“Grandma says I am a little scientist.” Apprenticeship, Photo-Storytelling, and Identity

A Science Educator’s Culturally Situated Auto-Ethnographic Family Case Study

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Abstract

To participate in everyday STEM (Science, Technology, Engineering, Math) and perhaps aspire to be a STEM professional, children need to develop a “STEM person” identity as welcome and capable investigators. This identity development can begin at home where a family lives its culture of values, attitudes, and interests. In this two and half year case study, I used auto ethnography to explore my dual identities as a science educator and grandmother to guide my granddaughter’s explicit early STEM identity development as she baked Sabbath bread with me. I modeled and mentored her through activity, conversation, and a photobook/reading technique. The book became a memory support and an identity artifact as a record of what we did. It also allowed for her voluntary revisiting of the experience to repeat the storytelling of herself as an emergent, able STEM participant. The study suggests that I did contribute to my granddaughter’s science identity development, learning to adapt to her growth. The photo stimulated storytelling, now readily available to most families, might be a transferable technique to support STEM identity building in welcoming children into our community of practice as everyday scientists. Critically, family photos are images of a family’s culture, as were mine.

Keywords: science identity development, family science, science storytelling, photobooks and science, family science identity

Introduction

I studied my dual identities of grandmother and professional science educator to explore how one granddaughter and I interact to welcome her into a "science person" identity, focusing on a relevant and culturally specific baking activity in our family environment. By using an auto-ethnographic case study method, I examined my practices with Toby (pseudonym) looking closely at how I encourage her to participate in a community of people recognizing the opportunities to observe, use common tools, collect data, and discuss findings in our everyday activities. This community includes science educators like me, but also families who recognize and encourage each other to be aware of science as a way of knowing (Bell, 2009; Dewitt et al., 2012; Herbert, 1980; Solis & Callanan, 2018). My identity as science educator includes the sharing of science education practices. In this case, I reflected upon what it is that many families do in common. We all need to eat, which makes kitchen science an accessible area of intergenerational science mentoring (Harbison, 1997; NSTA, 2009, Partridge, 1986; Tunnicliffe & Gkouskou, 2019; Zubrowski, 1981). I chose to use photography and photobook making as a central part of my data collection. Many families are documenting their lives with readily available photo technology (Everpresent, 2016). These photos present a family with the opportunity to tell stories about their experiences. As I spent baking time with Toby, I purposely wanted to tell a story about the science in which Toby and I were engaged as she participated in our baking of challah, the traditional Jewish Sabbath bread. I sought connections between identity development theory, which proposes that we need to think of ourselves as a member of a community to practice within it (Wenger, 1998), and storytelling, which is a method within many cultures to help transmit a specific cultural history of identities (Aghasaleh, 2019; Boyd, 2009; Gottschall, 2012). I have examined my overlapping boundaries of family member and science educator. Within both of these identities is the value of distributing knowledge. This paper concludes with possibilities for broader distribution of science education techniques for family use.

My career (and professional identity) has concentrated on "continual science learning" (CSL), as I refer to it, more commonly called "informal science education" (ISE). The terms approximate the kind of science learning that can happen almost anywhere when we pay attention to learning about how the world works. I prefer the term "Continual Science Learning" because it conveys a value to learning outside of schooling that "informal" does not, and it implies the cumulative nature of learning to which Tal and Dierking referred (2014). In this instance, I explored a science learning opportunity with Toby in my kitchen as *place* because it is not nestled in a science center, museum, zoo, aquarium, afterschool program, park, or other programmatic or institutional setting. Cooking is an essential (and culturally imbedded) activity among most families, making this form of CSL a far older way of learning science than formal schooling or other science education institutions. For, learning how the world works so that we can meet our needs predates schools (and even humans), because survival depends on our ability to learn, adapt, and, in the case of social animals, share the learning (Jarvis, 2006; Wilson, 1975).

We are continuing to learn that survival today is not centered in our tribe or community (Common Worlds Research Collective, 2020). Transport, communication, and a global economy connect us around the earth. Science has helped us understand what, how, when, and where we need information about interactions and impact. More critically, STEM education provides a means to learn how to learn (Bronowski, 1978; Quigley et al., 2010; Ritz, 2007). For both personal and global needs then, it is essential for science educators to assist families to engage in the process of encouraging their children to think of themselves as "science people," identifying as capable participants, increasingly responsible for their share of survival.

Research has shown us that there continue to be people who perceive STEM as difficult (García-Pérez et al., 2020). We also have evidence that there have been systemic biases against women and other groups to gain and control STEM knowledge (Delpit,1995; AAUW, 2010). We in the science education field have an obligation to share our knowledge to support our global communities to not only survive, but also thrive in harmony with the earth that supports us (Ross et al., 2015). Science education research can gain insights into how we encourage interest in STEM among all earth's people with whom we are interdependent. We science educators continue to seek ways to understand how both children and adults maintain curiosity in how the world works through asking questions, observing, gathering data, evaluating outcomes, and working together to solve problems (Ash et al., 2012; Lederman & Abell, 2014; Rogoff, 1990). We work towards supporting confidence in understanding the nature of science, its perspectives, its contexts, and its tentativeness (Fleer, 2009; Lederman et al., 2002). Those of us who concentrate on CSL pay attention to the non-curricular ways in which science learning happens. The investigation I am reporting here presents a case study of how I combine my personal and professional science educator identities. My interest is in sharing my insights to encourage other families to support their children to maintain the curiosity and problem-solving skills within their own cultures that are key to science learning and ultimately, survival for all of us.

This paper then, describes the background, processes, and outcomes in the use of a photobook created to document a cultural baking and science activity. As we move through the baking steps, I ask my granddaughter to do the measuring and mixing to develop competence. I ask her to consider what ingredients like sugar, yeast, and water contribute to our bread and how changing the amounts might change the bread. I see this participation and my questions as ways to enhance my young granddaughter's science identity---to practice as an everyday scientist who can feel physically and mentally able to consider ways in which to manipulate, observe, consider, and discuss outcomes. I am supporting her emotionally by welcoming her happily into the process (Immordino-Yang & Damasio, 2007).

Documenting this baking science apprenticeship through photographs and captions as a photobook creates an artifact to which my granddaughter could return (Tomson and Holland, 2005). I experimented with this process earlier and found it useful (Katz, 2011). Recent research in Australia, employing photobooks with families after using exhibits from a science center outreach program, provides evidence that photobooks enhance recall, stimulate conversation, and aid in science identity development (Howitt & Rennie, 2021). With this granddaughter, I added a specific cultural component. I suggest that family photo storytelling may be one useful way in which to encourage families to purposefully tell their everyday science stories supporting their children to see the STEM in their own culturally imbedded lives. The within family case study reported here follows in the tradition of Piaget, who examined his own children's cognitive development (Babakr et al., 2019) and Dana Vedder-Weiss (2017), who more recently studied her children's serendipitous science learning during home schooling. The three research questions I pose here are:

1. What is the relationship of my identity as grandmother to my identity as science educator/researcher?
2. How do I employ these dual roles in my purposeful effort to develop my granddaughter's "science person" identity?
3. How do the insights gained in this case study provide possibilities for other families?

Theoretical Background and Prior Evidence

Nature and Nurture

In considering how I make choices and act, blending my grandparent/science educator identities, I have drawn from theory in a number of fields that intersect. I first look at evolutionary biology. There is evidence that human families (however defined) provide the vital role of early learning about the world, as both protection and preparation for adulthood (Galinsky, 2010; Rogoff, 2003; Wilson, 1975). The discipline we call science, and more broadly, STEM, is an approach to learning about the world so as to protect and prepare us in our lives. Rutherford & Ahlgren, 1990; Bell et al., 2009). By starting with the theory of adaptation, we can gain insights into how we and our social interactions and institutions meet the life needs underlying our complex activities. According to basic evolutionary theory, genetic (inherited) and behavioral (how we live) components contribute to how we adapt and live to pass on our genes to the next generation (Darwin, 1859/1968). Evidence from our primate cousins suggests that we developed family learning patterns (even early identity through status) over millions of years as we assessed our performance among group members (De Waal, 2013). Evolutionary studies suggest that the survival of grandparents beyond their own reproductive years is part of "inclusive fitness," a term that describes how non-parental but related organisms cooperate for added fitness or survivability (Fisher 1973; Alvarez, 2000). Biological research has uncovered genetic evidence that our brains are protected from post reproductive decline (Schwarz et al., (2015). This would seem to indicate that our bodies are expected to function and presumably contribute beyond our own years of producing offspring. Recent reports from both the U.K. and the U.S. on the contributions of grandparents to their families support this biological theory (Brooks et al., 2009; Ferrie et al., 2016).

Human families have evolved a long period of childhood learning to provide for the complexity of what must be acquired to survive (Volk, 2011). In addition, Volk continues that this is recognized as play---a key element of CSL places (museums, science centers, aquaria, afterschool programs, and many activities in homes). Fenichel and Scheingruber (2010) write, "In the course of daily life, virtually everyone engages in informal science learning." (p. 1). They continue, "Everyday learning includes a range of experiences that may extend over a lifetime…

and may vary greatly across families, communities, and cultures" (p.3). Science learning within families is continuous (Gopnik et al., 1999.) We learn physical tasks of balance, walking, and hand manipulation. We learn how to obtain food, cook it, and eat it in flavors familiar to our family cultures. Food preparation involves measurement, materials science, and food safety. We celebrate events in our lives with culturally familiar rituals and music. Physical activities (including music and dance) require testing balance and movement.

There are many ways in which we have evolved to support learning how to survive in this world. There is research on mirror neurons that tells us that we have evolved to learn socially by being wired to mimic expressions and emotions around us starting from birth (Meltzoff & Marshall, 2015). Our early beliefs, attitudes, values, and motivations mimic those who care for us. Babies learn to smile from the happiness of their parents (Meltzoff & Marshall, 2015). We share emotions among our social group (Immordino-Yang & Damasio, 2007). Trust is an essential part of parenting/grandparenting. Trust in a teaching relationship is paramount. It is the basis of all teaching (Dillion & Avraamidou, 2020). I had played with Toby since birth. Baking and building were other forms of play where our processes yielded something for which she gained a useful product and recognition. I took photographs often. Photo documentation was a comfortable part of what we did together. She would ask at other times to look at the photos and she would tell me what she remembered from the images. We frequently read together. Her home and mine have a good selection of children's books. Most of these books tell stories. Biologically, we have developed to absorb and copy our family cultures. Through experience, we participate in the work and play of our homes. We observe how our families spend their time, what they choose to own, how they talk, and what they talk about. We find (or are assigned) our roles and grow to know our family's expectations. There are exceptions, but generally, our family's stories become ours.

It follows that closely related adults, usually parents or grandparents, help their offspring safely survive by assisting them to make sense of the world they have come into and to develop useful skills consistent with family cultural identities--everyday science. Interestingly, there is more research on grandmothers than grandfathers. Perhaps it is because there is less paternal certainty for men, or perhaps because culturally, men have been harder to study as they can be less accessible when their work takes them away from the home. More often, grandmothers are available for both their knowledge and their caregiving. This follows a pattern that has been observed among some other long-lived mammals as well. Notably, grandmother orcas (killer whales), in the Pacific Northwest where I now reside, live years past reproductive age (and the males). They have been monitored leading their family pods to food sources when the customary source is scarce, directly affecting survival rates (Nattrass, et al., 2019). Evidence from research on mammalian grandmothers, including humans, suggests that my imperative to share my own learning within my family has strong biological roots running deeply as a survival strategy, even across species. Within my identity as a science education researcher, I believe that I have an obligation to construct creative ways to assist this first, powerful STEM learning opportunity among other families, honoring and respecting cultures in which they have grown.

Identity Development

Sociocultural theory tells us that the family is most often the source of how we come to understand ourselves as part of a group with a history, a way of doing things, a way of looking at life (Rogoff et al., 2018). Identity speaks to how we see ourselves and how others see us in social settings (Gee, 2001; Varelas, 2012). I wanted my granddaughter's identity to include "science person." That is, I wanted her to feel physically, emotionally, and mentally confident to observe, experiment, question, collect data, draw conclusions and discuss her ideas with others. We have seen that families begin the process of identity development from birth as their behaviors and communications tell us what is available to the young within their family cultures (Rowe & Casillas, 2010; Sha et al., 2016). Families set expectations that influence their children's school achievement (Thomas & Strunk, 2017). This is not to say that no other influences are possible, but it is to say that family is where we first learn "to be in the world," learning to learn and to interact with other people. I chose to explore from the position of a grandparent, as this is one of my primary present identities.

Continual Science Learning Within Families

What I call CSL is a large part of what happens in families. Children play and learn to test and evaluate within their home environments. Children draw conclusions. They alter strategies based on the evidence of their experiences. This happens whether or not anyone recognizes these as nascent science skills. I have approached most everyday learning within my family as science education opportunity. Not only children, but all of us need to learn as our world and we change throughout life--adaptation. This is at the root of why I prefer the term "continual science learning," to "informal science education--ISE." Families are the first, and often most powerful influence on our identities (Galinky, 2010; Sikder & Fleer, 2014). They apprentice us in their own interests, values, and habits of mind (Sha et al., 2016). The science education professional community advocates for and acknowledges early exposure and family involvement to STEM (NSTA, 2009; NSTA, 2014). From these influences we craft our own identities as young people who may be free to choose, or may be limited, by how we have been nurtured. With the possibilities and potential for influence in mind, I invited my granddaughter to become a challah baking science apprentice.

Storytelling/Reading

From an evolutionary viewpoint, storytelling is an adaptation to gain attention "to explain things, from a child's or a country's pouty '*They* started it' to why the world is as it is, according to myth or science" (Boyd, 2009, p.1). A story is a uniquely human art form that Boyd (2009) characterizes as "a kind of cognitive *play*, the set of activities designed to engage human *attention* through their appeal to our preference for inferentially rich and therefore *patterned* information." (p. 85). Others agree that storytelling is an ancient and enduring form of knowledge transmission and is perhaps what makes us human (Gottschall, 2012; Harari, 2014). Living in communities, our complex language abilities have given rise to ubiquitous storytelling as a continuing form of this transmission (Boyd, 2009; Gottschall, 2012; Harari, 2015). Investigating the transmission of science as a way of knowing is to study how this aspect of human culture moves from one generation to the next. We are told and read stories about ourselves, other family members, or others in our communities. These often teach us acceptable behaviors and cultural ways of looking at the world (Bayer & Hettinger, 2019). Sfard and Prusack (2005) proposed that "we are the stories we tell" when they wrote of girls and math, as we form our identities of what we can and cannot do, linking storytelling specifically to math identity development. Other researchers have echoed the power of storytelling in science education, as did Avraamidou (2017) in her research in science teacher preparation. She explored the development of alternative narratives as a method to open new vistas to students whose former narratives did not include a science identity. I did the same with mothers who were leading the afterschool science enrichment programs I had developed (Katz, 2015). Stories help us to explain the past and envision a future. Considering this theoretical background, I set about to help create a narrative with Toby so that her story included a vision of herself as a comfortable, capable, early science participant. To make the story hers, I decided to create a photobook of one of our challah baking episodes. I knew that reading was an important early childhood activity and that a book about her would give Toby a sense of pride to further enhance her baker-science person identity. Earlier research had suggested that her storybook was a memory artifact (Thomson & Holland, 2005). She might choose to revisit the activity, to share the book with others, and to enjoy the attention of herself as the main character.

Photographic data for the story

Our eyes have evolved to sense visual images. Our brains interpret and store these images (Anderson & Contino, 2013). We have many visual neurons connected to multiple areas of the brain to accomplish this. Photography as data began in 1837 with Daguerre's invention of a fixed image on paper. Photographs of human activity are data which can provide us visual stories of people in places, enriching verbal data, and used often in community studies (Banks, 2007; Mitchell, 2015). Photographs can be used to prompt memories for story recall (Harper, 2002). Photography has been used in educational research (Eschach, 2009; Liebenberg, 2018; Patrick, 2019; Prosser, 1998; Wang, 1999). Some teaching techniques specifically use photography (Park & Bell, 2005). Photography has worked well with young children (Hoisington, 2002; Keat et al., 2009). Julia Hirsch wrote specifically about family photographs that they are "a rhetorical device which our society uses to inspire and to coerce because these photographs look back at us and touch our values, our beliefs and our frailties." (p.115). I chose photo storytelling because I was convinced of its power from both research and experience. With Toby, I could use photo elicitation (questioning derived from photo viewing), since she was accustomed to my frequent picture taking and questions. I also wanted to explore the photobook as storytelling artifact as a potential method for others. This paper then, considers the intersection of my own learning in evolutionary biology, theory and methods in continual science learning, identity development, and photographic data.

An October 2020 Worldcat search from 1950 (the beginning of the U.S. National Science Foundation) to the present, for articles in peer-reviewed journals on “teaching science in schools” yielded 963, 350 articles. Searching for “grandparents teaching science in family settings”, only yielded 12,352 articles. Family data are harder to gather. Researchers from outside of the family must find ways to understand family dynamics in the episodes they are allowed observe. They have used family self-report surveys (Jungert & Koestner, 2013) and observations of family interactions in CSL settings (Szechter & Carey, 2009; McClain & Zimmerman, 2019). There are studies that include home visits (Zimmerman, 2012). Access is understandably limited. Alternatively, it is possible to study a family from within as a participant-observer (Vedder-Weiss, 2017). A participant-observer family member can yield data of a different sort, supported by trust within the relationships, and woven into the culture of family life. I chose to do this study from within, exploring my own identities and their impact on the science learning of one child in the close relationship of my grandparenting. Grandparenting has put me in this position to both observe and participate. I have an emotional and professional interest in this situation of teaching and learning. I had the advantage of access and professional knowledge and the inherent bias, which I discuss further on.

Theoretical consideration from evolutionary biology, CSL, and identity development through family cultural interactions, prepared me to approach Toby as a granddaughter needing and capable of learning early science through the activities necessary for life maintenance. The theories that support storytelling and the function of visual data provided me with methodological approaches to this research.

Context-Setting and Participants

My study with Toby took place at my home and hers. We baked *challah* at my home on Friday mornings for our Sabbath meal in the evening. We worked in my kitchen and our conversations took place in both homes and sometimes outside as we played or walked. Toby is the youngest of three siblings. I began taking data for this study when Toby was three and a half years old and continued until she was six. Her older brother was eleven and a half when this study began. Her older sister was eight and a half. Their mother (my daughter) has a Master’s Degree and my son-in-law is a physician. These children have many advantages and a rich cultural heritage in which they are also immersed. Toby’s parents and Toby herself readily consented to participate in Grandma’s work.

Baking offers opportunities for mentoring, tool using, experimenting, observing, predicting, testing and discussing outcomes (Zubrowski,1981; FastTracKids, 2021). It has a natural payoff of something tasty to eat. For this challah baking book, a babysitter took snapshots. I made notes on paper and my cell phone over two and half years, which I transcribed into a project file. I apprenticed Toby not only in physical baking, but also through early science conversation (wondering out loud, considering alternatives, thinking of explanations). I gave her the opportunity to use the kitchen tools safely and added to her repertoire as she grew. We talked about how their shape and movement helped us. We followed a recipe and instructions. We considered alternatives. We observed. We tested. We also laughed, hugged, and tasted. She learned to take photos as well. We read the photobook together. She took it to her house and shared it with her parents and older siblings. We talked about baking for food and baking as science. When I had a later opportunity to engage her in a furniture kit building processes, she readily agreed and I documented that, mindful that baking might be construed as a "girl" thing and that building-engineering would expose her to other STEM possibilities. I was studying my processes to engage her. By combining our activities with photographs, arranged, and captioned as science storytelling, my goal was to help her develop an image of herself as a welcome and competent partner to me, and generalizable participant in the STEM world.

I have worked with visual data for many years. I include visual data to offer an alternative or supplement to literary data. Photography and drawing have allowed me and others to work with children who cannot yet write (Katz, 2011; Dai, 2017), with groups of people without a common language (Cainey, Humphrey and Bowker, 2017) and with those guided to consider visual data in addition to textual resources (McClafferty & Rennie, 2017; Patrick, 2017; van der Veen, 2017; Wind, 2017). Visual data expands the way in which I can tell the tales of how people learn science outside of schooling. I decided upon the photobook artifact as a central part of my research with Toby for these reasons.

Toby's house and ours are private houses in the Pacific Northwest of the United States less than a mile apart. The homes have many books and toys. Her parents have encouraged their children to be physically active as well as academically successful. They bike, skate, swim, ski, run, and hike. They have learned to maintain their equipment. They take music lessons. In addition to preschool for Toby and public grade schools for her siblings, the children attend a supplementary religious program, where they are learning Jewish history, customs, and Hebrew.

Toby is generally an exuberant, extroverted little girl. As the youngest of my daughter's three children, she watches her siblings and often mimics them, trying out both her sister's and brother's skills and strategies for attention. She has play dates with other children of her parents' friends and those friends she makes herself in preschool. While I have seen her tired and cranky, she is generally cheerful and offers to help out when the opportunity presents itself. She observes details and has a good vocabulary to describe her experiences.

As the auto ethnographer and therefore participant/researcher in this study, my preparation has been multi-faceted. To help establish trustworthiness, I include an overview of my own story to support my position and the authenticity of my work and approach (Guba & Lincoln, 1989). My parents were the children of immigrants. Neither spoke English when they started elementary school, nor were they able to study formally beyond high school because of the Great Depression in the U.S. Even so, they were grateful for Roosevelt's social programs. Their government had been compassionate in their survival. They brought a sense of social responsibility into our home. Although we were not religious, I learned that the values by which we lived were imbedded in our cultural lives. Rabbi Hillel (a first century B.C.E. sage) wrote a succinct, often-quoted guide: "If I am not for myself, who will be for me?; If I am for myself only, what am I? If not now, when?" (Epstein, 1935). My parents, my brother, and I helped family and neighbors, as they helped us. We raised our voices for Civil Rights, Women's Rights, and alternatives to war. Although my father did not have a higher education, he had an eager mind, interested in biology. As a butcher, he brought home lamb, chicken, and calf skulls and would ask me to notice their features and analogous parts. Sometimes, he would ask me to observe or tell me how chicken bones articulated with one another, when they were already on a plate of food. My mother loved reading and writing and took me to the library often. I was the first person in my family to graduate from college. I had a limited vision of what my professional options were. My parents were eager for me to become a teacher, to them a stable and respectable woman's job. I taught in NYC and Washington, D.C. schools for three years. As I taught, I also absorbed the changes of the late 1960s. I was fascinated with the communications research being done with dolphins and chimpanzees. Opportunities were beginning to open up for women. I decided to return to school to take science courses. I was able to work with prairie dogs and bower birds among other projects that taught me science research methods and animal communications. I also learned much more about the academic world when I married a young college professor. He had chosen to teach in an inner city college with a majority Black student enrollment, supporting the changes brought by the civil rights movement. As my science education work evolved, I, too, felt compelled to seek ways to bring the afterschool program I developed to those who might not have had enrichment advantages. We have been fortunate to be able to live our values.

My afterschool science career came about serendipitously. My husband took his first sabbatical in Toronto, Canada. With our three young children, we repeatedly visited the Ontario Science Centre. I learned that there was a field of science teaching that would use my interests, skills, and desire to teach as social change. I came to interpret out-of-school science and "science for all" as one distribution of social power. I saw science as more approachable outside of schools, without tests and as an extension of playful exploration. Out-of-school science had been labelled Informal Science Education (ISE), a term which I grew to view as inadequate as I came to understand its importance. I initiated and oversaw the development of a local afterschool science program that was soon funded by the National Science Foundation to test its portability around the United States. It grew to a presence in 43 states and was contracted by the U.S. Department of Energy and the U.S. Air Force, among others, to provide programming to children/families in their locales. I worked with this program for 25 years. My own children often gave me feedback on activity ideas. As I began to seek answers to what the program was accomplishing, I returned to a nearby university to complete a doctorate in science education research. The program I developed and my subsequent projects have largely involved learning among families. For the program's internal reports, I queried the parents' choice(s) to enroll their children, what interested children and parents, and what their satisfaction was at different ages and topics. External evaluators tackled the children's learning. Among my publications as I studied research, I investigated my oldest grandson's understanding of science, using a photobook (Katz, 2011), and the identity shifts and impact on mothers who chose to lead the groups with us (Katz, 2015). I explored the decisions made by three classroom teachers to take on our afterschool work (Katz, 2016). I led a paper reporting the outcomes of an internship in the afterschool program by teacher candidates (Katz et al., 2013). Both in my dissertation and later research, I have employed visual data. Drawings and photographs work well in a non-academic setting where these data collection methods do not create the tension of testing and evaluation. I edited a book of examples of the use of drawing data in science education (Katz, 2017). I continue to seek out projects where an understanding of science can lead to empowerment. Close to home, I could study how my family opened up the science perspective to empower a girl---one of my granddaughters. My science education work has spanned four decades. I have designed, implemented, and done research on afterschool programming and university teacher preparation that included CSL (Katz, 2007, 2011, 2017). I have found that each of these settings has had elements of identity development through storytelling. For young children, books and reading not only expand the world of stories, but help to build the emotional bond as families pay attention, cuddle, and /or sit together to share selected stories

Method

My dual identities as grandmother and CSL educator are what brought me to this research. I wanted to understand more about how the advantages I had as a family member and the methods I had internalized as a professional were interacting in the practices I employed as a way of knowing to my grandchildren. This meant studying myself and my interactions with them. I chose auto-ethnography as a research method to consider my thinking as part of the family dynamic. I chose to focus on Toby for practical reasons. She was the youngest of the accessible grandchildren. As a female, she might have been subject to societal prejudices about female roles (AAUW, 2015). From my studies, I believed I could be influential in her resisting such pressures. Her siblings were school age and already influenced by several years of formal education, making study outcomes more difficult to separate from formal educational influences.

Dana Vetter-Weiss (2017) recently did thoughtful work using self-ethnography to study science education within her family as they engaged in serendipitous science engagement (SSE). She distinguishes between self-ethnography and auto-ethnography. In self-ethnography, she is researching the cultural context. In auto-ethnography, she says, and I concur, that the researcher is focused on the impact of the self. My study is the latter. I am telling my own story. I have approached our necessary family activities (cooking, prime among them) to apprentice my granddaughter in life skills, explicitly indicating the science in which we are engaged. There is no lesson planning, but there is a structure to the activity. I do modeling, but my granddaughter is free to partner in setting the pace, using the tools, and asking questions at her level of interest. She was young, not yet reading or writing, although an avid listener to books. Toby also likes to scroll through the photos on my cell phone and retell the activities they captured. By documenting her science activity and labeling it as such, I help to create stories that recognize her as a young scientist and welcome her into the community of practice that is everyday science. For these reasons, I chose auto-ethnography to record and consider how I used my education in in this grandparent-child relationship over two and a half years to gain insights into what I do and how Toby responds.

I collected data from June 2017 through early October 2020. I kept notes about my observations and conversations with Toby. I made these notes both on paper and on my phone's note taking app and then transferred these to a Word computer file and kept them chronologically. The photographic data was gathered from several sources. I asked Toby's frequent babysitter to document a challah baking session when I began this research. She used my small Panasonic snapshot camera.

Other photographs of Toby or the two of us were taken by family members who forwarded them to me. I also took many of the photographs over the succeeding two and half years myself with both the camera and my cell phone They were filed electronically by date in a computer file dedicated to this research. I took several videos, which were also filed with the snapshots. My family is accustomed to my taking many photos as the "family historian." Taking snapshots of activities is a frequent activity whenever I am present. It is not unusual for my children and grandchildren to say, "Take my picture," when they are with me and want their activity recorded.

I began making photobooks in 2007 as a way to tell stories of our travels and events. I explored my oldest grandson's understanding of what science meant to him as my first effort to use this medium for science education (Katz, 2011). This grandson is now 19 years old and recently asked me if I would like to go through the book pictures again and see what his notion of science is at this point in his life. We read through the book using Zoom technology and recorded the session. His continued interest in my work and his growth as a "science person" provide me with evidence that an explicit science focus from his youth has remained as part of his identity. This made me even more optimistic about the power of photobook storytelling as a longitudinal memory.

The first baking/science photo documentation with Toby was done June 2, 2017. I asked Toby's babysitter to position herself facing us in the kitchen work area and to take photos as we prepared the challah dough together. I gave her no other instructions. When I viewed the photos, I selected 40 from the 134 images she took. I chose them with three criteria: 1) Storyline, as a visual reminder of her participation in the process; 2) Specific "science person" cues that would identify her as such; 3) Potential for captions and copy that would include questions that would continue to engage Toby in thinking about how things worked. I used these criteria to connect my purpose to the research on stories as identity builders. I wanted to potentially model how my choice of this family activity could be an opportunity to document CSL goals in family life. In our family culture, pinpointing the opportunities for science and mathematics are part of who I am as a grandmother and what I do within the family. For example, when we raise our glasses for a Sabbath toast, the children are encouraged to calculate the number of clinks, dependent on the number of guests at the table. The younger ones observe the older ones and this math game has passed along among the grandchildren now.

The book uses techniques I have learned about asking questions and conversing with young learners (e.g. Valle & Callanan, 2006). When the photobook was produced and first arrived (July 2017) we read it together and I made notes about her comments. I had ordered two copies and left one in our living room. I wanted her to see our pride in her participation and to see if she revisited it. She was eager to take her copy home and show her family a book all about her. The cover of the book (with her name blocked out) is shown below in Figure 1.

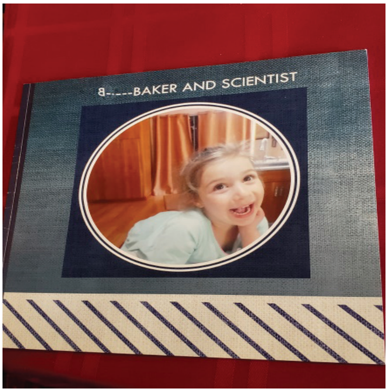


Figure 1. Photobook Cover

This was our first reading and conversation.

Grandma: Do you like the book?

Toby: Yeah, I like the pictures of me.

Grandma: What do the pictures tell us?

Toby: That we were baking and having fun.

Grandma: So, you are a baker?

Toby: Yeah.

Grandma: Are you a scientist?

Toby: Yeah.

Grandma: What is a scientist?

Toby: Ummm. I don't know.

This was interesting. I realized that at almost 4, she had not been exposed enough to the connection between her own science activity and what a working scientist did, even though she had accepted the term "scientist." She had been entranced with episodes of *The Magic School Bus*, (on which I had been an adviser), and she certainly had absorbed Ms. Frizzle's mantra and mine, to enthusiastically "Take chances!" and "Make Mistakes!" but in this first finding, I learned that she did not yet have the concept of a working scientist.

Analysis

Since the baking/science photobook with Toby was a key piece of this research, I planned for input from other science education professionals in considering my own potential bias. I asked two colleagues to review the photobook (separately) and score their thoughts on the match of the photos to the Informal Science Strands described by Bell et al, in 2009 in the U.S. National Research Council's publication, *Learning Science in Informal Environments*. Having designed the research and book, I did not score the picture inclusion myself because I had "spoken" in my initial choices. I provided the photobook and a table asking each colleague to check the presence of these strands for each photo. I left the room and there were no further conversations about the photos or scoring. My colleagues scored their observations of my photo selection by marking the presence or absence of any strand in each photo. Table 1 shows the NRC Strands (Bell et al, 2009) and in the rows below, the number of photographs (from the 40 I chose) that each of the two raters viewed as evidence for each strand.

Table 1. Picture inclusion analyzed by Informal Science Education Strands

There was clear agreement that my photo selection for Strands 1, 3 and 5 were consistent with the goals. As I discussed these ratings with my colleagues, the first rater expressed that Toby was surely participating, but that she did not see evidence that Toby was generating, understanding, and using models in the snapshots---Strand 2. The second rater equated Strand 2 and 5 more closely. Both did not see much or any evidence of reflection on science as a way of knowing and I came to agree with this as I talked to Toby (Strand 4). I found the responses on Strand 6 about identity especially puzzling when I first looked at this data. I came to understand that giving Toby words and pictures to support her "science person" identity was only a beginning, which she herself confirmed as we talked months later. She did volunteer that she recognized herself as part of a generational learning pattern. I had not expected that:

January 2018:

Grandma: How do you feel? Do you like science?

Toby: Yeah.

Grandma: Why do you like it?

Toby: Because it's fun.

Grandma: Do you have any idea what makes it fun?

Toby: Baking. The baking and the measuring makes it fun.

Grandma: So, okay, are you, are you a scientist?

Toby: Ah uh. Not quite yet, but a little bit. I am learning to be a scientist. But, if you teach me lots of science, I'll be able to make that science and teach it to my kids when I grow up.

Grandma: Wow. I didn’t think about that. You think you’ll do the same thing? You’ll teach your kids? Hmm. And then when they grow up….

Toby: They will teach their kids.

The photobook contains both visual and literary data from which I have provided samples below. For consistency, I have used the NRC Informal Science Education strands for the photo/caption analysis (Bell et al., 2009). In Table 2 below, I have analyzed sample images from the photobook with their accompanying captions. The left column has the captioned photo samples. In right column, I analyze the support I have learned to provide as a science educator over many years. I have labeled it ESS (Explicit Science Support). This acronym is also a cultural and somewhat humorous reference. “Ess” in Yiddish, derived from German, is an imperative to eat. Jewish mothers are often pictured as encouraging their children to eat by saying, “Ess, ess mein kind” (eat, eat, my child). In this sense, we encourage our children to be nourished and to thrive. Applied here, I am supporting my granddaughter’s ability to thrive by making science part of her intellectual nourishment.

Because these data follow the NRC strands, they are not chronological to the baking sequence

Table 2. Sample photographic and caption data from the photobook.

1: Experience excitement, interest and motivation to learn about phenomena in the natural and physical world.		
image	**caption/copy**	**explicit science support**
	Wow! In a few minutes, Toby sees foam at the top of the mixture The yeast is good What is the yeast doing? What will it do in the bread mixture? Let’s see…	Selection of kitchen science experience that includes drama, participation, and learning about phenomena within the Jewish cultural framework of preparation for Shabbat.
2: Come to generate, understand, remember and use concepts, explanations, arguments, models and facts related to science.		

	How does the dough feel? We add more flour until it is not very sticky. Making bread is a little different each time because the amount of flour depends on the humidity (wetness) in the air We need to experiment and adjust the amount of flour.	Introduction to baking variables. Multi-sensory opportunity with Toby's participation and input into outcome determination (understanding, explaining conceptual development).
3: Manipulate, test, explore, predict, question, observe and make sense of the natural and physical world.		
	Grandma has a jar of yeast What does the yeast do in a mixture of water, flour, and sugar?	Use kitchen science opportunity to prepare a food that brings science and our culture together in sense-making about the processes that require tool use, prediction, testing, questioning and observation of results.
4: Reflect on science as a way of knowing; on processes, concepts, and institutions of science; and on their own process of learning about phenomena.		
	We are baking in our kitchen to make food The kitchen is also like a scientist's laboratory---we are doing baking chemistry!	Science is a way of developing and using information. Involve Toby in all of it. Age appropriate limits: No institutions here. Little metacognition.
5: Participate in scientific activities and learning practices with others, using scientific language and tools.		

	We measure the warm water. Grandma added enough water to have almost 1 ½ cups. Toby tells Grandma that we need just a little more to be just right on the measuring cup line. Grandma adds the warm water until Toby says, "It's just right."	Bake challah and label it science with me and at other times with others. Learn to use measuring and mixing tools safely and appropriately as part of a caring apprenticeship.
6: Think about themselves as science learners and develop an identity as someone who knows about, uses and sometimes contributes to science."		
	Toby is practicing science She is a kitchen chemist. She is measuring, mixing, observing, and figuring things out Toby likes to be a baker and a little scientist with Grandma It is fun!	Be explicit about the partnership in learning science and label it as such. Reinforce emotional component of trust, learning, and identity development.

I had tried to tie science and baking together. What I learned as we continued was that I had not considered that my young granddaughter was directly equating baking and science and had not yet developed a more generalized concept of what it was to be a scientist as an adult. I had made assumptions and had to reconsider these. Not much later, at her house, Toby's brother proudly wanted to show me that Toby was learning about science from me. Below is their brief exchange.
March, 2018:

Brother: Are you a scientist, Toby?

Toby: Yeah.

Brother: Why do you think that you are a scientist?

Toby: Because Grandma says so. She wrote a book about me.

This exchange confirmed that Toby trusted my efforts and judgement and that the book was influential. However, as I interpreted this exchange, I wanted to adapt to broadening Toby's opportunities to expand her everyday science experiences beyond the kitchen for her science person identity. I invited her to play with games and puzzles that employed manipulative and reasoning skills. She liked the simple game of pick-up sticks. It requires strategy and small muscle control. I asked her to assist in building a gate-leg table from a furniture kit. I photo documented this process and made another photobook. In that photobook, I talked about Toby's construction and engineering skills. In 2020, reviewing these data, I again wanted to query her, especially about her conception of science. She had said, "if you teach me lots of science, I'll be able to make that science and…." (2017). Was science still the same to her as making/baking bread or had she developed a generalized approach to learning about the world? Along with my activities, she had preschool experience by this time.

October 2020

I hoped to gain additional insights through another conversation with Toby shortly after her sixth birthday. I was aware that she liked to please me and so I asked my husband if he would visit her at her house and talk with her once again about her views of science and her identity. This was recorded and I transcribed it.

Grandfather (G): Can you tell me…what does the word science mean to you now?

Toby: Practice.

G: What?

Toby: I said, practice and possibilities and things that people haven't discovered before.

G: What kinds of things?

Toby: Probably, like, the first person that discovered crystals.

G: Crystals Is that a scientist?

Toby: Probably, or, like, uh, things that you do, like you do it and you memorize it so you know how to do it.

G: What do you memorize?

Toby: I memorize the book with pictures in it.

G: Yeah, you did. So, where do you learn about science?

Toby: At Grandma's house[Laughs].

G: At Grandma's house? Is that the only place you learn science?

Toby: No, I learn at home. I bake with my mom, of course.

G: Well, who can do science?

Toby: Grandma.

G: Is that the only person who can do science? Grandma?

Toby: No. You and mom and probably Dad. And probably my brother and sister and probably some of our neighbors.

G: Well, can you do science?

Toby: A-uh. Well, I can do science a little bit.

G: What kinds of things can you do?

Toby: Baking…..and learning…..and discovering…..

G: What kinds of things do you discover? Have you discovered something?

Toby: Laughs.

G: What kinds of things do you discover?

Toby: I discovered a bottle, a glass bottle (moves hands in bottle shape) that was this tall. It was sea glass. It was …throwed back in the ocean.

G: So what is sea glass?

Toby: It's a kind of glass. It's from the sea. Someone has dropped it into the sea.

G: What does the sea do---anything?

Toby: When it got spiked in, it makes it, um, it makes it not as sharp. The edges not as sharp, like they would be.

G: How does the sea do that?

Toby: I don't know

G: What do you think?

Toby: It scrapes on the sand on the bottom of the ground and it's full of crabs with their claws.

G: Crabs, oh.

Toby: And they step on the bottom of the ground.

Vic: That's an idea.

Toby: And they go splash and splash and the hard waves go "wheek, wheek."

G: Anyway, so what do you like about science?

Toby: Oh, it's fun. And it's learning and discovery.

G: You like to discover things?

Toby: (Nods yes).

G: Is there anything you don't like about science?

Toby: (Nods "no"). Science is fun.

At six years old, Toby still considers baking a key science experience with me. We continued to make challah frequently, so it is a well repeated memory. She indicates that others who bake are also doing science. Toby has developed a view of science that includes general learning and discovery. She uses an example she provides outside our relationship and experiences together. She had found sea glass along the beach. When probed, she readily says that she does not know how sea glass is smoothed, but she is also willing to put forth a reasoned explanation. She has confidence with both answers. There was no shame in not knowing. There was a willingness to draw from her situational observations and venture a proposal. Toby's identity as a participant includes a wider swath of activities and in this way, I see her as a young girl confident in her everyday science participation.

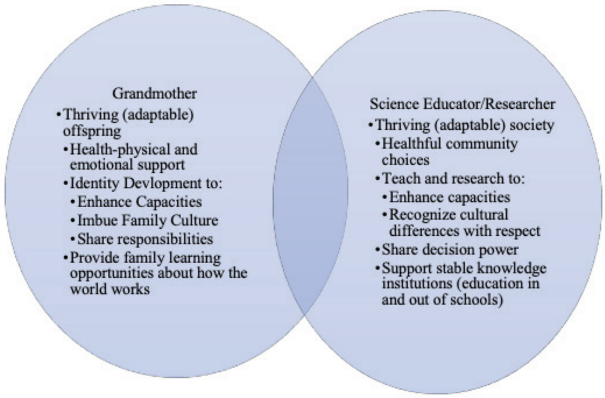
Findings

My first research question asks how my two identities of grandmother and science educator overlap. My biological instincts to nurture my granddaughter were evident in the time, attention, and affection I gave her with a welcome into a "science person" identity through an apprenticeship in challah baking within our culture and early science support that I had learned through my own education. What did I do as a trained science educator in this featured challah baking activity? I referred to years of reading science education research and viewed the data through the lens of the National Academy of Sciences report on Learning in Informal Environments, including the home (Bell et al., 2009). I asked Toby to notice things (example: what happens to yeast when mixed with water and sugar?). I apprenticed her in the use of tools (example: measuring spoons and cups, mixer). I asked her to consider alternatives (example: changing amounts of sugar or flour). I asked her to describe what she was observing (example: stickiness of dough). I asked her to solve problems (example: What can we do if the dough is too sticky?). I welcomed her into the community of practice of everyday science by respecting her answers to questions and referring to her as a young scientist. I offered her messy fun in the baking process and excitement with the finished bread. I connected science learning through a trusted relationship and warmth. In these ways, Toby was exposed to all six strands described by the NRC publication during the challah baking activity that I documented. Although we did talk about science as testing and organizing our tasks, I did not converse with Toby about her own metacognition or science institutions. These were not age appropriate concepts to me. I also concluded that professional science work was a concept that would come along as her life experience broadened. Toby sees me as her grandmother and science person in her partnership with me. She accepted my designation of her as a young science person. The photobook was an artifact that told Toby's story as a "baker and scientist." It was available for voluntary reading. I cannot report all instances of "reading" (or being read to) because one copy was at her home and I did not have access to information on all readings (parent, sibling, babysitters), or her own picture viewing. At my home, she picked up the book to ask for a reading, or flipped through it more frequently when it was first printed and less so as time went on, but it was referred to at times throughout the two and a half years of the study.

Toby was clear that at 3½, she knew she was able to bake. But when I probed for her understanding of whether she was a scientist, she had said, "I am learning.." This gave me the opportunity to think about how the science in our activities could be made more explicit. I would say, "This is science because we are testing the yeast (proofing)," or "this is science because we are considering the variable of humidity--the moisture in the air."

My analysis is an example of the balance of nature/nurture arguments. Evolutionary biologists, notably, Richard Dawkins, have proposed that life continues through "selfish genes" that control their own self-perpetuation by directing the body that hosts them (Dawkins, 1976). Considering this theory, I should be compelled to care about my granddaughter's optimal chances for survival and science participation as a mechanism to do that. As well, the work of Etienne Wenger (1998) and Barbara Rogoff (2003) speak to how we nurture our need to learn (and survive) during our lives by participating in communities of practice that afford (or channel) our opportunities for learning. As a science educator and researcher, these theories have guided me. I have learned to provide opportunities for "science for all" within the social context that is the fiber of society supporting all individuals. My education then, prepared me to see science as a useful thinking tool. My family culture helped me to choose further education and a career that could enhance the lives of others in our mutual home on earth and for personal satisfaction. This Venn diagram in Figure 2 visualizes the overlap of dual roles:

Figure 2. The Overlap of Grandmother and Science Educator Roles



My second research question asks how I employ these dual roles. My data provide evidence that my grandparent relationship---in which I have helped to nurture this grandchild, and my career---thinking and acting so that other children/families can use the benefit of science education research, are intertwined. Both relationships share the limiting (and enabling) factors of our planet and its resources. For myself, my family behaviors (enacted in my cultural context) and my professional behaviors (an education over decades) support each other. Biology theories have informed me that to survive as social animals, we must meet individual needs and group needs. Science education is to me an essential enterprise then, on both a personal and professional level. In each case, I have been engaged in supporting the activities and the welcome to become "science people."

I posed my third question to ask how this piece of research might be not only relevant, but enacted within other families. A Pew Research study posted in April 2021 reported that 97% of the U.S. population uses a cell phone (Mobile Fact Sheet, 2021). Globally, two-thirds of the world's population have unique mobile phones (Digital Around the World, 2021). Photographs are freely being shared on social media platforms such as Facebook, Instagram, and share sites, such as Cluster.com or Shutterfly.com. Utilizing this existing photo sharing trend, I have given some thought as to how it might be possible to inspire families to support their children as STEM participants, through photo storytelling, picturing themselves as continual science learners. Not all families have access to photobook technology or want to budget for photobook purchases. There are other options. For example, bloomlibrary.org allows anyone with a computer and printer to produce their own books. Perhaps, my enjoyment of physical books is a 20th century relic to young families today. Perhaps they will derive benefits from the storytelling experience in digital form alone, reliving and talking among themselves simply by looking at their snapshots with science in mind. It is the professional challenge of science educators to be activists in suggesting ways to put science in mind through prompts and encouragement. I think of cereal boxes, milk cartons, and other places where I have seen educational games featured. Where are people already gathering in their communities to share their stories? What partnerships might be created with CSL institutions for website space or signage? These are certainly topics for further research, as is further family photography and the science identity storytelling process.

Limitations

I cannot claim that my influence has been the only source of my young granddaughter's comfort and eagerness to engage in science. Her parents, her siblings, and their way of living provide her with many ways in which to learn about the world and her agency in it. There is also the process of normal maturation and with it, changes in understanding. In this case study, there could not be a control to test whether Toby would express her understanding and interest with or without my apprenticeship. This is an advantaged situation in which my professional life and personal life coincided to provide my granddaughter with support for early science identity development. It is a study that is limited, as all case studies are, to one example, with the expectation that families have basic needs in common, and that the findings in this study may be replicable.

Conclusion: Summary and Active Advocacy (implications)

By focusing on myself, I was able to examine how I apprenticed Toby. I gave her attention. I used our existing emotional bond and the trust that she had with me to actively engage her in baking challah as a cultural activity that could be approached with its science content. I indicated how we could do baking science together and explicitly, how that made her a young scientist as my partner. I watched her mirror my enjoyment of science and the techniques I used. I documented her participation to tell the story of her experience, reading and repeating the story, and I listened as she adopted it as hers. I adapted to her readiness, praising her growth as she took on measuring and mixing by herself. She declared she was a young scientist because I had addressed her that way, clear evidence that I had some impact on her identity development.

Basic biological theories had predicted that I would want to pass on my useful survival skills and part of that was my strong emotional interest in doing so. I employed recommended science education techniques. When I looked at my purposes both as a grandmother and a science educator, they were similar and differed by scale---personal and societal. I recognize that learning is cumulative and occurs constantly (Dierking & Tal, 2014). My activity with Toby was clearly not a school requirement. It was not an exhibit, demo, or museum class. It was not serendipitous learning that happened as a child played (Vetter-Weiss, 2017). It was a science education opportunity that presented itself to me in our daily living. Such opportunities are recognized in professional discussions of science opportunities for parents/families (NSTA, 2009, 2014). This research is an insider's view of what can happen in a family setting, taking advantage of existing activities imbedded in a family's culture and explicit conversation about science. Reading and photography are widespread pastimes in many homes and I brought them together in my efforts. In this case, my granddaughter is growing up as a welcome member of the everyday STEM community as part her identity. Most families do not have professional science educators. However they do have the same biological drives and concerns that I have about continuity and success of their children. They talk. They take photos and they relive their big and small adventures within their cultures.

The value of this case study is that it afforded a close and prolonged look in one setting. From this vantage point, it is possible to consider what is unique and what is worth investigating among a larger number of cases. I have provided evidence that my granddaughter is developing an everyday science identity partly through her apprenticeship with me in our family's cultural activities and rhythms. The processes I used to encourage science identity building with Toby were: 1) trusting apprenticeship 2) explicit science identity building 3) photo documentation 4) repeated storytelling, aided by photo elicitation. That she has had these advantages with a science education researcher grandparent presents me with a challenge in my professional life. Storytelling around family necessities contains science involvement in every culture. How can I link photography, in which many families are already engaged, to familiar and comfortable cultural activities that are science rich and are already part of their identities?

The photobook component has the advantage of being an artifact for revisiting a particular story. But the storytelling process is likely valuable without the expense. Further research within more and varied families is needed to compare my experience. I performed this research as a grandparent. Would parents and other family members take the time to document their stories through a science education lens? What support do non-science educators need to prompt the telling of stories about everyday science learning as they go about their lives? I see the challenge as two-fold. The first is an awareness campaign to highlight that families are already engaged in everyday science. The second is the process of science identity photo storytelling as an activity.

Perhaps by providing inspiration and guidance in photo documentation, photo elicitation and reading about the science already in their homes, this research can be turned to practice where the roots of attitude and interest develop---in the home. While it is more difficult to access and negotiate the home setting, I want to make a greater effort. In the U.S. there are many experts in marketing products. We see advertisements on every surface (buses, billboards, t-shirts, and social media). I suggest here that utilizing an activity (taking family photos of science activity) and telling ourselves identity stories is something that families are already engaged in, and with marketing, could be a way to honor and encourage science recognition within differing family cultures. At what age might children create their own auto-ethnographies of themselves as science participants? Much of this further research is dependent on engaging families from varied cultures. Forming collaborations with marketing entities that have co-interests in reaching families is a first step. Perhaps breakfast cereal producers, who aim at family markets and some of whom print games and facts on their packaging, would be a first possibility. Let us literally think outside the box in our need to take a more active approach to our knowledge sharing for all of our sakes. I invite conversation and action among my colleagues here and in other places around the globe.

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