

## **From ‘having a day’ to doing astronomy: Supporting families learning together**

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Families are an important context for learning astronomy, one that researchers on astronomy teaching and learning have largely overlooked. At public observatories, families have an opportunity to learn both the substance and practices of astronomy together. However, the typical structure of public observations (one visitor looking through a telescope while an expert explains what they see) creates tension with families engaging in the disciplinary practice of building disciplined perception through collaborative sensemaking. In this paper, we report on a preliminary study in which a family pilot tested new activities to encourage collaborative sensemaking. Key factors that supported the family’s collaborative learning include (1) Using activities that shift authority and control to each member of the family, (2) Having a variety of activities that can be deployed at strategic times rather than a fixed schedule, and (3) Being responsive to the family dynamics, including the emotional needs of each family member.

## I. INTRODUCTION

Research on astronomy teaching and learning has largely overlooked an important context of science astronomy: *families*. Recent research has demonstrated how families provide rich environments for children to learn not just the content of science, but also the practices, such as collaborative sensemaking discussions [1-2] where children (not just parents) share and assess their ideas together.

Astronomy is a promising, but understudied, domain for family science learning. Even very young children express interest in the Sun, Moon, planets and stars [3]. Star parties and public viewings at local observatories are one popular outlet for collaborative learning of astronomy [4], including parents and children to learn about astronomy. However, these events tend to focus on conceptual explanations of telescopic observations, which are typically guided by an expert. There are few opportunities for families to plan and conduct their own investigations, to interpret telescopic images for themselves, and to generally engage in the practices of astronomy.

We have designed and pilot tested activities for families to learn astronomy collaboratively. Our activities focus on developing the disciplinary practice of developing disciplined perception through collaborative sensemaking. Disciplined perception [5] means the families learn to see astronomical objects [6], through highlighting aspects of the visual field [7]. In collaborative scientific sensemaking [1, 8] families contribute and discuss their own ideas to understand a phenomenon. In this preliminary study, we describe how one family engaged with these activities, detailing the factors that supported their engagement in collaborative sensemaking and disciplinary vision. In particular, we focus on the dynamics of how one family member become increasingly engaged in disciplinary practices of astronomy. This case study reveals how family dynamics, including epistemology and affect, can interact with activities designed to teach disciplinary practices.

In what follows, we first describe our methods, including a description of the family, the activities, the data collected and the research methods to analyze the data. We then provide a case study of one family member’s increased participation in the disciplinary practices of astronomy. Finally, we draw conclusions about the factors that supported the families’ engagement in astronomy practices, and consider broader implications for family astronomy learning.

## II. METHODS

In this pilot study, we recruited one family (a father and two daughters) to attend a 2-hour astronomy workshop. We noticed that one family member in particular (the younger daughter) displayed a dramatic change in engagement over the course of the evening. We conducted an interaction analysis of video and audio data to provide insight into her

shift in engagement. In this section, we describe the data collection and analysis methods.

### A. The family

The family was recruited from the general visitor population of the university observatory’s weekly public observations. Visitors with at least one child near middle-school age were given an opportunity to sign up for a “family astronomy workshop”, where they could have more opportunities to learn astronomy together. A poll was sent out via email to gauge interest and availability among the 22 families who signed up. Four families responded to the poll, and we chose the family who could attend the first scheduled night.

Three members of the Galiano family (pseudonym) attended a 2-hour family astronomy workshop: a father “Jerry” and two daughters Ivy (age 9) and Cassie (age 7). In their poll, the Galianos reported being interested learning about moon craters as well as the planets Jupiter and Saturn. The workshop activities were chosen to align with their interests.

### B. The activities

Over the course of the evening, the Galianos participated in five different astronomy activities designed to encourage their disciplinary vision and collaborative sensemaking (Table 1).

TABLE I. Family astronomy activities.

Activity	Description
<i>Card sort: Aging Craters</i>	Sort craters in temporal order.
<i>“I spy” on the Moon</i>	Spot features on the Moon.
<i>Find the Planets</i>	Decide which “stars” are planets.
<i>Scavenger hunt: Jupiter</i>	Find clouds, storms, moons.
<i>Scavenger hunt: Saturn</i>	Find specific rings and moons.

While there was a general plan to complete some of these activities, there was no rigid schedule. The plan itself was designed to be responsive to the families’ ongoing interests and possible changes in weather, including cloud movement. Some activities (Scavenger Hunt: Moon) were scrapped in real-time, while others (Find the Planets) were strategically deployed to address the family’s real-time dynamics (Cassie wanted to go outside).

One of us (Author 1) was present during the activities, serving as facilitator. The focus for facilitation was on encouraging engagement and discussion, rather than on providing information. However, the facilitator did provide information and help opportunistically, especially when it seemed like it would encourage engagement of particular family members and/or spark discussion.

### C. Data Analysis Methods

The Galianos agreed to be videotaped and audio recorded for research purposes. The families' activity was recorded with two strategically-placed GoPro™ cameras and a digital audio recorder. A total of four hours of video and two hours of audio were recorded for later analysis.

We conducted a video analysis of the families' interactions to provide insight into the factors that supported the family's disciplinary engagement [9]. The facilitator wrote field notes immediately after the workshop, indexing key moments [9]. We then created content logs of all the video files, marking the time of key moments and major transitions and activity. We isolated and transcribed video clips of these key moments of activity, and through collaborative viewing we developed an analytic narrative focused on factors that supported the family's engagement in disciplinary practices of astronomy. We tested these narratives against alternative interpretations.

### III. CASE STUDY

In the following case study, we focus on the engagement of Cassie, the younger daughter, as it changed dramatically from near total disengagement to enthusiastic engagement by the end of the night. We split the case into three "phases" and note the specific supports both in the activity and in the interactions that encourage her engagement.

#### A. "Having a day"

Before the workshop officially started, the younger daughter Cassie was showing signs of resistance. While the facilitator sat down with the family at a table in the classroom to offer snacks and go over the plan, she was continually getting up and wandering around. She was saying "no" to everything, including snacks. The father informed the facilitator that she had been, in his words, "having a day".

##### *Activity 1: Aging Craters Card Sort*

The first activity was a card sort that took place around a table in a classroom. The family was given four close-up images of moon craters and asked to arrange them in the order they were formed, from oldest to youngest. While the facilitator was explaining the activity, Cassie got up and walked to the back of the room. Since the father did not try to actively engage her in the activity, the facilitator followed his lead and let her roam.

The older sister Ivy worked with her father to complete the activity. While they were working, Cassie came back to the table and participated peripherally: she picked up one of the cards and inspected it, before flipping it back onto the table. Ivy and her father quickly decided on the order together, and the facilitator asked them how they did it:

Facilitator: So you think this is the oldest, this is second oldest, this is third oldest, and this is the newest.

Ivy: Newest.

Facilitator: And how did you work that out? What were you paying attention to?

Ivy: ((Pointing at craters)) The layers. Um,

Father: Be specific. So what do you mean like um,

Ivy: The layers...this one ((pointing)) is oldest because it's underneath all of them, the craters. And that one's on top of that one, and this one's on top of that one, and that one's on top of all of these.

The facilitator confirmed their reasoning as part of how astronomers order craters, and explains a couple of other factors astronomers pay attention to: the sharpness of the crater rim, and the brightness of the crater. The father then asked some questions about when the craters formed. During this, Cassie moved away from the table and sat at one of the classroom desks. She put her head down, swung her legs, and groaned.

Cassie's active resistance could have been simply due to a bad mood, as the father implied ("having a day"). Alternatively, she could have been bored or not interested in the activity, perhaps because she perceived the activity was too much like school (the classroom setting may have reinforced this). Another possibility is that she may have felt she was not able to contribute, as her sister was so eager and quick to complete the activity with her father. Of course, all of these dynamics could have been going on at once.

#### B. Increasing Participation

After the 10-minute crater sorting activity, the facilitator scrapped a second card sort activity and took the Galianos up to the observatory on the roof. He had the sisters help open the dome shutter by turning a crank, hoping it would help them feel more involved. Their excitement at participating led to a conflict: Ivy walked faster to get to the crank first, as Cassie turned to her father and complained. After Ivy took a few turns, Jerry intervened, "Alright, give her a chance, Ivy" and Cassie got a turn as well. Once the dome was open, each family member took turns having a look through the telescope at the Moon, with Cassie going first.



FIG. 1. The Galianos in the observatory at the family astronomy workshop. From left to right: Jerry (father), Ivy (daughter, age 9), Cassie (daughter, age 7) using the telescope, and facilitator.

### *Activity 2: I spy on the Moon*

Once everyone had a look at the Moon, the facilitator started the next activity: “I spy on the Moon”, a modification of a common kids’ game in which one player “spies” something that the other players have to guess. The facilitator confirmed with the girls that they were familiar with the game, and played a practice round (“I spy something blue!”). After both girls offered guesses, Ivy figured it out (a tarp on the floor).

The family then took turns “spying” something on the moon. Cassie went first. She looked through the telescope intently, but when Ivy asked her what she saw, she jumped down and said “Meh!”

Ivy went next, spying a crater that looked like an emoji. Cassie insisted on looking:

Ivy: I spy a crater...  
Father: Oh, you see!  
Ivy: A crater that actually looks like...  
Father: A crater that looks like?  
Ivy: What? Guess!  
Father: Like?  
Ivy: Like a yellow emoji...  
Father: Like a smiley face?  
Ivy: Yes!  
Father: Let me see, I’ll probably find it  
Cassie: ((steps in front of father)) Let me see!  
Father: Let Cassie see.  
Ivy: Fine by me!  
Cassie: ((looks into the telescope but says nothing))  
Father: Is it toward the top, or the bottom?  
Ivy: Toward the bottom

Cassie looks but then gets down without saying anything. The father then looks and finds it fairly quickly. After a few more rounds, Cassie participates more by finding an object Ivy spied, and then by spying her own object:

Ivy: Oh, I see something that looks like an emoji, not really a face  
Father: Which one?  
Ivy: Toward the bottom  
Father: Like a heart emoji?  
Ivy: Yeah, a heart!  
Cassie: I wanna see it! ((trips as she climbs ladder))  
Father: Okay. Careful honey, be very careful ((holds ladder)) There you go.  
Cassie: Wait, where?  
Father: On the tip honey, so near the bottom. Bottom tip. You have to use your imagination a little bit, too.  
Cassie: Yeah, I see it!  
Father: Okay, very good! ((winks at sister))  
Cassie: And I see a crater shaped like a bird  
Father: A crater shaped like a bird? Where is it?

Cassie: On the top.  
Father: Oh, I see that! ((to Ivy)) I think I see your heart. And there’s one at the top that looks like a bird.  
Ivy: ((looks through telescope)) Oh yeah, near the top part? Yeah!

Overall, Cassie gradually shifted in her engagement during the “I spy” activity. At first she is only materially engaged, by taking turns looking through the telescope without engaging in any verbal coordination to “spy” objects on the Moon. After several rounds, however, she not only claims to see an aspect of the Moon that Ivy had “spied” (heart shaped crater), but also offered her own observation (bird shaped crater), which the others confirmed.

Despite this increased engagement, eventually Cassie became restless and started to ask repeatedly to go outside. The facilitator decided to switch to an activity they could do outside, Find the Planets (not captured on camera).

### **C. Enthusiastic Engagement**

Once the family came back inside after the Find the Planets activity, the facilitator decided to take a closer look at the planets. First, they looked at Jupiter. The facilitator asked if Cassie would like to help move the dome to see Jupiter. She pressed the “star” button to rotate the dome, then pressed “stop” when Jupiter was centered in the window. The family collaboratively completed a Scavenger Hunt where they had to see if they could see the cloud bands of Jupiter, the Great Red Spot, and each of the four Galilean moons.

Lastly, the family completed a Scavenger hunt for Saturn, in which the family had to try to spot the rings, a gap in the rings, and at least three moons. Ivy expressed excitement over the scavenger hunt activity, and wanted to read the accompanying worksheet. Cassie was more interested in the equipment. The facilitator got Saturn in the eyepiece, then asked Cassie to drive the telescope to center it while asking Ivy to tell everyone what they needed to find from the worksheet.

After the activity, the facilitator asked, “Did anyone see the gap in the rings?” All three excitedly answered “Yes!” and Cassie added, “I saw three!”

### **IV. CONCLUSIONS**

One important finding is that the activities supported the families’ disciplinary engagement. In particular, there is evidence that the Galianos’ engagement in the workshop activities involved the disciplinary practices of collaborative scientific sensemaking [1,8] and disciplined perception [5].

Evidence of collaborative scientific sensemaking occurs, for instance, in the crater card sort. Ivy built an explanation of how to tell the age of the craters with her idea of “layers”, with newer craters layering on top of older craters. This is indeed one of the ways astronomers determine the relative age of craters. This sensemaking is at least somewhat

collaborative, in the limited but important sense that the father made space for the substance of Ivy's "layers" idea by asking her to be more specific.

Evidence of disciplined perception comes primarily in the "I spy on the moon" activity. The family's shared perception of features on the Moon was challenged by the fact that only one person could look through the telescope at a time. Much like seasoned observers [4], the family faced this challenge by spontaneously finding ways to highlight objects in the visual field for each other. They highlighted features in multiple ways, including describing how it looked ("smiley emoji", "heart emoji", "bird") as well as its location on the moon ("Near the bottom", "at the top", and "on the tip").

Another finding is that the supporting families' engagement in the disciplinary practices involved navigating their affective dynamics. In particular, Cassie's engagement shifted dramatically from start to finish. The valence of her emotional expression started off negative, but gradually shifted to positive. During the card sort, she walked away from the activity table to slouch in a desk chair, and groaned. Gradually the negative valence switched towards a more neutral expression during the "I spy on the Moon" game, when she asked to look for her sister's object but when asked about what she saw she just said "Meh." Finally, by the last activity of the night, Cassie's emotional valence shifted to positive when she excitedly volunteered that she found three gaps in the rings of Saturn.

Key factors that supported the shift in Cassie's engagement can be split into two categories – (a) family factors and (b) facilitator factors. Family factors include (1a) recognizing emotions, (2a) giving space and (3a) flexible turn taking. The father recognized in the beginning that Cassie was "having a day", but did not attempt to force her participation. Rather he gave her space to engage on her own terms and in her own time. This involved the father and sister recognizing when she wanted a turn and sometimes giving up their own turns to allow this to happen. This happened explicitly when Ivy reached the crank first to open the observatory and her father asked her to let Cassie have a turn. It also happened when the father was going to take a turn to find Ivy's emoji on the Moon, but Cassie expressed that she wanted to see and so they let her take a turn instead. All three family factors represent strategies for responding

to their family members' emotions in ways that encourage further engagement.

Facilitator factors that supported Cassie's shift in engagement include (1b) being responsive to the family dynamics, (2b) having a variety of activities that can be deployed at strategic times rather than a fixed schedule, and (3b) using activities that shift authority and control to each member of the family. The facilitator followed the father's lead in giving Cassie space during the first activity. The facilitator subsequently scrapped a second card sort in response to Cassie's mood, and later switched to an outside activity when Cassie expressed a desire to go outside. All of the activities allowed each family member to experience authority and control. In some cases, the authority came in the form of manual control over the materials (opening the dome, aiming the telescope), which was afforded by the small group nature of the workshop where supervision was possible. In other cases, this authority was epistemic in nature. For instance, the person who "spied" an object became positioned as the authority on that object due to their close epistemic distance [8].

## V. DISCUSSION

This was a pilot study to test a new way for learners to participate in collaborative astronomy learning at a public observatory. Our findings represent an existence proof that families can engage in disciplinary practices of astronomy using this format, and that doing so required both family and facilitator to attend to the family's affective dynamics. Cassie's shift in engagement highlights the role of emotions, but even if she were not "having a day" we suspect that attending to affect is essential for following families' interests and encouraging their engagement in disciplinary practices.

Admittedly, this family's steps toward engagement in disciplinary practices were only preliminary. Future workshops and case studies will focus on ways of deepening families' collaborative sensemaking in the service of developing disciplined perception.

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