cool thing, if they recreate something like that that's an amazing thing, all of that (39:27).

Interviewer: What do you imagine you would see in an exhibit about snow?

Child 78: Probably models of snow and stuff, and maybe –.

Adult 78: Molecules.

Child 78: Oh yeah, molecules (78:20).

Child 81: Maybe a little model of a snowy area with animals camouflaging in it, and like, a little board saying, "Can you spot these animals"?

Interviewer: That's a great idea.

Child 81: And I can probably imagine a white fox in it for some reason (81:22).

Twenty-two percent of the interviews included a reference to including hands-on activities in a museum exhibit about snow. Respondents offered a variety of activities from simply wanting to have objects to touch and making paper snowflakes to feeling different types of snow 3D printing snowflakes.

Adult 11: I think it would be cool if there was some way to have an interactive experience with snow. Maybe not even actual snow, because that would be hard to keep it cold and frozen. But like ways of feeling different types of snow (11:18).

Adult 20: Maybe build a snowman [...] Cause I think kids would like that if they've never done it (20:22).

Adult 19: Maybe grab a snow sample and maybe get a scan of it so you can 3D print it. And you could have one year round, you don't have to wait for it to go snow or go somewhere that gets snow regularly and be like, fall into my parcel and then catch it and have to keep doing that. You could just 3D print one or a bunch of them and look at them under a microscope.

Interviewer: That's a great idea. 3D printing. I hadn't heard that. Any other ideas for snow exhibit or something from your background maybe that makes you very interested? (19:20)

Child 20: I just thought of something. I saw a lot of the cool mechanisms you had downstairs. Maybe some sort of snow maker, which would make snow and maybe put it in a tiny little container, you could see it happening. (20:24).

Adult 29: Definitely I want some extreme angles. Maybe something interactive, like can I touch some snow? Or can I go outside in some snow? Or can I taste some snow? Can I make some snow? Can I have a snow cone? Something to get me going (29:19).

Child 68: Like a snow machine that would be cool. So like kids are able to turn it on and off and have different settings on it (68:21).

Child 69: Well, frozen rain and they're all different shapes and they're really pretty. Like you could have like a microscope or something to look at them (69:12).

Conclusions

This evaluation clearly found that potential science museum audiences would enjoy a museum exhibition about snow. Both adults and children appreciate snow, or at least the memories they have of snow – sledding, sometimes with epic crashes, building snow forts and tunnels, throwing snowballs at their friends, and sometimes being hit with snowballs, making snow angels, eating snow, and skiing. Conversations about snow also prompted memories of important family members – learning to ski with a parent, building a snow cave with dad, and playing with a brother or sister. At the same time, snow conversations raised the specter of snow dangers – driving in whiteout conditions, blizzards described as “snowpocalypse,” and power outages. For some these dangers were exciting, for others, frightening.

Even with snow’s potential dangers, or maybe because of those dangers, adults and children interviewed were excited to expand their limited knowledge about snow. A majority of respondents want to know how snow and snowflakes form and they want to observe and manipulate the process. Viewing snow art and snow crystals and learning about snow ecosystems were also particularly interesting to interview participants. Less interesting snow topics were popular culture references to snow or snow pastimes (e.g., skiing, sledding), topics with which they were already very familiar.

Climate change and its impacts on snow was also clearly a topic that interview participants were interested in seeing in a museum exhibition about snow. Interview respondents reported being interested in learning about the future of snow, how snow is changing, how snow benefits the climate, and about the water cycle and water supply in relation to snow. A less interesting topic to potential exhibition visitors related to the role that snow plays in the earth’s climate system was weather events, again a something very familiar to those interviewed whether they experienced weather events themselves or witnessed them through the media.

Potential exhibition visitors want to learn about snow and the role that snow plays in the earth’s climate system in a hands-on environment with representations or real “winter world” objects, including snow structures like, a snow cave, a tunnel or a snowman, fake snow, and replicas of snowflakes. They want to make snow or observe the process of its formation. In addition, they want to hear from people who live in snowy climates. With these aspects in place, exhibition visitors are sure to leave with a better understanding of the vital role that snow plays in our global climate system and in providing two billion people essential water resources.

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