# Scratch ♥ Memories

**Visualizations that empower children to celebrate and reflect on their creative trajectories**

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*September 2018*

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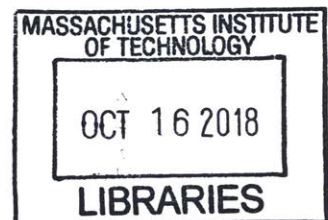Program in Media Arts and Sciences
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# Abstract

Millions of young people around the world are increasingly engaging on digital platforms in learning computer programming to create and share interactive projects, and connect with others online. Not surprisingly, this has also led to a growing interest in designing tools and methods that can automatically assess children's progress in computational learning by analyzing the data being generated by their participation. Many of these approaches are looking at children's data with a narrow lens, often using it to generate dashboards that are primarily designed for educators, and focus exclusively on evaluating specific computational concepts in children's projects. In this thesis, I design and offer an alternative approach — one that utilizes children's data for empowering children themselves to *celebrate*, *discover*, and *reflect* on the full range of their contributions as members of a creative community.

I introduce *Scratch Memories*, a new web-based visualization system I developed to enable children to reflect on their creative journey with Scratch, the world's largest online programming community for children. The system dynamically generates personalized visualizations highlighting a child's key moments, diverse creations, and collaborative experiences with others since the time they first joined the community. I share my own creative journey and the iterative development process behind this work. Based on observations and semi-structured interviews, I describe how the system not only sparked children to reflect on their personal trajectories, but also to feel inspired to make new *memories*. I conclude by describing future work through what I call my *explorable explorations* — a set of new in-progress tools and ideas that I hope can inspire others to create positive reflective experiences with data that *celebrate, rather than evaluate, children's creative selves.*

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# Acknowledgments

I have a hundred words
a hundred emotions
a hundred thoughts
a hundred ways I want to say
thank you

a hundred always a hundred ways
you have inspired me
a hundred ways you have
helped me learn and grow
a hundred times
you have heard me
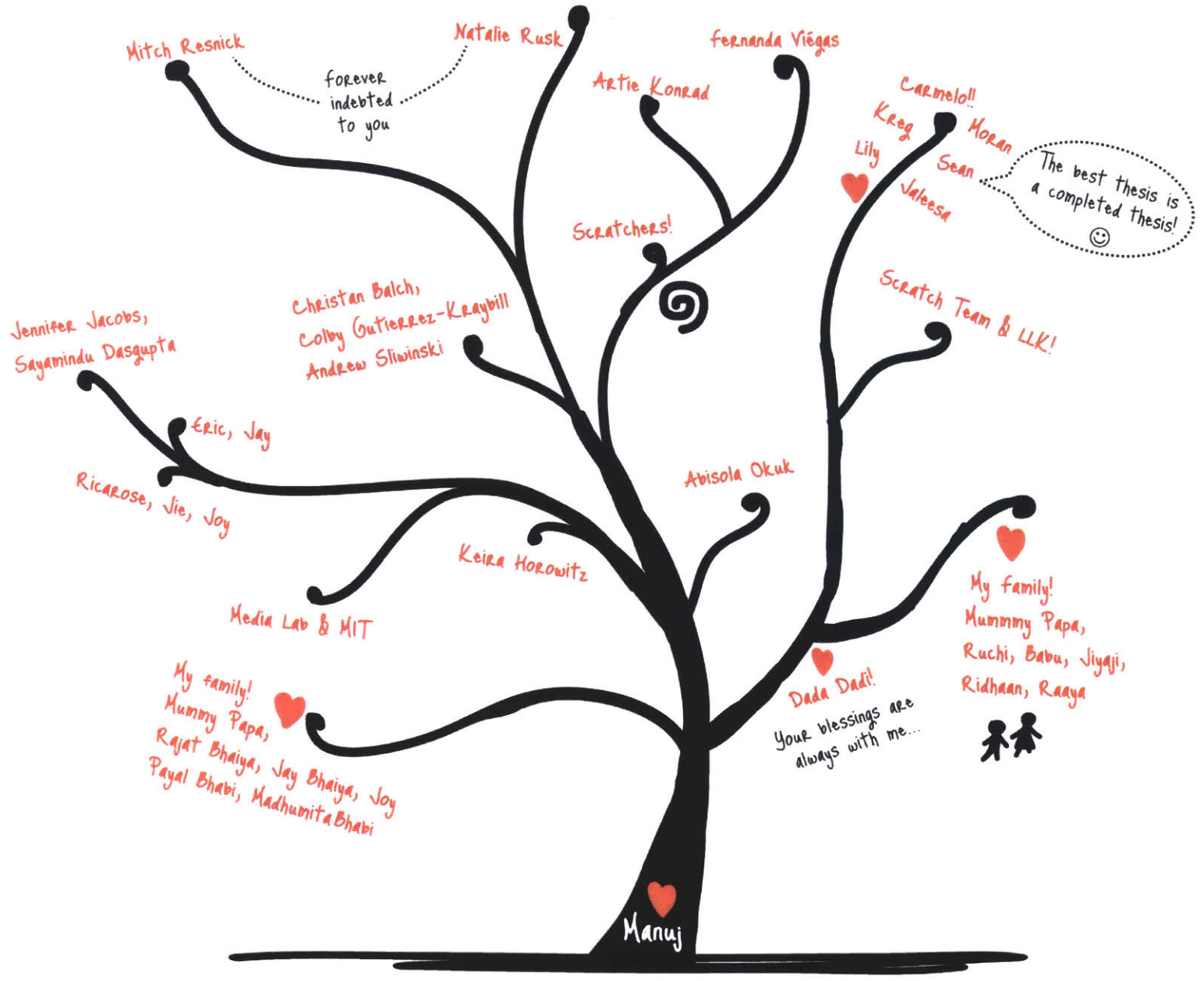a hundred ways
you have supported me

a hundred smiles
we have shared together
a hundred troubles
we passed together
a hundred ways you
have loved me
a hundred ways you
have blessed me
a hundred ways you
have taught me
a hundred ways you
have been there for me

a hundred always
a hundred ways I want to say
**thank you**

# Spiral of Contents

This thesis is a celebration and reflection of my own creative journey of thinking, designing, and studying new ways of empowering children to celebrate and reflect on their creative journeys. Like any journey, mine is also not linear, or structured, or perfect, or over. To represent the iterative process behind this work, I therefore decided to structure this thesis with the help of the *creative learning spiral* [26](Figure 1), the kindergarten approach to learning designed by Mitch Resnick.

It starts with imagining new ideas; then creating something based on those ideas; then playing and experimenting with the creation; then sharing and collaborating with others; then stepping back to reflect upon it; and through that reflection, starting to imagine again [30]. I use each of the stages as a lens to highlight different aspects of my work (and my journey). I end with the beginning of another spiral that describes how I continue to *imagine* and design new types of personally meaningful visualization tools for children to reflect on their learning trajectories. I call these new tools-in-progress, *explorable explorations*, because they are more than ideas on paper, but less than fully developed tools, they are *explorations* that are designed to be *explorable* by children.
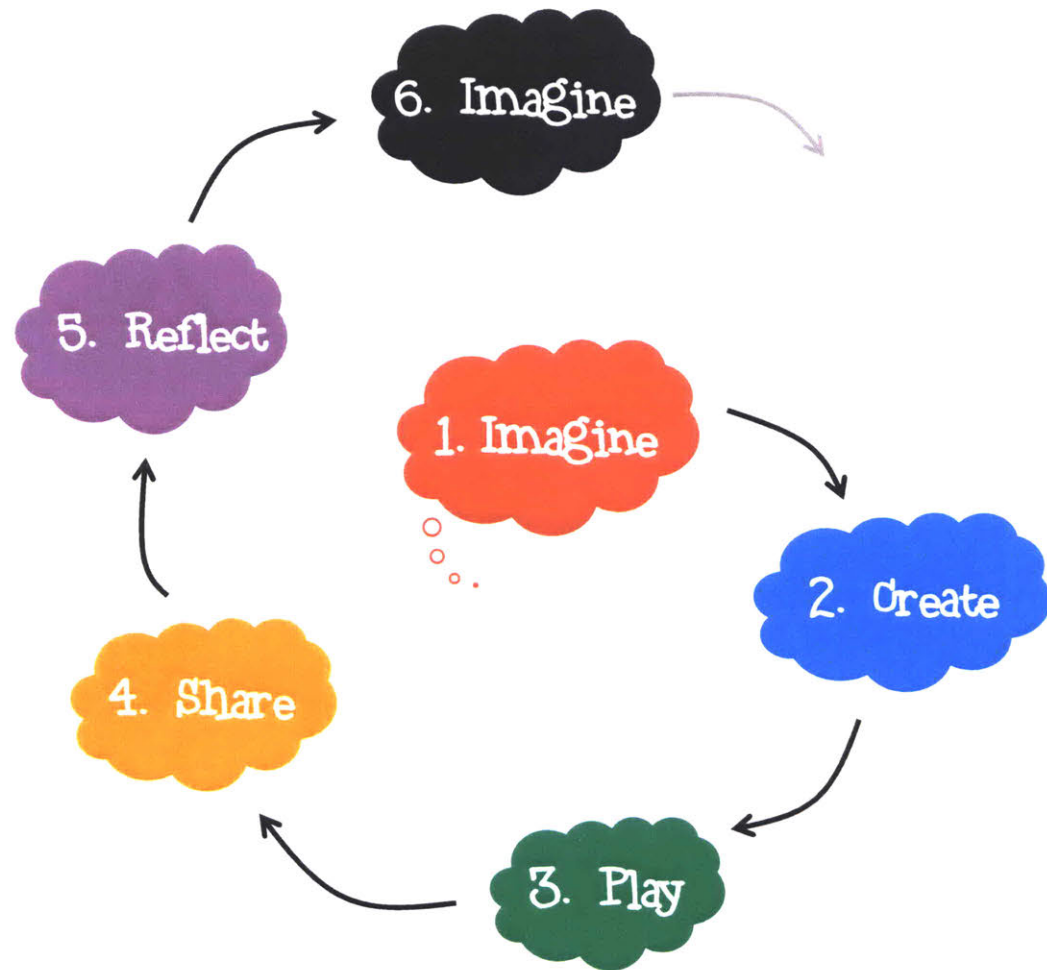
Figure 1: Creative Learning Spiral by Mitch Resnick
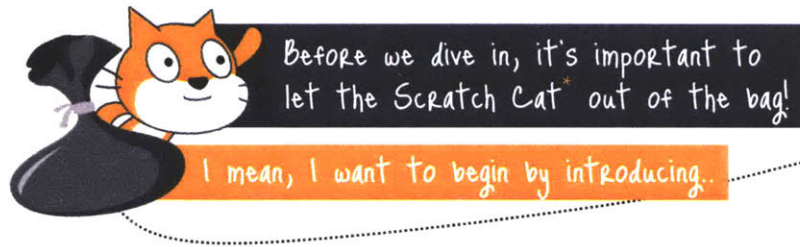
**NOTE**: For simplicity, I have tried to divide my work to fit in different stages of the spiral, but in reality, *imagining*, *creating*, *playing*, *sharing*, and *reflecting* are mixed together in many different ways.

# "The medium is the message"

*- Marshall McLuhan*

You would have noticed by now that this thesis diverges from the standard thesis writing formats and specifications. It is colorful. It's also in landscape format, reading more like a coffee table book than an academic document. Even the table of contents is called the *spiral* of contents! Similar to a coffee table book, my goal with this thesis is to share the tools and ideas I developed **not** as finished research but more as instances that can spark conversations, shift perspectives, and open up new possibilities. The format however does not imply that the exercise has not been a serious research endeavor. Rather, how Seymour Papert talked about his writing style in the book, *The Children's Machine* [25], it is the case of *making the medium the message* [20].

An underlying theme of my message is that every young person's creative journey is unique — their ideas, interests, and inspirations, their learning choices and styles, their friends and collaborators, and a range of other experiences that constitute their personal learning trajectory. This thesis is about empowering children to celebrate and reflect on their own trajectories, and thus focuses on the design of tools and experiences that are most importantly, **personally meaningful** for children. Writing, or rather designing my thesis in a form that is *personally meaningful* for me, empowers me to both reinforce the central idea, as well as show in my own little ways, how it is possible to tinker with something that is often assumed untinkerable. In doing so, I hope that *the medium influences how the message is perceived.*

Before we dive in, it's important to let the Scratch Cat* out of the bag!

I mean, I want to begin by introducing..

..what is SCRATCH

## The Platform

I start by introducing Scratch, not only because it of course forms the title of this thesis, but more imporantly, because it is a platform that is empowering millions of children around the world to express themselves creatively with new technologies, and I truly want everybody in the world to know about Scratch, that is, if they don't yet! Scratch (Figure 2) is a free visual computer programming language and the world's largest coding platform for children [29]. Young people around the world use its inviting



Figure 2: Scratch website (scratch.mit.edu)

programming interface made of blocks that snap together like LEGO bricks, to create their own interactive projects, such as games, stories, animations, art, and anything else they imagine, and then share their creations with one another in the Scratch online community [33]. As of August 2018, the community has more than 29 million registered users from all around the world and more than 33 million shared projects. While Scratch is designed especially for ages 8 to 16, it is used by people of all ages, including younger children with their parents. Scratch is used in a wide variety of settings, including homes, schools, museums, libraries, and community centers.
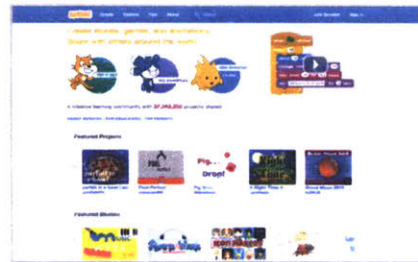
## The Powerful Ideas

I explored Scratch for the first time four years ago with my cousin brother's 7-year-old daughter, *Tavishi*, in New Delhi, India. Within few minutes, I watched my niece snap code blocks together to create a wonderful interactive card for her mother by following one of the online tutorials. I was blown away, and so was her mom. I couldn't believe that at the age of 7, she was able to make sense of complex computational concepts, such as conditionals and loops, which I had explored only when I got to high school! And more importantly, she was so engaged in the process, tinkering and experimenting with new ideas, and felt so proud of what she had created. This was a powerful moment for me, and although at the time I didn't know about Papert's *powerful ideas* [23], I knew I had experienced them in those few minutes, and I knew my niece had too. Fast forward to today, I have come to deeply appreciate the ideas, values, and the four guiding principles behind Scratch called the 4Ps of creative learning — *projects*, *passion*, *peers*, and *play* [27]. Every day Scratch helps thousands of children like *Tavishi* engage with powerful ideas in a safe and inspiring environment where they can work on projects, based on their passions, in collaboration with peers, with a playful spirit. The 4Ps have thus also served as my guiding principles as I set out to design reflection tools that can reveal to children their unique creative trajectories on Scratch capturing not just their projects, but also their passions, peers, and their playful spirit.

Keeping this powerful context and the powerful ideas as the backdrop of this thesis, I now invite you to unpack my spiral, one phase at a time. Consider this document as also my personal invitation to you to share your comments, feedback, or critique, to collaborate with me, or if you like, to remix the tools or ideas I present in ways that you find personally meaningful and in the contexts that you find powerful.

**Please access the current version of this thesis at:**
https://shrutidhariwal.github.io/mas_thesis

**Note**: Wherever necessary, identifying information in this document, including names of interview participants, Scratch usernames, and titles and screenshots of specific Scratch projects have been changed to preserve anonymity.

# 1. Imagine

In this first phase of my spiral, I share what led me to imagine the new ideas presented in this work. I talk about my personal motivations, the pedagogical foundations, and the thoughtful research by others that my work builds upon. I describe the current approaches that I contrast my work with as well as highlight the connections I discovered with work done in contexts outside of learning in the area of data visualization, memories, and storytelling that served as inspirations for my own work. Finally, I conclude this section by introducing my own approach towards using data to design delightful and personally meaningful reflective experiences in the context of creative online communities for children.

# 1.1 Motivations

I wonder if you wondered about the heart (♥) in the title of this thesis. Like all other small design choices so far, this too is intentional. The heart represents what I consider as one of my key motivations behind this work. I have been inspired by the use of the word *love* by Seymour Papert in several of his seminal works [23][25][24]:

"

I fell in love with the gears.

- Mindstorms

"

Closely related to appropriation is another word, love. Einstein said, "Love is a better master than duty."... So you can get 100 times more mileage by creating those conditions in which the children will appropriate knowledge by falling in love with it.

- A Critique of Technocentricism in Thinking About the School of the Future

"

If you love what you learn, you'll get to love yourself more. And that has to be the goal of education, that each individual will come out with a sense of personal self-respect, empowerment, and love for oneself, because from that grow all the other loves - for people, for knowledge, for the society in which you live.

"

I fell in love with my newspapering (as I did with mathematics and other areas of knowledge) for reasons that are as personal and in a sense as unreproducible as those that determine any kind of falling in love.

- The Children's Machine

Why do Scratchers love Scratch?
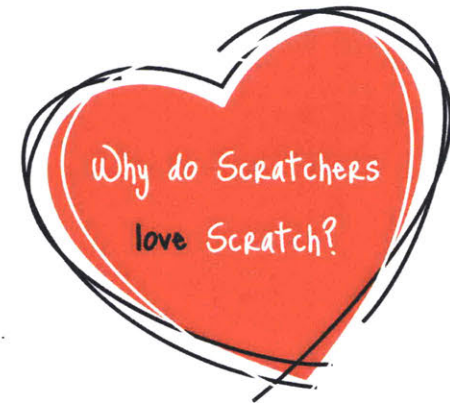
Interestingly, there is another place where the use of the word *love* inspires me in a similar and profound way. This time, it appears within thousands of diverse projects created and shared by young people in the Scratch Online Community (a.k.a Scratchers) expressing in their own ways why they *love* Scratch. I share some examples in Figure 3.
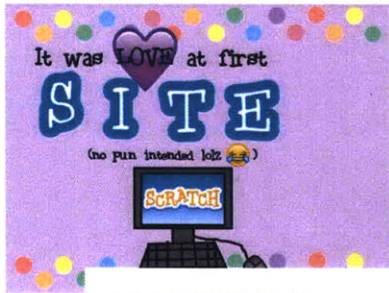
## #1 FRIENDS

One reason I love Scratch is that you can have really close 'Friends'. Like me and @Angelblade. who I have never met before. He (she?) is always contacting me and we are collabing on Scratch-Feed. Another thing is you can Scratch WITH friends. like me and @RiseRover. we're friends in real life. but Scratch has brought us together.
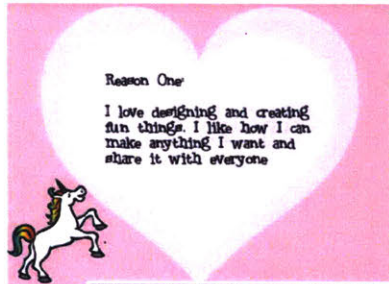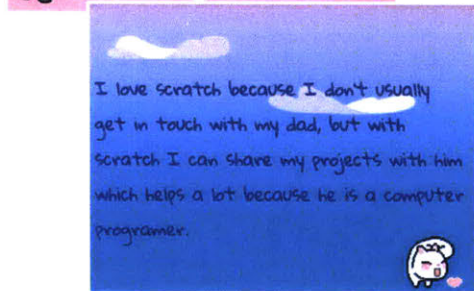


Reason One:

I love designing and creating fun things. I like how I can make anything I want and share it with everyone



I love scratch because I don't usually get in touch with my dad, but with scratch I can share my projects with him which helps a lot because he is a computer programer.

Figure 3: Screenshots of Scratch Projects made by Scratchers: @cooljewels, @I-Am-Unicorn, @glittercodes14, and @cat_lover12 (from top to bottom)

"

*This is something that cannot be reduced to purely "cognitive" terms.*

"

I couldn't stop myself from watching and interacting with hundreds of these personal Scratch projects created by old and new members of the community. It actually inspired me to curate a few of these in the form of a new book I designed called, *Why do Scratchers Scratch?* (Figure 4). If you are curious, you can see these projects here: https://scratch.mit.edu/studios/4942203/



Figure 4: Why do Scratchers Scratch book

But most importantly, in looking closely at these colorful and personal stories shared by children, I realized that what Seymour said about his love for gears holds true for the journey that Scratchers experience as members of this creative learning community.

**Note**: The original research and initiative inviting Scratchers to create projects on the prompt, 'Why I Scratch' was led by (the amazing) Natalie Rusk from the Scratch team [35]. Even though the prompt was posted several years ago, children continue to share projects every year expressing their *love* for Scratch.

*So what does a young person's creative journey on Scratch look like?*

As young people create and share projects on Scratch, they are not just learning computational concepts and techniques, but also expressing their interests, stories, and values with technology. They are engaging in meaningful interactions with others around the world, getting inspired by each other's creations, expressing their appreciation and feedback on other people's projects, and building on each other's ideas. All of these diverse creative and collaborative experiences contribute to their personal growth and identity, both online and offline.
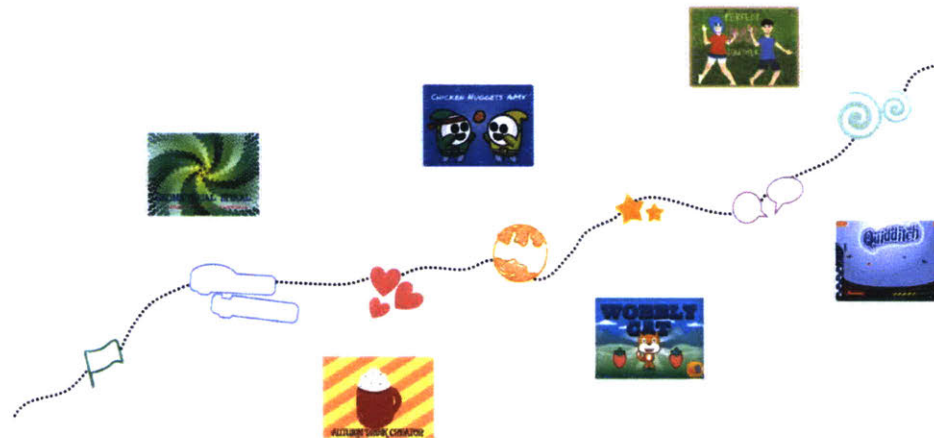
*But...often children's learning experiences are viewed with a very narrow lens.*

Existing tools for visualizing children's progress in computational learning tend to overlook and undervalue the rich creative and social-emotional [14] aspects of children's trajectories, and instead, focus exclusively on evaluating the computational complexity of their individual projects in isolation. Moreover, these tools are primarily designed only for educators, and not for learners themselves.

Project 1    Project 2    Project 3    Project 4

16
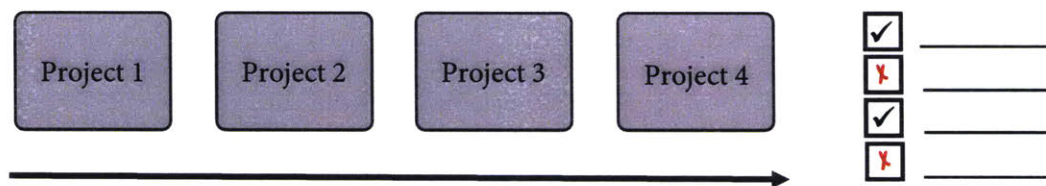
In this thesis, I use the rich context of Scratch to present an alternative lens towards looking at children's learning pathways within creative online communities. I share my approach towards using children's data to develop new visualization tools that can reveal and celebrate the full range of children's contributions, and are designed to engage children in personally meaningful reflective experiences about their journey.

My personal motivations behind this work stem from discovering and resonating deeply with the love that underlies children's creative trajectories on Scratch. I underscore these three words because they represent the three core strands of my work. I introduce these below briefly, but they would continue to appear in different ways at different stages of this thesis.

1) *Love:* As is evident through Papert's quotes mentioned earlier, the idea of putting *love* and *learning* together is by no means a new idea. What I see as one of the bigger (or I should say, small) contributions of my work is therefore not this idea itself, but my attempt at *concretizing* it by designing *Scratch Memories* as a tool that makes what children *love* about their own learning experiences visible. This far extends beyond just the coding concepts they

learn and includes their unique ideas, inspirations, creations, collaborations, and the meaningful connections they make with others along the way [6]. At a time when there is an ever-growing interest in introducing and teaching computational thinking and coding to all children, I hope that my approach towards visualizing children's trajectories in more holistic and personal ways can help broaden perspectives and inspire others to design experiences that along with the cognitive value the affective aspects of children's learning too.

2) *Children:* In the context of digital learning platforms, the data that is generated by children's participation is often used only to design dashboards that can be used by adults (educators, designers, or policymakers) for evaluating children's progress based on the criteria that they determine to be valuable. I imagine a different approach — *Scratch Memories* has been developed keeping children at the center of the experience. Every small design decision I made is based on finding, respecting, and *valuing what children value*. Through my work, I try to make a call for being more *careful*, *caring*, and *creative* towards making reflection tools that are especially *appropriable* [24] by children; that children can resonate and engage with,

both at the aesthetic and emotional level; that can empower children to make sense of their own learning; and that can motivate children to explore new possibilities for themselves.

3) *Trajectories:* The word *trajectory* forms a very significant part of my work and research. It also serves as one of the key differentiators between *Scratch Memories* and other related approaches towards designing for reflection. In learning contexts, reflection is often seen as going hand-in-hand with the immediate activity or the project learners are engaged in. In other cases, learners are encouraged to reflect on a project after they have created it. While I completely support these approaches as valuable ways of engaging children in reflection, I explore an alternate view, one that enables children to reflect not just on a single project in the short term, but their rich and complex learning trajectories over time. With *Scratch Memories*, I thus present an approach towards discovering children's trajectories in data, and revealing them to children so they can *reflect on themselves* through the lens of their own creative journey.

I will explore these strands more deeply as we dive further into the spiral!

## 1.2 Foundations

I begin this section with a story [28] shared by Mitch Resnick that had really touched me, and I find myself resonating with it even more as I am writing this thesis. Here it goes:

*"A few years ago, I made a presentation about my research at an educational technology conference. In the Q&A that followed my talk, someone asked, rather aggressively: "Wasn't Seymour Papert trying to do the same things 20 years ago?" The comment was meant as a critique; I took it as a compliment. I answered simply: "Yes." Indeed, almost all of my work is directly inspired by Seymour's ideas, and I have no shame about that, only pride. I fell in love with Seymour's ideas more than 30 years ago, and I never fell out of love with them. I continue to feel that Seymour's ideas provide a vision for the type of society that I want to live in. I will be happy to spend the rest of my life working to nurture the seeds that Seymour sowed - and I hope others will too."*
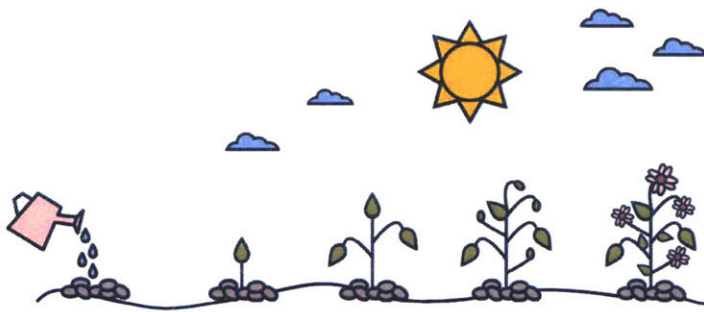
I bring this up because I too want to happily and proudly acknowledge that the foundations of all the little/big contributions of my work lie in both Papert's powerful ideas and Resnick's (and the entire Scratch team's) powerful approach towards making it possible for millions around the world to experience and engage with these ideas. Even at the risk of sounding repetitive or redundant, I choose to reiterate some of these ideas because firstly, I believe the contributions of this thesis can be better understood if one can appreciate the pedagogical foundations and the empirical context it is situated in; and secondly, because I have come to experience through my work that it's important to look back to look forward. I also recognize that ideas have their own creative trajectory, and therefore through Papert's and Resnick's ideas, I am also building upon the work of several learning philosophers who inspired them. I mention this because even though I might not be able to cite all the people whose work and ideas resonate deeply with my research, I want to explicitly acknowledge the contributions of everyone (in the past or present) who has or is working towards similar ideas. In one way or the other, I have been influenced and inspired by them.

I have intentionally chosen to highlight some of the foundations of my work in the form of these *windows to wonderful ideas* [11]. I do so because I honestly don't believe that I can or want to summarize these ideas in a way that feels 'sufficient' or 'clear' enough to not require further thinking. I rather hope that these glimpses will spark others — just as they sparked me — to open the *windows* wider and probe deeper into the powerful ideas they reveal around learning, thinking, creativity, reflection, emotions, communities, making, sharing, documenting, and at the heart of them all, children (1 [12], 2 [7], 3 [16], 4 [4], 5 [2], 6 [32]).

## The Hundred Languages by Loris Malaguzzi (Reggio Emilia Approach (1))

The child has
a hundred languages
a hundred hands
a hundred thoughts
a hundred ways of thinking
of playing, of speaking.

a hundred always a hundred ways
of listening, of marveling, of loving
a hundred joys
for singing and understanding
a hundred worlds to discover
a hundred worlds to invent
a hundred worlds to dream.

## Four P's of Creative Learning (Guiding principles of Scratch)
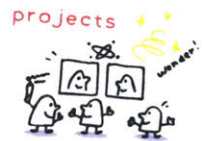
projects

People learn best when they are actively working on meaningful projects – generating new ideas, designing prototypes, refining iteratively.

passion

Learning flourishes as a social activity, with people sharing ideas, collaborating on projects, and building on one another's work.

peers

When people work on projects they care about, they work longer and harder, persist in the face of challenges, and learn more in the process.
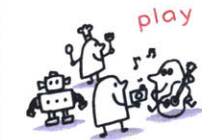
play

Learning involves playful experimentation – trying new things, tinkering with materials, testing boundaries, taking risks, iterating again and again.

## Resnick on why coding for children

Becoming fluent, whether with writing or coding, helps you develop your *thinking*, develop your *voice*, and develop your *identity*.

## Actual minds, possible worlds - Bruner (2)

The components of the behavior…are not emotions, cognitions, and actions, each in isolation, but aspects of a larger whole that achieves its integration only within a cultural system.

## Papert's theory of Constructionism - Kafai and Resnick (3)

Constructionism is both a theory of learning and a strategy for education. It builds on the "constructivist" theories of Jean Piaget, asserting that knowledge is not simply transmitted from teacher to student, but actively constructed by the mind of the learner. Children don't get ideas; they make ideas. Moreover, constructionism suggests that learners are particularly likely to make new ideas when they are actively engaged in making some type of external artifact – be it a robot, a poem, a sand castle, or a computer game – which they can reflect upon and share with others. Thus, constructionism involves two intertwined types of construction: the construction of knowledge in the context of building personally meaningful artifacts.

### Reflection: Turning Experience into Learning – Boud (4)

..the reflective process is a complex one in which both feelings and cognition are closely interrelated and interactive. Negative feelings, particularly about oneself, can form major barriers towards learning. They can distort perceptions, lead to false interpretations of events, and can undermine the will to persist. Positive feelings and emotions can greatly enhance the learning process; they can keep the learner on the task and can provide a stimulus for new learning. The affective dimension has to be taken into account when we are engaged in our own learning activities, and when we are assisting others in this process.

### Edith Ackermann on the importance of Reflection (5)

..both "diving in" and "stepping out" are equally important in reaching deeper understanding. I argue that separateness resulting from momentary withdrawal does not necessarily entail disengagement. It may well constitute a step toward relating even more closely to people and things. As the Chinese saying goes: "The fish is the only one who does not know that he swims" (anonymous). People cannot learn from their experience as long as they are entirely immersed in it. There comes a time when they need to step back, and reconsider what has happened to them from a distance.

### Models of teaching and learning – Rogoff (6)



An illustration of learning as the filling of a receptacle. Note that the information is portrayed as simply stored in the child's skull, and given access to seeing inside, the adult can assess whether or not the knowledge is possessed by the child.

### Resnick on Quantitative Assessment

Rather than just trying to *measure* what children learn (through numbers), we also need to document what children learn (through compelling examples).

### A Critique of Technocentrism in Thinking About the School of the Future – Papert

This is another reason why it's wrong to ask, "What is the effect of the computer on the child?" It has many different effects on many different children, depending on what they are interested in. The children who are more language-oriented use language more. The children who are visually-oriented use visual and geometric representations more. The ones who like to plan in an obsessive way can become better planners. The ones who like to create freely in an expressionist way can do that better. If there is an effect in this environment, it is that each individual can follow his or her own style. You can become more yourself; you can become what you are, whatever that may be.

### Papert on Testing – The Children's Machine

The method of controlled experimentation that evaluates an idea by implementing it, taking care to keep everything else the same, and measuring the result, may be an appropriate way to evaluate the effects of a small modification. However, it can tell us nothing about ideas that might lead to deep change.

# 1.3 Frustrations

I have deliberately chosen to place this section immediately after sharing some of the most powerful ideas around children learning, and technology. In doing so, I hope to provoke you into wearing your *critical hat* and 'appreciate' the stark contrast in the values (or lack thereof) that many of the current tools and approaches are being designed with (I give full credit to **Natalie Rusk**, for helping me develop my *critical hat*, and for the ideas I share in this section). To illustrate my point, I share below a project created by a member of the Scratch community (Figure 5).
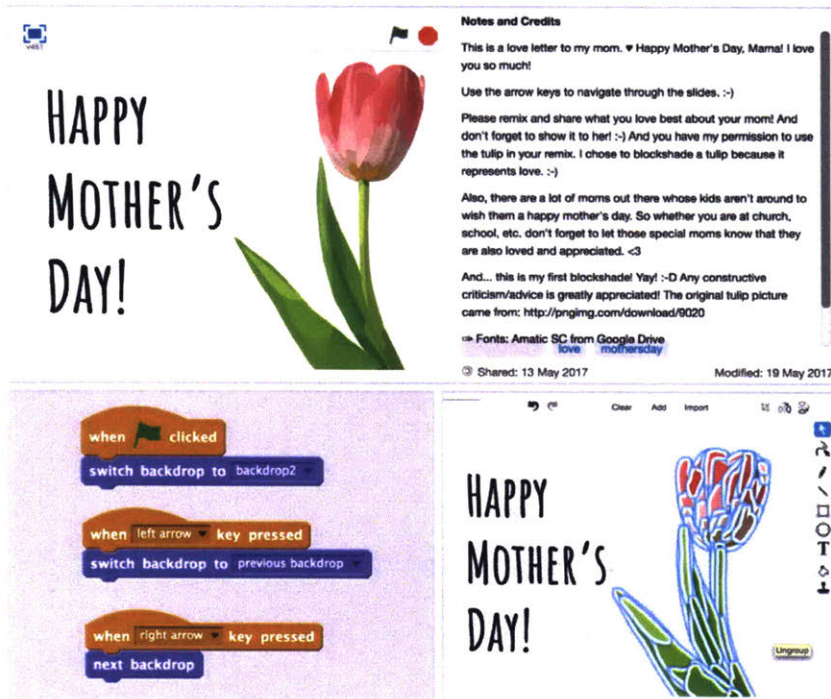


Figure 5: (Clockwise from top left) Screenshot of a Scratch project; the Notes and Credits section on the project page; the paint editor showing the complexity of the art made for the project; the project code made of Scratch blocks

As can be seen from the comments in the Notes and Credits section on the project page, the Scratcher created this project to express their love for their mom, and also to encourage others in the community to *remix* their project and wish their moms in their own ways, happy mother's day. The project has been designed in the form of an interactive card — it doesn't involve complex code, but it does involve complex artwork that was made with a lot of effort as mentioned by the creator. Moreover, the project is certainly very personal and meaningful for the Scratcher.

Now hold your *critical hat* tightly, and let's look at the same project using *Dr. Scratch* [22], a web-based tool that has been developed to automatically *analyze* Scratch projects and generate scores on how 'computationally good' the project is based on pre-defined programming concepts. Figure 6 shows what the tool generated upon entering the URL of the project.
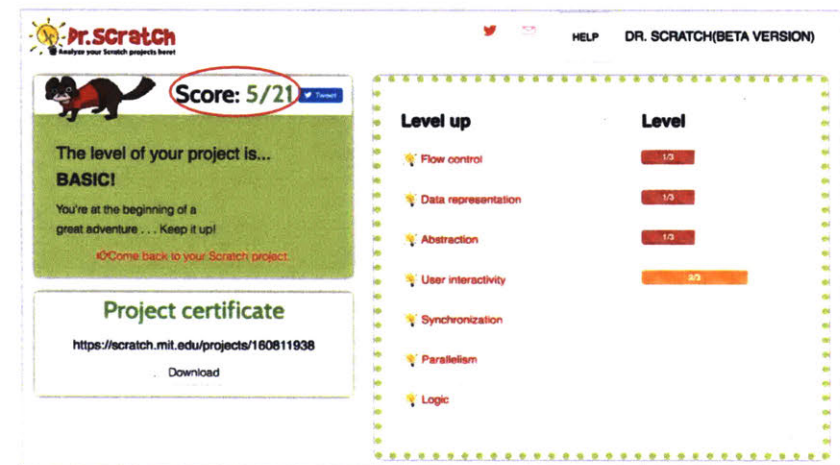


Figure 6: *Dr. Scratch*, a tool for evaluating a Scratch project based on pre-defined programming concepts

21

When you click on any of the concepts, you get a standard explanation of what the different levels of scores mean. For instance, if we click to see why this particular project received a score of 1 out of 3 in 'Flow control', it suggests using a *repeat* block in the code, implying that this project received a poor score because of the absence of the *repeat* block in its code.

That's not all, it also generated a certificate highlighting the total score that it computed for the project (Figure 7). On the certificate, it is mentioned that *Dr. Scratch aims to provide a means of learning and feedback on the quality of the projects on Scratch.*

Figure 7: Certificate generated by Dr. Scratch

Okay, now peek inside your critical hat...
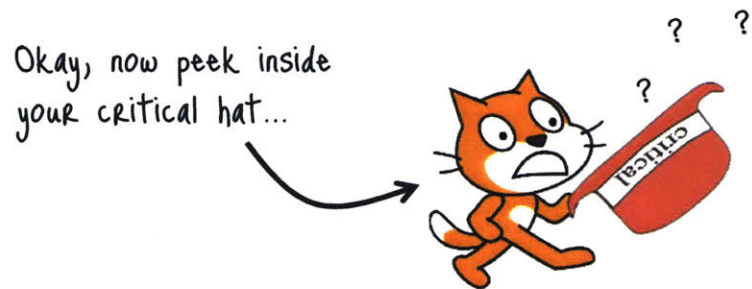
There are several glaring issues with a tool like *Dr. Scratch* — which, to the frustration of anyone who deeply cares about the ideas behind Scratch, is becoming a popular way for educators to *assess* children's progress on Scratch. I highlight these issues in the form of (many) questions that popped out from my *critical hat*, and I hope they did from yours too:

1. How can we see a Scratch project, made by a young person to express a unique personal idea they had, only as a computer program stripped off completely of its creative intentionality?

2. How can we determine the 'quality' of a creative project?

3. How can we reduce this 'quality' to a single quantitative score?

4. If a project <u>did not need</u> a control block for the purpose it was designed with, does that imply that the creator doesn't understand the concept of 'Flow control', and so should get a poor score?

5. How can we understand the full range of children's learning experiences on Scratch only by looking at the (not even correct) measure of the computational complexity of their individual projects in isolation?

6. By taking charge of evaluating children's work based on the limited dimensions determined by the developers of such tools, are we not taking away children's agency to reflect on what they value as part of their own creative experiences?

7. Finally, and most importantly, by using a narrowly defined cognitive lens that undermines children's rich creative, social, and personal experiences in computing, are we not receding back to the same issues around *technocentrism*, that Papert then and Scratch now has been showing us a way out of?

I acknowledge these are big questions, and some may want to question these questions, which is great.

**"It is better to debate a question without settling it than to settle a question without debating it."**

– *Joseph Joubert*

For instance, it can be argued that *Dr. Scratch* claims to be a tool for analyzing only the computational aspects of a Scratch project, which many educators may find of value. That is probably a correct statement, but also an irresponsible one. That's because, in focusing *only* on the computational *concepts*, while ignoring the rich computational *practices* and *perspectives* children are developing [5], we are giving out a message to young creators that — their ideas don't matter as much; their efforts don't matter as much; the stories behind their process don't matter as much; their contributions in inspiring and collaborating with other young creators in the community don't matter as much; and their personal growth, confidence, and evolving identity as creators don't matter as much — what matters is *only* whether they've used certain types of code blocks in certain types of ways, just so that *it's easy for us to evaluate them*. **THIS IS WRONG.**

I want to clarify here that I put my finger on *Dr. Scratch* more to have a concrete example for the discussion. I am not against a particular tool, but a particularly narrow perspective that is widely prevalent and visible in almost all of the coding platforms for children, that I know of. Figure 8 shows screenshots of some of the *dashboards* [41][31] that are used to *track* students' progress on these platforms. It is unfortunate that all of these look the same, focus on the same narrow perspectives around coding, and use learner data only for the purposes of assessment on limited dimensions.
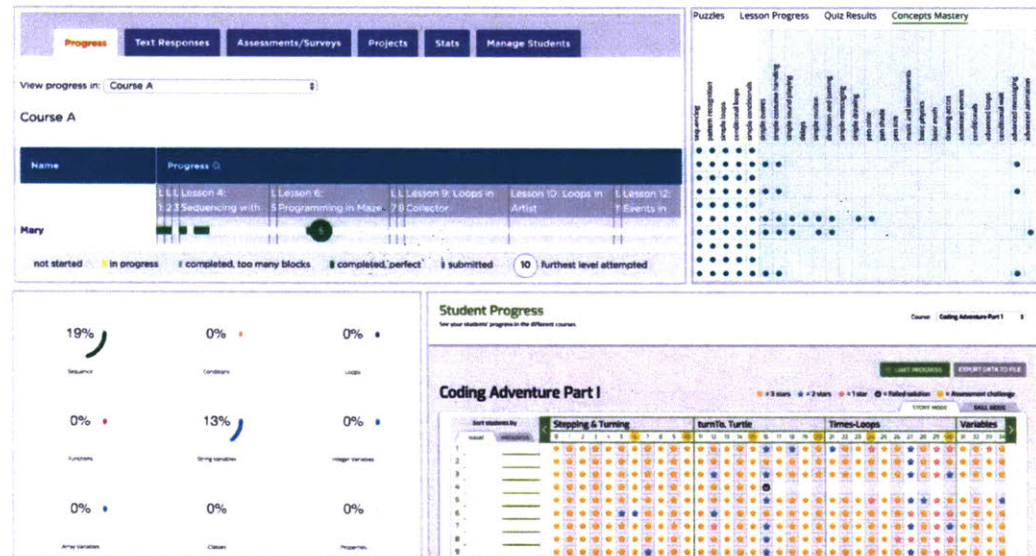


Figure 8: Screenshots of dashboards in other coding platforms for children

Sharing his skepticism on using data for personalized feedback, Resnick points out [40], '*My concern, it's only easy to give feedback on certain types of knowledge and certain types of activity. I think there's a real risk, that we as a society, are going to end up giving too much privilege to the types of knowledge and the types of activity that are most easily evaluated and assessed computationally.*' I completely agree. It's true that we cannot computationally *assess* the full range of children's creative learning experiences, and I think, we should not even aim to. What we can do computationally though is also to document and reveal children's creations and other learning experiences without trying to compress them in the form of dots on a dashboard. Through my work on *Scratch Memories*, I aim to show how we can use data to let children do the talking, instead of letting the data talk for children.

# 1.4 Connections
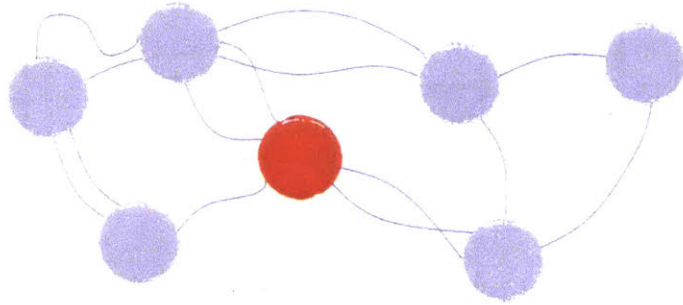
The idea of *Scratch Memories* stems from the connections that I drew with different ideas in different contexts. I use this section to highlight some of the ideas, tools, and approaches from both in and outside of learning contexts that have inspired me in different ways.

"Oh! I've seen videos like these on facebook!"

When I shared *Scratch Memories* with adults, many of them instantly made this comment, identifying the tool as being similar in concept to the personalized videos generated for users on Facebook, a social media platform. I must add that most times this has been said in appreciation, with people expressing, *oh that is so cool that you thought of this connection,* or *that is clever, I never thought of this, it makes a lot of sense.* However, I feel it's important for me to shed more light on this connection. The use of the video format and the broader aesthetics of *Scratch Memories* have indeed in-part been inspired by Facebook's data-driven videos [42]. The part that is interesting about this connection though is— why did I think of this connection? To answer this question, I want to travel a bit outside of the learning domains to highlight some of the research on the effect of memories and reflection on personal well-being.

The videos on Facebook are designed to engage people in reminiscing about their lives using pictures they have shared on the platform. At the core, the experience is about having people remember and reflect on the moments of their life, and celebrate their milestones and friendships with others. It can be both a joyful and nostalgic experience. There is rich body of research on the positive effects of reflection for personal well-being and behavior change [15]. Nostalgia has been seen as a way of bolstering meaning-making efforts of authenticity, self-growth, and interpersonal connection [1]. There is also an extensive literature regarding the characteristics and functions of autobiographical memory, which consists of personal memories from our lifetime. Konrad [18] discusses the three primary functions of autobiographical memory, referred to as *directive*, *social*, and *self-consistency* — Directive functions help in planning and directing our future behaviors. Social functions involve sharing past experiences with others to promote interpersonal relationships. The third function is self-consistency, where we remember our pasts to preserve and enhance our identity.

I see close parallels of this research with the literature on the relationship between emotion and reflection in learning [13]. But existing online learning platforms do not leverage technology and data to concretize this research in ways that other contexts and social communities have shown is possible. I believe, all of us treasure memories of our personal lives whether it is through looking at digital photographs or analogue albums. We look back at them and reflect on different phases of our journey, our experiences, how we started, the people we have met along the way, and how far we have come. I saw children's creative trajectories with the same lens. I saw their learning experiences on Scratch as *memories*.

This connection is what led me to think beyond the impersonal quantitative dashboards, and imagine and develop a more personal tool that could enable children to reflect on the *memories* of their creative lives, much like how we reflect on the memories of our personal lives. By looking at the research behind Facebook Memories [43] and other work in the field of technology-mediated reflection [15], I was able to appreciate the similarities and differences in the goals and opportunities provided by the different contexts. While Facebook engages people in reminiscing about their social lives, *Scratch Memories* is specifically designed for the context of a creative learning community, and aims to present a new approach for engaging children in reflecting on their learning trajectories.

I also draw close connections for my work from the research in the broader field of personal data visualization. Viégas, in her thoughtful work on visualizing personal email archives, highlighted that *'visualizations ought to be seen not as an end in itself but, instead, as a means for communication'* [39]. *Scratch Memories* is also designed to catalyze reflective conversations and spark inspiration for further engagement rather than to be used as a metric for determining children's progress.

In the context of Scratch, the concept of reflection-in-action [36] was explored with the help of Jots, an experimental system that was designed for helping users create brief updates or 'jots' while working through their projects [34]. Another system, called Scratch Community Blocks [9], was developed to provide children programmatic access to the data about their participation on Scratch through new types of blocks. I build on the ideas illuminated by the previous research in this domain, but explore an alternate view of reflection that can support young people in reflecting not just on their individual projects, but on their full journey on Scratch, by designing visualizations that children with any level of experience with Scratch can easily understand and relate with.

Beyond academic contexts, as a designer, I also draw my inspirations from the work of several data visualization artists who approach data in the ways that I closely identify with. Amongst these, I particularly appreciate the work of Lupi and Posavec on 'Dear Data' [19], a book with a collection of postcards they sent to each other capturing and drawing visualizations of their personal data. About the project, they write, *we've always conceived Dear Data as a "personal documentary" rather than a quantified-self project which is a subtle – but important – distinction. Instead of using data just to become more efficient, we argue we can use data to become more humane and to connect with ourselves and others at a deeper level.*

Through my experiences, I have learnt that it can be immensely valuable for designers and developers to be able to make cross connections between ideas from different contexts and synthesize new tools and experiences that push the boundaries of what is assumed to be the norm. Austin Kleon, in his book, 'Show Your Work!'[17] makes a similar argument in interesting ways. He writes, *'If you look back closely at history, many of the people who we think of as lone geniuses were actually part of "a whole scene of people who were supporting each other, looking at each other's work, copying from each other, stealing ideas, and contributing ideas." Scenius doesn't take away from the achievements of those great individuals: it just acknowledges that good work isn't created in a vacuum, and that creativity is always, in some sense, a collaboration, the result of a mind connected to other minds.* The Scratch Online community exemplifies this kind of creative appropriation [21] by encouraging children to remix each other's ideas and create new projects that are meaningful for them, and can further inspire many others in the community [8]. The purpose of this section in my thesis is to help others see the value in this kind of creative remixing of ideas in order to make something that is unique and meaningful for their own contexts. I hope that someone would remix *Scratch Memories* too in ways that I have not yet imagined.

# 1.5 Imagining a new approach

data 'values'



Mixing together my motivations, foundations, frustrations, and connections, I created a set of 'data *values*' (no pun intended) to **(re)imagine** the role data can play in the context of online learning platforms for children (Figure 9). I use these values to capture and share with others the core essence of my approach, as well as to constantly remind myself of the values that I hope to make visible with my work. I am fortunate to have Scratch as my context, because I know you can only make visible that which exists in the first place. It is thus the values and meaningfulness embedded within Scratch that allows me to imagine the new ideas and approaches I present through my work on *Scratch Memories*.

| **Data as a means to** | Data as a means to |
|---|---|
| assess and evaluate | celebrate and reflect |
| track progress | catalyze engagement |
| deliver personalized content | design personally meaningful experiences |
| generate scores | discover stories |
| simplify complexity | reveal complexity with simplicity |
| show dashboards | share memories |
| take control | give agency |
| be impersonal | be personal |
| provide one-sided feedback | spark conversations |
| measure thinking | value feelings |
| compare with others | connect with others |
| arrive at conclusions | inspire new possibilities |

Figure 9: Creating new 'Data *Values*' for digital learning platforms

# 2. Create

If I am asked to choose my favorite phase in the spiral, it would have to be this one. I love designing and creating new things. I love the excitement of making my ideas come alive, and the unexpected discoveries in the process. In this phase, I start by sharing some of my initial experiments in trying to visualize children's trajectories on Scratch. Like any idea, the idea of *Scratch Memories* evolved *(and I'd like to think is still evolving)* from a process of tinkering, from making cross-connections with other ideas, and of course from the many conversations with the incredibly creative and thoughtful people around me. I introduce the tool and describe its experience by giving a walkthrough of *memories* generated for a Scratcher as an example. I conclude by highlighting the *small* design choices I made in the tool.

# 2.1 Initial experiments

Let's start with the backstory of *Scratch Memories*... because, of course, every idea has a trajectory to tell!

The first thought of developing a personal visualization for Scratchers came from two different conversations that I had coincidentally on the same day with two different people that I really admire – Natalie Rusk and Sayamindu Dasgupta. Looking back, I see those two conversations as seeds from which the idea of *Scratch Memories* grew. I was brainstorming (separately) with them potential ideas around visualizing Scratch data for one of my class projects. Natalie shared with me how she had been thinking about a personal dashboard for Scratchers to look at different aspects of their projects. Sayamindu also(!) suggested a similar idea around creating a slideshow based timeline for Scratchers to browse through their projects. I instantly resonated with these ideas and was excited by the prospect of making a personal visualization for Scratchers to reflect back on their creations.
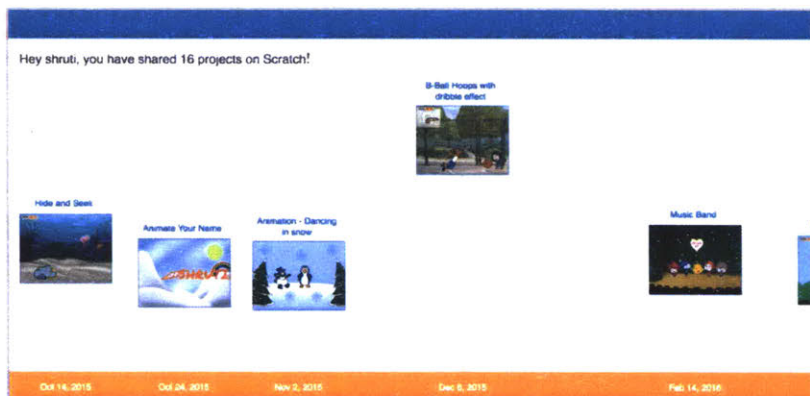


Figure 10: First attempt at making a timeline of Scratcher's projects

Although at the time, my mind ran in very ambitious directions about what that could look like, as my first attempt, I used the Scratch API and created a simple web-based scrollable timeline in JavaScript that showed a Scratcher's projects in the order of when they were shared in the Scratch Community (Figure 10). I also added a height dimension that indicated the relative popularity of a project among other projects shared by the Scratcher, based on the number of loves, favorites, views, and remixes it had. I thought this was a good first iteration since currently, Scratchers do not have a way of looking at this information at a glance. At the same time, I felt this approach did not reflect the richness of children's experiences on Scratch, and it didn't capture what I identify as the spirit of Scratch — creative, social, personally meaningful, and playful.

So parallelly, I was thinking and prototyping the design for the ambitious end of my imagination, which was inspired by the term coined by Papert called, *Mathland* [23]. Papert used this term to propose a conducive environment for learning mathematics as naturally as one learns French while growing up in France. For my context, I wondered about designing a 'Scratchland' where Scratchers could go and revisit their *memories* on Scratch. I imagined creating literally a three dimensional virtual world that children could explore, and they would be able to see their projects, friends, and other milestones along the way. Figure 11 shows a very rough design sketch that I had prototyped to explore the idea. I now realize, I took the word 'land' quite literally.



Figure 11: Design sketch of another approach to timeline - 'Scratchland'

While being engrossed in my own creative process though, at some point, I decided to step back and reflect on my motivations behind wanting to develop this tool. I realized that to design a meaningful reflection tool *for* children, I needed to understand *how* children were reflecting on their experiences on Scratch and *what* they were reflecting on. In looking at the Scratch website for inspiration, I stumbled upon hundreds of projects shared by young people in the community titled, *My Scratch Journey*, and several other projects with a similar theme.

I show screenshots of some of these projects to highlight the things that stood out to me (Figure 12). Some share stories about the different types of projects they created over time, others reflect on how they are inspired by their friends on Scratch. Through these projects, children are celebrating and reflecting on how far they have come since the time they started on Scratch. A quote shared by a Scratcher in one of the projects helped reinforce my thinking about *memories* as a medium to not just reflect on your past experiences but to also feel inspired to keep going further.

Thinking about children's learning experiences as *journeys* expanded my own thinking about what constitutes a meaningful reflective experience. At the same time, it led me to set appropriate constraints for myself — the type of constraints that actually supports the creative process, instead of suppressing it [37]. I was able to shift my focus now from creating a rich and elaborate *tool* to creating a rich and meaningful *experience* for children, and I'm glad I realized soon that the two didn't exactly mean the same.
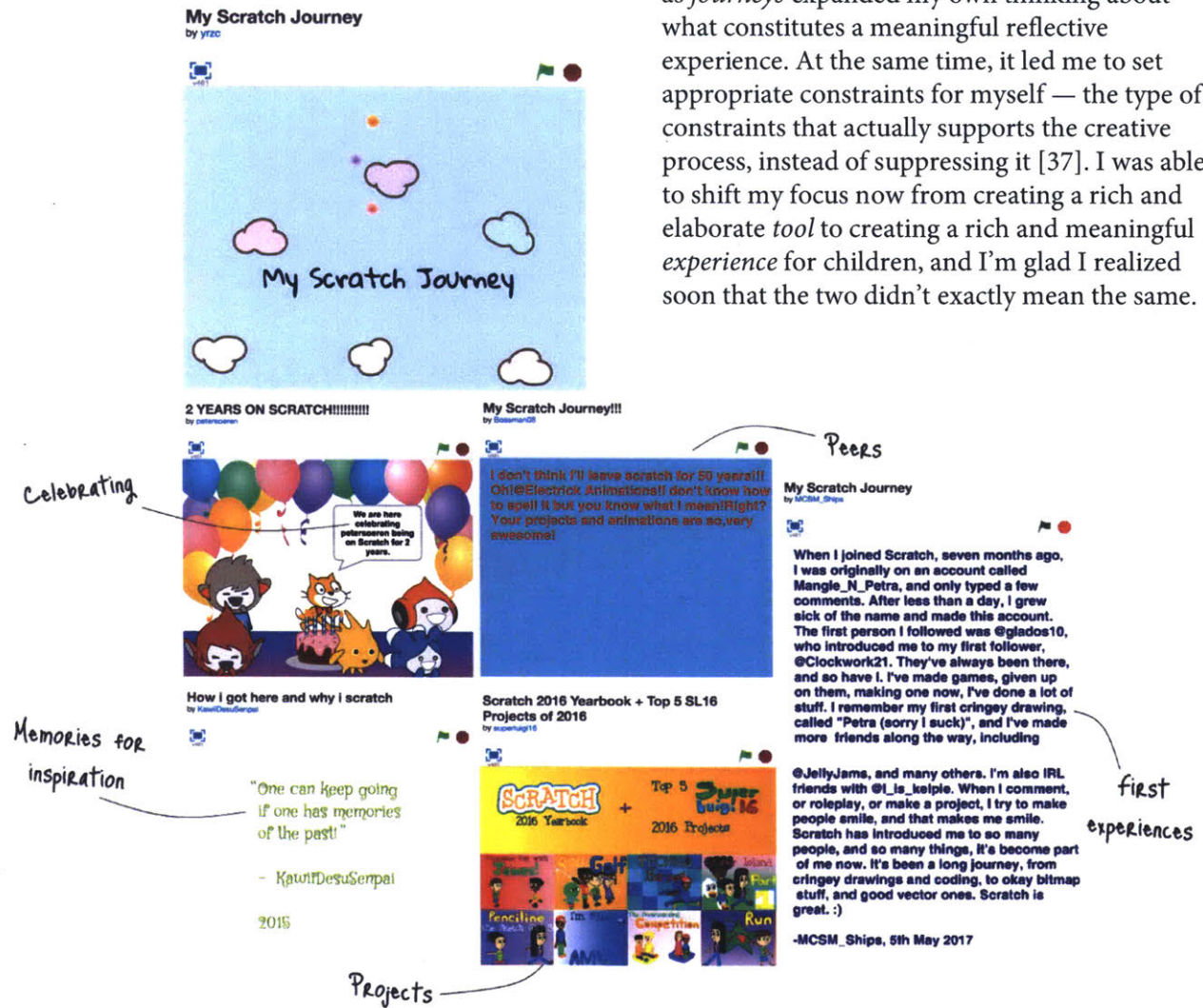


Figure 12: Screenshots of 'My Scratch Journey' and other related projects shared by Scratchers

Through my initial experiments, I learnt an important lesson about the creative process. I highlight this with the help of some humorously wise illustrations (Figure 13) shared by Christoph Niemann (a graphic designer whose work I admire) in one of his insightful talks [44].

As a designer, I realized it is often easy to fall in the trap of your own creative imagination. You start by wanting to do things that are probably more satisfying for the 'artist' in you, and that are helping you push your own boundaries in some ways.

### But then, this is where,
as Niemann expressed...

He further adds that simplicity is not about making something that doesn't have lot of ornaments or details.

### "It is about cutting it down to its very essence."

And, even after you might think you have done that, you sometimes need your inner editor to take control and let go of your own ideas in order to create room for better ones through a process of tinkering and experimenting.
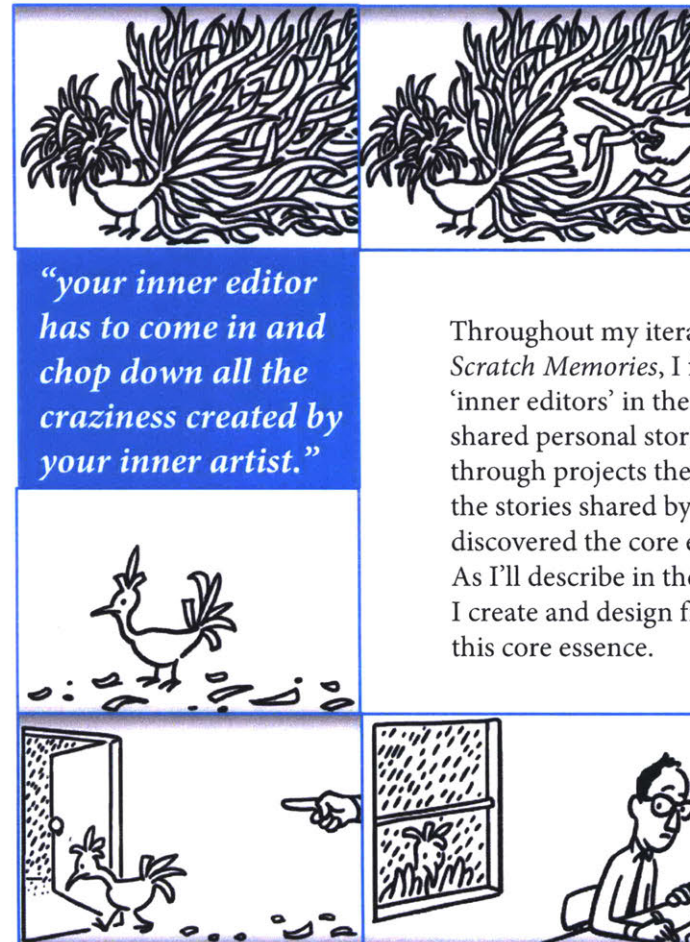
"your inner editor has to come in and chop down all the craziness created by your inner artist."

Figure 13: Illustrations by Christoph Niemann (inner editor vs. inner artist)

Throughout my iterative process of creating *Scratch Memories*, I found not one but several 'inner editors' in the form of all the Scratchers who shared personal stories about their journeys through projects they shared on Scratch. It was in the stories shared by children themselves that I discovered the core essence of *Scratch Memories*. As I'll describe in the next few sections, everything I create and design from here onwards stems from this core essence.

## 2.2 Creating
## *Scratch Memories*
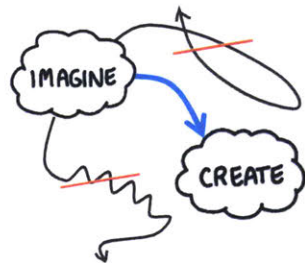


Personally, this is my favorite part of the spiral — it's when as a creator and designer, I finally felt that I had a perfect mix of — clarity (around the core ideas and values I imagined), nervous excitement (for the creative outcome I was expecting), and passionate persistence (needed to bring my ideas to life). At this point, I had let my inner editor(s) get rid of all my initial (crazy) experiments to make room for creating what now is *Scratch Memories* [10].

**...so, what is *Scratch Memories*?**

On the technical side, *Scratch Memories* is a web-based application written in JavaScript that takes any Scratch username as an input and fetches data from the Scratch API about the user's publicly shared projects and participation within the Scratch online community. This data is then dynamically processed to generate personalized visualizations for that Scratcher. The visualizations highlight the temporal, creative, computational, and collaborative aspects of projects shared by the user since they first joined Scratch. They also highlight the connections the user has formed along the way with other Scratchers from around the world. Using creative web design elements and CSS animations, the different stories are played automatically along with background music. To the user, it therefore seems that they are looking at a short personalized video created on the fly.

*Scratch Memories* is designed as a way to enable young people to celebrate and reflect on their creative trajectories with Scratch — starting from their first experiments in expressing ideas through code to seeing the increasing diversity and complexity of their projects over time; and from their initial steps in engaging with the community to realizing how they are inspiring other young creators from around the world.

...I find it both amusing and amazing that there is a big smile on my face as I'm reflecting on this part of my journey. I now understand deeply, why every young creator who reflected on their journey through Scratch Memories, also had a big smile on their face. More on that in my share phase later.

31

Before exploring how *Scratch Memories* works, it would help to know about the different Scratch specific terminologies that have been used in the tool (Figure 14):

| | |
|---|---|
| **Sprites & Scripts** | Objects or characters in Scratch are called *sprites*. Each sprite can be associated with a set of programmatic *scripts* (or code) that define its behavior. Scripts are made by snapping together blocks in Scratch. |
| **Loving & Favoriting** | Users can express their appreciation for a shared project by clicking on the *love* icon and bookmark a project by clicking on the *favorite* icon. |
| **Remixing** | The source code of every project shared in the Scratch community can be seen by users, who can then *remix* the project to build on each other's ideas. |
| **Following** | Users can *follow* other members through their profile page to receive updates about what they are sharing in the community. |



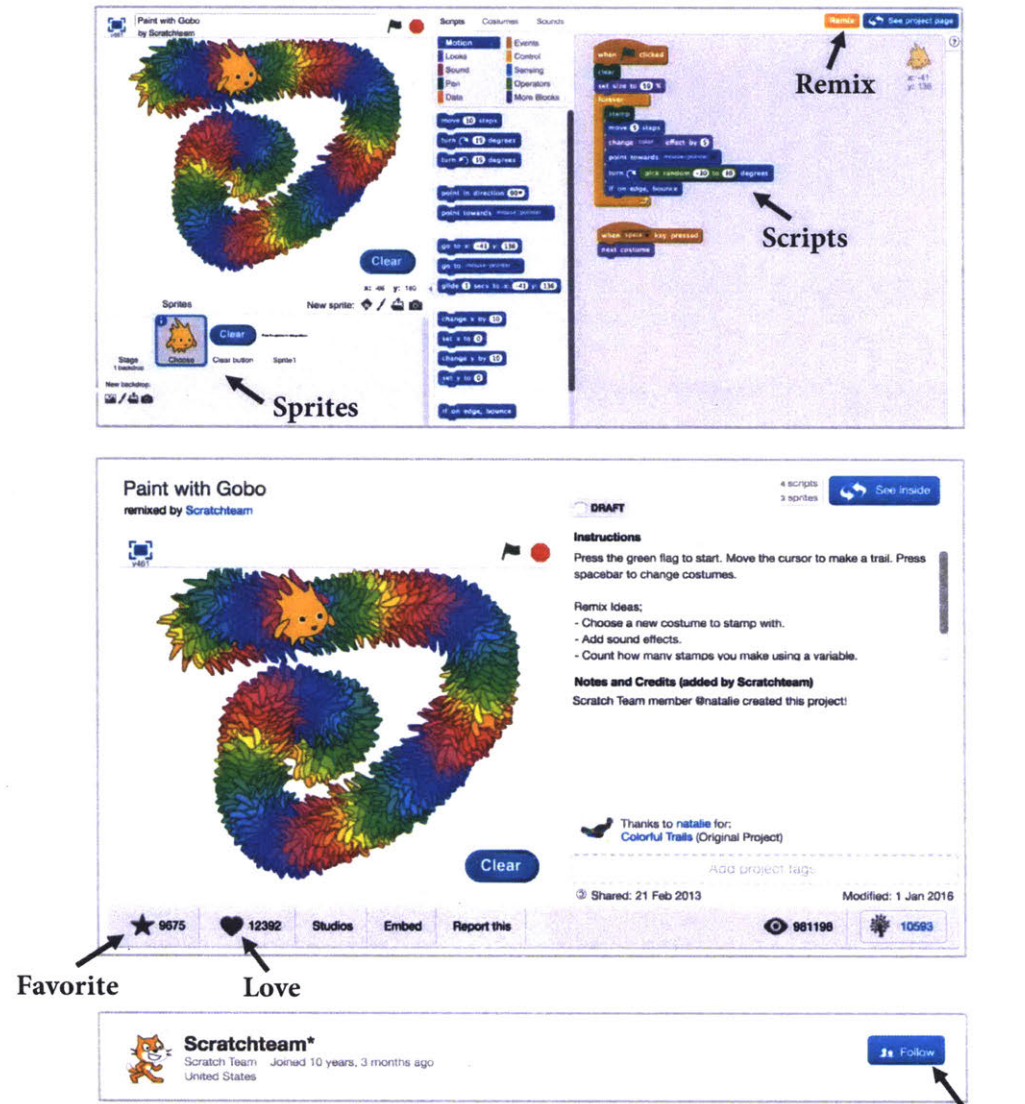Figure 14: Highlighting the Scratch terms used in *Scratch Memories*

## Time to see Scratch Memories in action!

Let's see what happens if a Scratcher enters their username in the *Scratch Memories* web application. The screenshots over the next few pages illustrate the flow of personalized stories that are dynamically generated by the tool for the user, @CrazyNimbus (as an example). If you are reading this document online, you can click to see the video here: **https://shrutidhariwal.github.io/scratchmemories_thesis**. Else, if you are reading a physical copy of this document or unable to open the link to the video, I ask you to imagine an upbeat music playing in the background as you flip through the next 28 pages showing @CrazyNimbus's *memories*. That's because, as I'll discuss later, music is a central part of the design of the tool.

**But wait, 28 pages?** I agree that it would have probably made more logical sense to share the thumbnails of all the stories on one page so one could quickly glance through them. My intention here though is to not just describe the tool I designed, but to share the experience I designed with the tool. Each story that the tool generates holds significance in a young person's creative journey on Scratch. In revealing the visualizations one-by-one in this thesis as well, my goal is to evoke others to pause a little and reflect on the importance of designing experiences that capture all of these different creative, social, and personal dimensions of children's learning trajectories.

I hope you enjoy seeing @CrazyNimbus's *Scratch Memories* as much as she did.

**Me:** Is there anything you might want to add or change in this video?

**@CrazyNimbus:**
NO, I love it. It's perfect. I don't want to change anything about it!
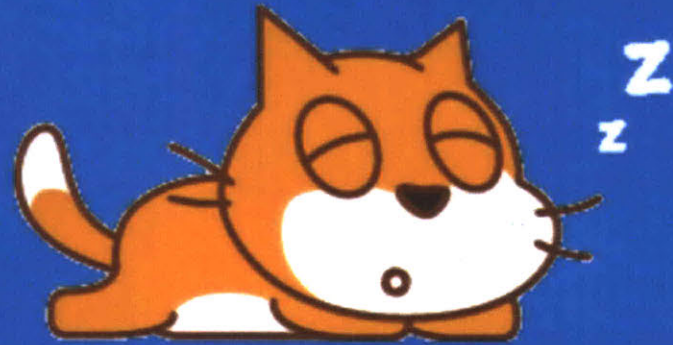
OK, I'm getting your memories.
Last one minute of napping..I promise!
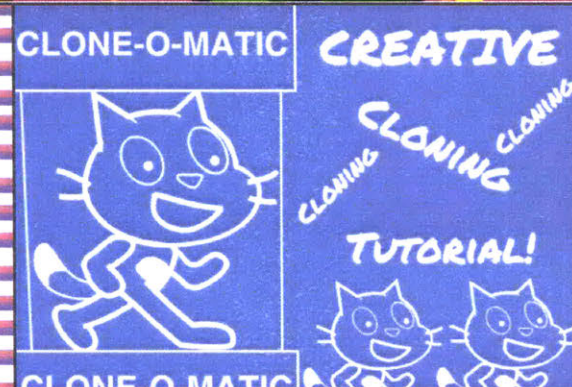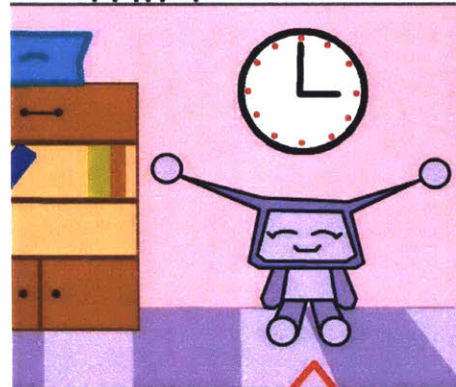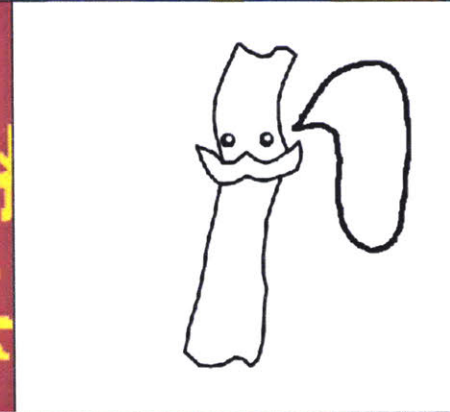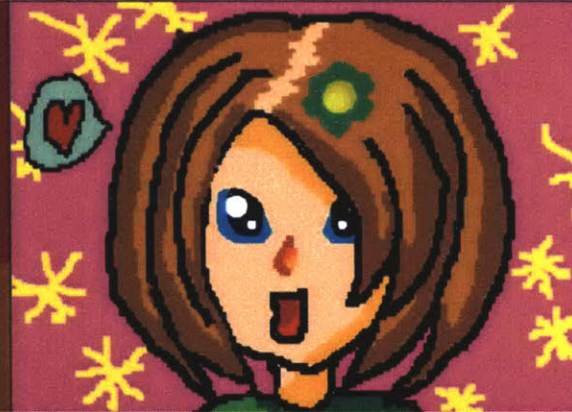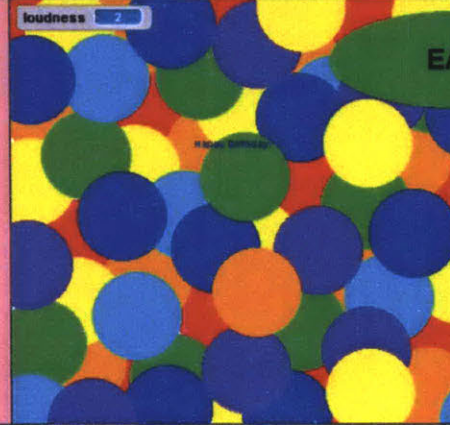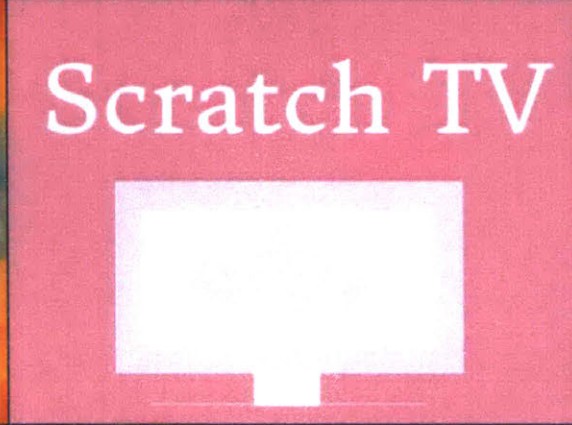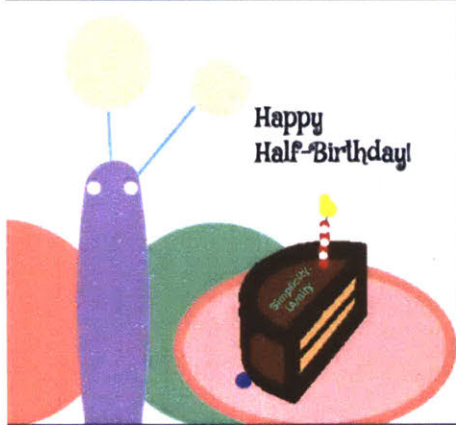
Hey CrazyNimbus,

You joined Scratch on
Jun 9, 2013

Remember the first project you shared!

Dance your way to stardom - WEBCAM REQUIRED
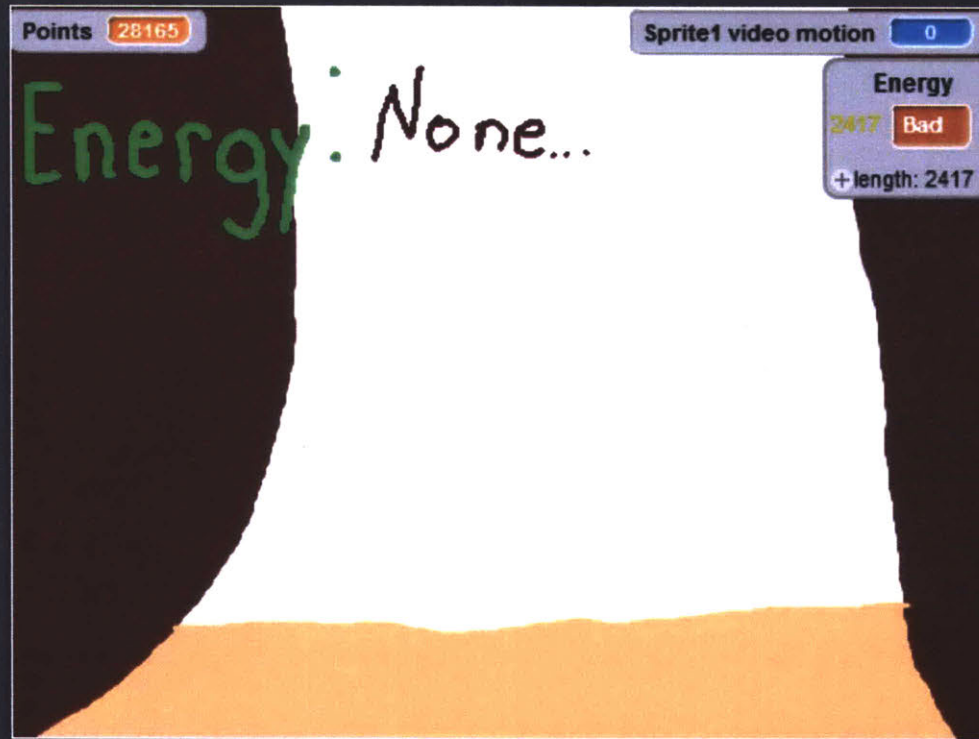


Jun 9, 2013

♥ 13  ⭐ 7

and the first scratchers you followed!

thenatashas

roughhouse

Marqueev

GhostFactor333

The first project you favorited was made by
Weirdguy101

The first project you remixed was made by
Scratchteam

Musical Buttons + Sing Along (REMIX OF MUSICAL BUTTONS)



Jun 9, 2013

♥ 1  ⭐ 1

Scratchers really loved this project you made!

Sep 5, 2016                    ❤ 2204  ⭐ 1590

182 Scratchers remixed this project you made!

Countdown to Scratch Day 2018!



There are [ 1 ] days to Scratch Day!

Mar 9, 2014

♥ 954   ⭐ 784

From the time you had your first followers..


thenatashas


GhostFactor333


JewelKeeper


4orange66

..to now when you are connected with **3538** Scratchers from **157** countries in the world!
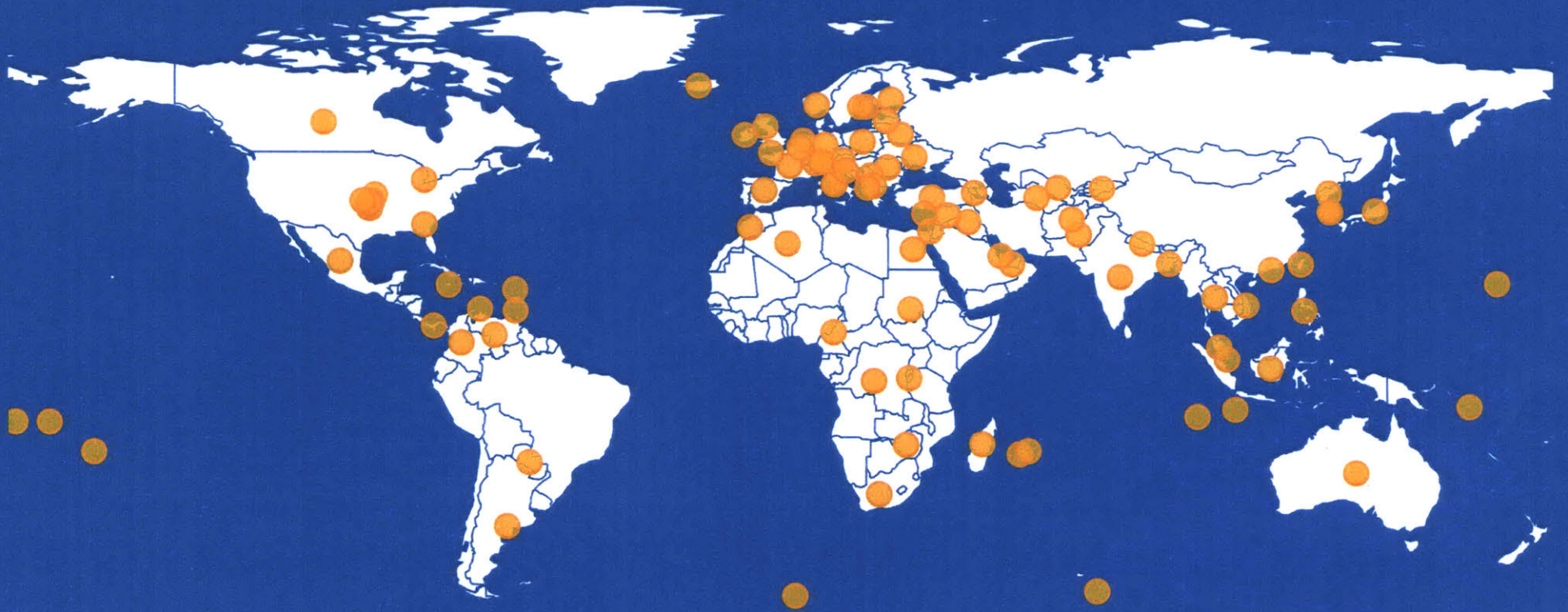
From a project without a script..

Nano Everywhere!



Jun 28, 2013

♥ 1

..to the one with 327 scripts!

# Scribblenauts Like Game
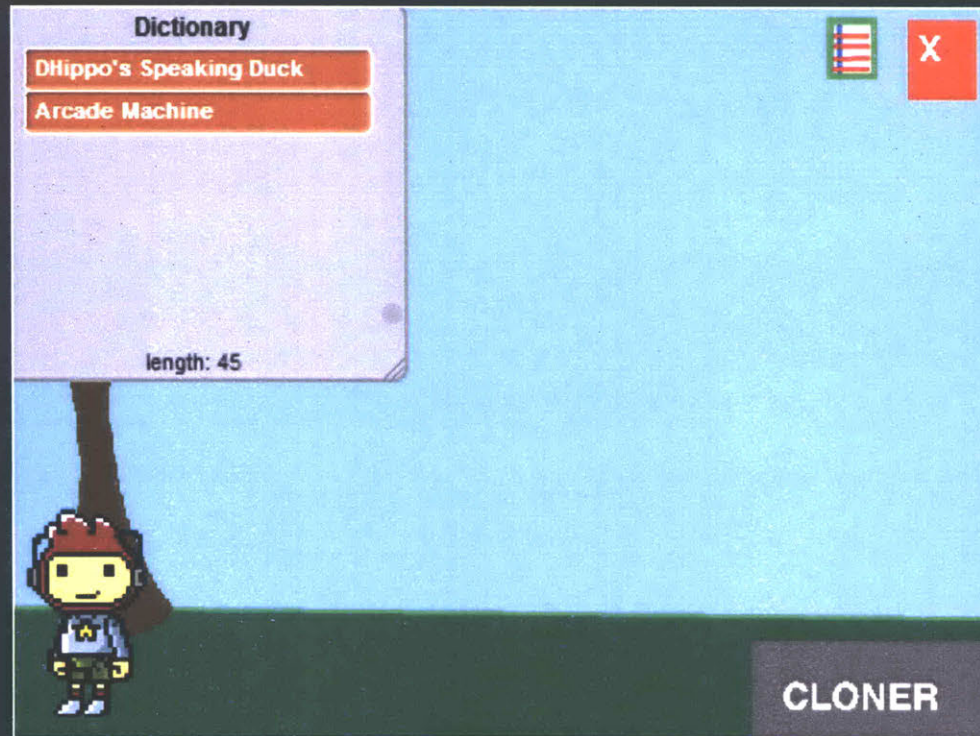


Jun 24, 2013                              ♥ 53 ⭐ 43

From a project without a sprite..

St. Patrick's Day Icon!



Mar 17, 2014                                    ♥ 4 ⭐ 3
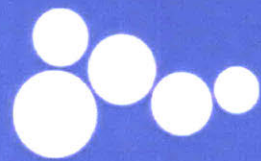
..to the one with 89 sprites!

Sep 5, 2016

❤ 2204 ⭐ 1590
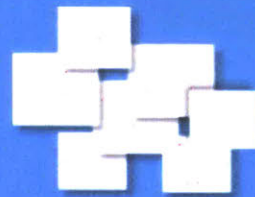
You have shared 235 projects on Scratch!

Here's to 5 years of
imagining, creating, and sharing
with Scratch!
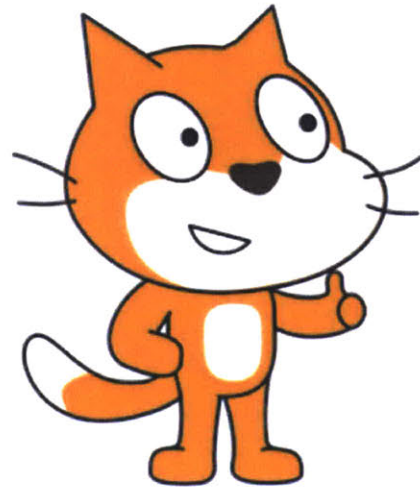
# Scratch On CrazyNimbus

Replay    Restart

There can be many questions raised at this point, the most common and the most important one being — **why these particular themes?** (Figure 15). I would answer this question in detail in the next phase of the spiral, when I describe my four key design principles after going through the iterative development process.

For now, I want to use this walkthrough of *memories* to highlight some of the **'small' design choices** I made that may go unnoticed, but were in fact, a key part of making the experience more meaningful and delightful for children. Here they are:

Figure 15: Key themes in Scratch Memories

**1. Wait leads to wonder**

The design sketch of my earlier prototype for *Scratch Memories* included both the story and the vignette of the associated project on a single page.
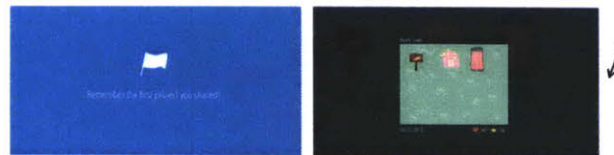
Figure 16: Early prototype of *Scratch Memories*

I decided to separate the two later. Now, for instance, when one sees the story about their first project, in that small moment, they start to wonder about the first project they shared. When the project appears later, it sometimes can be surprising, or it confirms what the user was thinking. Either way, the story becomes more powerful because it causes one to pause and wonder. As I'll share later, this little act of waiting and guessing often surprised children and made them question, think, and sometimes smile to themselves.

**2. Music makes *memories* come alive**

Music is known to have an extraordinary ability to evoke powerful emotions. It is interesting how in learning contexts, adding music to any reflection tool is largely uncommon. One of the reasons is that the process of reflection is not often seen as an emotional experience for learners. *Scratch Memories* is designed to enable children to reflect on the *memories* of their own creative journey. This by design is an affective reflective experience. It evokes both joy and nostalgia. The background music plays a central role in evoking a positive emotion as children look back on their creations and collaborative experiences with others over time. I carefully chose an uplifting instrumental track to be in sync with the stories and visualizations that appear on the screen. A primary reason that the tool looks like a personalized video is also because of the music that plays alongside the stories. Lastly, as I'll share later, if there was no music, I would not have been able to see so many children dancing and celebrating while watching their *memories*, and that, I think, would have been a missed opportunity.

### 3.
### Colors reinforce context
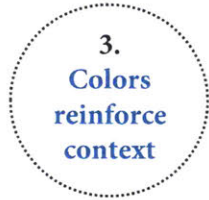
The colors in *Scratch Memories* are based on the colors of categories of blocks in the Scratch programming environment.

| Motion | Events |
|--------|--------|
| Looks | Control |
| Sound | Sensing |
| Pen | Operators |
| Data | More Blocks |

Figure 17: Categories of blocks in Scratch 2.0

The colors, therefore, are integrated to help reinforce the context. This can help children to resonate with the tool as it is designed with the similar colorful visual aesthetics of Scratch that they closely identify with. Digital reflection tools in any learning context can be made more meaningful by integrating the qualities of the context they are situated in. The design of *Scratch Memories* makes a point against the 'one size fits all' approach that is visible in the design of dashboards, used across a wide range of online learning platforms, that all look the same irrespective of the context or the users.

### 4.
### Words matter

The text in the stories generated by the tool carries with it the spirit and values of Scratch, and is a central component of the design of *Scratch Memories*. There is a small but careful distinction between saying, for instance, that *you are now connected with 3000 Scratchers from around the world*, as opposed to saying, *you have 3000 followers*. A similar distinction can be drawn between saying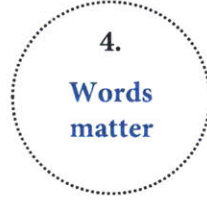, *Scratchers really loved this project you made*, instead of saying, *this is the most loved project*. One brings into focus, the community and the role of other people in your journey, the other puts the focus on the metric. The latter would not only be an incorrect representation of the values of Scratch, it might also reinforce a wrong message to children, that it is the metric and the number that needs to be celebrated and not how they are being supported, or how they are supporting other people in the community. In designing reflection tools for children, it is thus important to be careful about the message and the values being communicated through these small design choices.

### 5.
### Sleeping cat brings a smile

While the user data is being fetched and processed by the application, instead of showing a conventionally used loading icon, I use a sleeping Scratch cat (who wants to nap for a minute before getting your *memories*). First, it makes waiting for your *memories* to load a lot more fun than it is. Second, and more importantly, it sets the tone of the tool at the very beginning. Every time I watched a young person (or adults even!) interacting with the tool, seeing the Scratch cat made them smile (sometimes even laugh!). Scratchers instantly identify with the Scratch cat, and start looking forward to what the tool is going to reveal. Little choices like this may not seem critical to the process of reflection itself, but they can make the experience a lot more joyful for children. And, as Resnick points out in his book, *children deserve nothing less*.

As I'll share in my next phase, there are aspects that I didn't consider in the initial stage of creating the tool, which would surface as I go through my iterative development process next.

# 3. Play

It is interesting to me that *play* lies at the center of the five stages of the creative learning spiral. In my journey, this is the phase in which I dance around freely and frequently in all the other four stages at the same time — I *share* the tool with others, make careful observations and ask for feedback; I *reflect* on the emergent issues; I *imagine* both incremental and new ideas that I hadn't thought about earlier. I *create* and implement these ideas back in the tool, and then share, reflect, imagine, and create, again, *playing* and tinkering all along. I use this phase to highlight this iterative development process for *Scratch Memories*. I then conclude by describing the key design principles that characterize this work.

# 3.1 Iterative development process

My memories of the first time I watched someone watching their *Scratch Memories* are very special. That someone was my advisor, Mitch Resnick, and my mentor, Natalie Rusk, who are the creators of Scratch, and of course, active Scratchers in the community whose *memories* are spread over 10 years! I hope they do not mind me sharing this picture of them watching their *memories* (Figure 18).



Figure 18: Mitch and Natalie watching their *memories* for the first time

This was the first time I witnessed the joyful emotion that I had hoped the tool would evoke. I continued to share with others in the Scratch team and saw the same smiles on everyone's faces while watching their *memories*. The part that I

should mention at this point is that the system at this stage was designed only for Scratchers who are active participants in the online community. This was done to be able to generate a rich variety of insights from the data about their creative and social participation. Up till now, I had shared the tool only with people who were active Scratchers, and so the tool always worked in the ways I had expected.

The next step was observing how children might react to this tool. I put up a booth during the Scratch day [45] held at MIT where children could come and type in their username to see their *memories* as generated by the tool (Figure 19). Several children came to interact with the tool. There were couple of siblings who were both Scratchers and came to see their *memories*. There were parents and guardians watching and celebrating children's Scratch journey together. The *memories* also became a medium for children to explain to parents different parts about Scratch that they weren't aware of. For instance, one Scratcher started explaining the difference between loving and favoriting a project to their parent. The most interesting part of the experience was that as children were watching their video, they started talking and sharing on their own, stories about their creations and the people they were connected with on Scratch, without my involvement in any way. I noted down some of the comments made by children:



Figure 19: Children interacting with *Scratch Memories* on Scratch Day

This is really cool!     I love this!

I knew I had 500 followers, I didn't know they are from 60 countries!

Wow, you have a friend in Australia!
(Younger brother to sister)

Oh yes, I remember, this was the project I had made for Science exhibition at my school.

I had forgotten about some of my projects!
(An 8-yr-old Scratcher who had shared 105 projects in 10 months)

It was great to see so many Scratchers reacting so positively to the tool. But, **this was only one part of the story**. There were many children who were not able to see their *memories* because they had not actively participated in the online community, or had not shared any projects on Scratch. I had considered this aspect and made the system display a message (Figure 20) in such a case, explaining that as users share more projects, love and favorite others' projects, and follow other people, they will be able to see their *memories*.
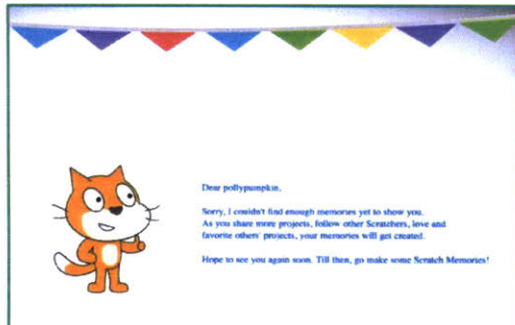


Figure 20: The message screen for no *memories*

This led to some interesting reactions by children. In one instance, a brother sister duo came to see their *memories*. The video was not generated for the brother, so when his sister was about to try next, he said to her, *"if I don't have enough memories, you definitely don't have enough memories!"*. I found it interesting that children and even adults started referring to their experiences on Scratch as 'memories'. Looking back, I

think the name *Scratch Memories* has a huge role to play in how people perceive the tool, which then affects how they might perceive their own diverse experiences on Scratch. In another instance, something unexpected happened. A Scratcher who had made his account on that very day and had created six projects wanted to see his *memories*. I let him know that it only works if you have shared your projects. He went away for a while and came back all excited. He said to me, *"I just shared all my projects. Now can I see my memories please?"*. I had not imagined that being *unable* to watch their *memories* could motivate children to share their projects on Scratch, so that they could also see their personalized video. To me, this instance makes an important point about the need for designing reflection tools and experiences that children *want* to engage with, and that can inherently motivate them to try things they haven't before.

From my observations and feedback, it surfaced that most children expected the system to play at least few stories for them based on their current level of participation, even if they were not yet active on Scratch in all the other ways. In one particular instance, a young Scratcher with username @TimsAccount got upset that he couldn't see his *memories*. In a sad tone, he said to me, *"Oh, it's probably because I'm not very popular on Scratch."* This really bothered me as it was the opposite of what my intention in designing the tool was.

The whole experience of observing children interact with the tool led me to reflect on the design decisions that I needed to take to ensure that *Scratch Memories* wasn't just a tool for a few in the community, but was inclusive of the many different levels and styles of participation that others had. I also realized how it is so important for designers and developers to go through this iterative process of testing the tools, reflecting, and re-thinking some of their own decisions. For me, the positive reactions confirmed that there was certainly something that children found delightful and meaningful about the tool. My biggest take away at this stage, however, came not from the smiles, but the small amount of sadness that I saw on the faces of children who couldn't see their *memories*, even when they thought they should be able to.

## Time to iterate and redesign, but before that...

...the first thing I wanted to do after the Scratch day was to make sure that @TimsAccount could see his *memories*. I did some quick hacks in the code to generate his personalized video. I uploaded it privately on YouTube and sent the link to his dad's email id as he had registered for the Scratch day. I was relieved and re-energized to receive a comment on the video by his dad saying, *Tim says "Thank you so VERY much!!"*.

## Personalizing types of stories based on participation

Through subsequent iterations, the tool is now revised to be inclusive by design. It adapts for Scratchers with varying levels of participation in the community. Based on the projects children have shared and the extent to which they have participated, *Scratch Memories* now generates different number and type of personalized stories for each user. For instance, if a Scratcher has not yet remixed or loved any project, the system will show more stories about their own projects, such as the first time they used a variable (Figure 21), or the project where they used most number of blocks. The text is also customized to maintain the flow of different stories.
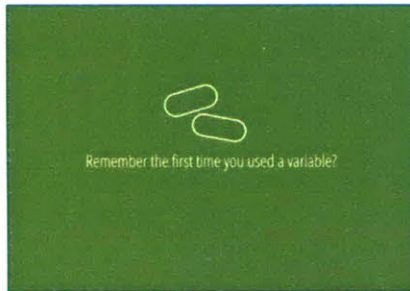


Figure 21: Alternate stories

Redesigning the system in this manner made *Scratch Memories* accessible to both new and experienced young members of the community.

# 3.2 Key design principles

Although the design of *Scratch Memories* is informed by the unique affordances and culture of the Scratch community supporting creative self-expression, experimentation, and collaboration, the key principles I used for designing a meaningful reflection tool can be applicable across other online learning platforms for young people:

**1.** Celebrate (rather than evaluate)

*Scratch Memories* aims to shift the prevalent approach of using children's data only for evaluating their progress, as defined by adults. By focusing on the dimensions that are personally meaningful for children, the system is designed to engage young people in a celebratory experience about their own journey. The use of the video format and the design of the interface reflects the playful spirit that children identify with. The types of stories are dynamically personalized to reflect each Scratcher's unique trajectory in order to create positive affect even if a user might not have yet participated actively in the community. For instance, if a project has not yet received any love or favorite, instead of showing 0, that feature is not shown, so children can reflect more about their own process of creating that project, rather than the absence of loves (Figure 22). Similarly, the map only shows if a Scratcher has at least 10 followers. However, the story about the first followers is not entirely skipped if a Scratcher has few but less than 10 followers. The text is customized for each case to maintain coherence. These small design decisions can play a big role in fostering confidence in children who are just beginning to engage with the community.
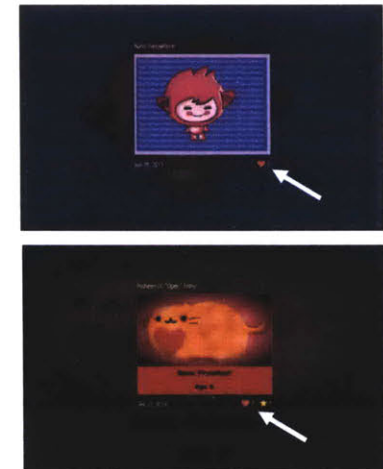


Figure 22: Customizing the icons shown in *Scratch Memories*

## 2. focus on projects, but don't forget the peers

In prior research, it has been found that the online community plays an important role in supporting children's creative learning experiences [3]. Sharing projects, loving and favoriting, remixing, commenting, following other people are some of the diverse ways young people collaborate and learn from each other on Scratch. But often, reflection in learning contexts is limited to reflecting on one's own work in isolation. *Scratch Memories* is designed to reveal a more holistic view of young people's creative trajectories. The tool, therefore, is not narrowly focused only on children's own projects, but instead, reveals the rich interplay between their individual and collaborative learning experiences on Scratch.

## 3. Mix the known with the unknown

What parts of their journey will children love to celebrate and look back on, and what kinds of insights can be surprising and lead to a new discovery? By keeping a balance between the known but happy memories (e.g. their most loved project) and the unknown but interesting insights (e.g. the project that has most number of scripts), we can utilize data to empower children to look back on their own experiences with a new perspective. *Scratch Memories* is also designed to avoid generating repeated projects across categories. For example, the stories about projects with minimum scripts or sprites, if generated linearly in the order of when such a project is encountered in the data, will often lead to the same project appearing twice. The system is designed to ensure that if there are different projects with these attributes, it does not show the same project in multiple categories. That way, children can be surprised by the different insights they discover about many different projects.

## 4. Combine small steps with giant leaps

While thinking about designing for celebrating, it is important to not place an undue emphasis on highlighting only the big achievements and not the initial steps that shaped children's learning experiences. *Scratch Memories* generates stories that help children think back to their first experiences in sharing projects and engaging with the community, as well as reflect on how their work and connections have evolved over time. By combining small steps with giant leaps, such reflective experiences can not only help children feel proud about how far they have come, but also feel inspired by their own trajectories to keep exploring new possibilities for themselves.

# 4. Share

This is the most personally enriching part of my spiral because it lends meaning to everything that I imagined, created, and played with so far. In this phase, I share comments, reflections, smiles, and the stories that children shared with me as they watched their creative journey on Scratch through *Scratch Memories*. I highlight the key themes that emerged from my in-depth interviews with 14 young members of the Scratch community. I also discuss how children engaged in giving thoughtful feedback and suggestions on the design of the system by reflecting on different phases of their own journey. Finally, I describe a delightful experience I had while sharing *Scratch Memories* at a public event that revealed new and surprising directions of my research.

# 4.1 Interviews with children

…one might wonder.

My answer is **NO**, it's not, and I have two reasons for this:

1) The very idea of *Scratch Memories* stems from recognizing and celebrating children's **own** motivations and efforts towards creating projects, collaborating with others, and contributing in the community. To base the 'success' of *Scratch Memories* on whether **it** has led to increased participation by children on Scratch would not only be incorrect, but also completely contradict the goals and foundations of this thesis. The goal of *Scratch Memories* is to serve as a lens for children to celebrate and reflect on their creative selves and to feel inspired by their own trajectories to explore new possibilities for themselves. To say that these new possibilities *only*, or *should only* mean creating more projects on Scratch, would be like saying that the goal of Scratch is to inspire children to create more projects on Scratch, and that will be such a terrible misconception. For some children, these possibilities may manifest in the form of sharing more projects; for some others, it could mean connecting and collaborating with new people; and for many others, it can get manifested in much deeper and personal ways that cannot be measured in any tangible form. This brings me to my second reason.

2) The success of *Scratch Memories* as a personal reflection tool that has been designed for children, lies in how well it resonates with children and evokes them to share their own thinking, personal stories, and feelings about their journey, and about themselves. More than any other measure, it's the stories children share that would give much deeper insights about their learning trajectories and the experiences that matter to them. The interviews thus served as both a qualitative research setting as well as a meaningful way to engage children in reflective conversations.

## Methodology

I conducted in-depth semi-structured interviews with 14 young people (ages 10-18 years), who have shared at least ten projects on the Scratch website, and are active participants in the online community. Two of the interviews took place in person, rest were done through video/audio calls, by sharing the *Scratch Memories* link with them during the call. For children under 18, consent forms were signed by them and the parent. For children who were 18 and above, consent forms were signed by themselves. I asked few open-ended questions to all the children, such as:

1) *How did watching this video make you feel?*
2) *What did you find surprising?*
3) *Which of the stories stood out to you?*
4) *Does the video reflect your Scratch journey? How?*
5) *Does looking back at your experiences make you want to try something next?*

Based on their responses, I sometimes asked follow-up questions as required.

In the *play* phase, I had shared how *Scratch Memories* sparked children to share their stories on their own without any external prompts or questions. This time though the setting was different. I thought children would watch their *memories* and then wait for me to ask questions since these were pre-organized interviews, most of which were done online and not in-person. But to my surprise, immediately after watching the video, all the 14 young people expressed on their own how much they enjoyed seeing their *memories*. I share some of their comments to highlight the positive affect triggered by watching *Scratch Memories*.

Oh that was so nice! Oh my gosh I really like that. It was literally like traveling down the memory lane. Like I remember making all of those [projects] and all of the people, oh that was really nice to watch!

Wow, that was really cool! That was so neat, it was literally like watching all my memories.

Wow, that's really wow! That was really, that was impressive and amazing. Surprisingly, you know the whole variety and how customized it was and like how in detail it was, that was incredible.

## Key Themes

A series of themes emerged from children's comments in the interviews. I now describe the most frequent ones along with stories (or, case studies) of Scratchers whose comments clearly illustrate the theme being discussed. Any facts I specify are based on their activity on Scratch at the time of the interview.

### 1)  *Reflecting on personal experiences*

The diverse stories shown in the video sparked several children to reflect on their personal experiences, efforts, and inspirations. The stories and thumbnails of their projects made them think about how hard they worked on some of them.

> *I remember like doodling in school how I wanted it [the project] to look like and seeing the thumbnail again come across the screen reminded me of when I would stay up late, draw, and try to plan it out.*

**Scratcher story: Ria**

Ria is 18 years old. She has shared 57 projects on Scratch. She joined Scratch in 2014. Ria really liked how the video made her remember the first people she followed and the first project she had made. One of the stories made her think about her initial experiences on Scratch.

> *I remember when I first started Scratch, I didn't know anyone, I didn't know how to use the program at all. And my friend from my math class told me what her username was, and so I looked her up, and I loved and favorited her platformer she had made. I remember that, and **that was exciting for me to love and favorite for the first time**, and she was my first follower, and I think she loved and favorited my first project, and so **that was special to remember.***

On her project with the maximum scripts, she shared a personal story about how she came up with the idea and why seeing that project made her happy.

> *That's the project I worked most hard on. I've never worked harder on a project than that one. I can say with much certainty. I had looked at several animated series on Scratch, and I thought they were all really cool. I didn't even know you could animate like that in Scratch. And, I was actually interested in voice acting, and still am on Scratch, and I thought it will be really cool to start my own series, but I didn't think I was able to, and so I kind of brushed it off. But then I actually like heard my sisters playing this game in this imaginary world that all these characters live in, and they pretend to be different characters. And I thought, wouldn't it be cool if I animated their story. And so I got this idea and I went with it and I wrote non-stop and so I decided I did want to turn it into a series. Actually, it reflects my faith and I decided I want to make a trailer to let everyone know about it. I think I worked for 3 weeks nonstop on that trailer. And because I had only animated once before, so it took me a while coz I had to retrace my steps a lot and go backwards. But **I have never been so satisfied at sharing a project than I had with the trailer so I was very happy that that one came up.***

Ria also shared that she had spent a lot of time on her most loved project. During the call, she pointed out to me that she was wearing a T-shirt that she had gotten made to commemorate that project.

### 2)  *Reflecting on creative and collaborative experiences*

The video highlights the projects made by others in the community that children favorited or remixed. This sparked several children to share stories about how they got inspired by other people's creations. Some of the Scratchers also reflected on how they had started

collaborating with others in the community. Collaboration is a central part of children's trajectories on Scratch, but it is often undervalued in computational learning contexts.

> *There was one part of the video where it said I went from a project that had one sprite to a project with thirty-five, and that was actually a MAP [multi-animator project] that I helped make with a bunch of other Scratchers. That was like, I went from making projects solo to working with other Scratchers to make something, that was really cool.*

**Scratcher story: Dani**

Dani joined Scratch in 2015. She has shared 209 projects on Scratch. She has also favorited more than 1000 projects made by others in the community. Dani expressed how seeing the first project she remixed and the first project she favorited brought back memories for her.

> *The first project that I remixed, that's a fond memory because it's the bio for a role play and I remember deciding to remix that because I was invited to the studio for that role play. **It was my first studio invite so I was very excited by it**. It happened to be about something that looked very interesting and so I decided I would give it a try...and I've been role playing for about two and a half years now!*

> *Seeing the first project I favorited you know literally brought me back to that time, like I remember looking through it. That used to be a topic long time ago. It brought me back to that time and you know that was really interesting seeing and remembering.*

I found it interesting that the absence of some of Dani's collaboration projects in her *memories* video made her think about them and share how they have been an important part of her journey.

> *Some projects that I sort of wished I had seen were probably some of the collaboration projects I was in, like the multi animator projects I've hosted, because you know **that was one of the first ways that I interacted with the Scratch community a lot, by working with other Scratchers on planning to make a game or multi-animator projects**, I call them MAPs for short. I've been making multi animator project parts for quite some time.*

Dani added how she tries and be very helpful to the community, trying to give back if she can now for all the things Scratch has helped her with. She also talked about how *Scratch Memories* makes her think about the fun she has had being on Scratch. As I had shared in the *play* phase earlier, I noticed that in my interviews too children used the word *memories* often to refer to their experiences on Scratch.

> *It's really nice coz it brings back all the memories and you know I have a lot of fond memories with Scratch and all the fun I've had with it. You know making internet friends, interacting with the community and helping out, being FPC (front page curator), and **it's just happy feelings, makes you think back to all these different times**.*

### 3) Reflecting on connections and friendships

Almost all the children expressed that one of their favorite parts of the video was seeing the world map visualization that shows the countries where their followers are located (data is based on the self-reported information by the user). Many of them were surprised by this discovery, as this is not shown anywhere on their Scratch profile.

## Scratcher story: Casey

Casey is 13 years old. They have shared 33 projects on Scratch. They joined Scratch in 2016, although they had an account earlier that they stopped using. Casey liked seeing how many people they connected with in the community, and also the friendships they kept over time.

*I liked seeing how many people I've connected with, because I feel I've made a difference kind of, just knowing that people wanted to talk to me or be with me.*

*I had never really checked the first followers thing, and I felt really happy because **I kept those friends**. I'm still with them, I still talk with them. So that's really cool.*

They further expressed how the community has played a big role in their Scratch journey, and shared the story about how they got so engaged on Scratch, and even got their grandparents to try Scratch.

*When I started, I started at school, and I hated it, because my teacher didn't really explain how to use it. Like she didn't show me the community, she didn't show me everything, it was just coding, and the coding is great, but I feel like the community also really adds a certain part of it, that makes it really enjoyable. Then my sister was doing it with a friend and she told me that I should join. I did, and I stopped using the Scratch account that I had created and I got more into it because I discovered that there was a community and it kind of made it more fun and I can also learn, it was like a win-win situation.*

*So I kept doing it and then I finally wanted to create an account that was cleaner and nicer and so I did, and I got really into it. **I thought well what if my family also got onto Scratch, so I asked my grandma and grandpa to join so now they both have accounts and they really like it.** They are enjoying it, so that was kind of cool.*

They further reflected on how the reasons they like the projects made by other Scratchers in the community have also evolved over time.

*Honestly, I think when I first started following people and favoriting and loving the projects, I was kind of just thinking about how great they were and how I wanted to be like them and how I really wanted to improve and just remember those projects so I could create a kind of version of them on my account. And, as gone through my scratch 'journey' I guess :), now when I favorite projects, it's the same reason, except **it's also about showing that I appreciate what they are doing**, and how they are really making a difference to the world, and how they should keep doing it, and how I think it's really awesome what they are doing you know.*

Casey shared how they found and connected with people in the community who had common interests as them, and how they learnt new things with them.

*I was part of the baking studio that was featured recently, like I was there and helped start it and everything. It was really awesome, because I love baking and my friends like baking in that studio and it was really cool to show the appreciation of baking to the world. I learnt new recipes, I learnt what people like baking, and I could bake whatever other people liked and it was really exciting, because **none of my friends like baking at school, so it was really awesome to find new people that did**, so I could connect with them with that.*

### 4) Discovering new insights

Many of the children were surprised to see the different insights presented in their video. Some reflected on the reasons why a project had most sprites or scripts, thinking about how they learnt to use new programming blocks over time. Others were delighted to see the number of people who remixed a project they had made. And, some were surprised by their own journey.

> I was surprised to see that I actually did so much stuff on Scratch and had that I guess shown to me, because I didn't realize that I was going to get this into Scratch when I first started.

### Scratcher story: Ann

Ann is 14 years old. She joined Scratch in 2015, and has shared 26 projects on Scratch. She shared how she really liked that the video showed her things about some projects that she didn't even know. For instance, her project with most number of sprites got her curious and she started thinking out loud about how she might have made it.

> It was my first memory game, because I made three now. I do remember making it. **I think that was the time before I started using clones.** I could have used clones, or I could use clones now and have it a lot less sprites. Ya, I don't actually remember having that many sprites in there. So I'll probably check that out, it's not even that many, it's got like 38. Actually, that's quite a lot. I'm not really sure. I'd like to see how I used that many sprites in a project though, coz I'm pretty sure my most recent memory games didn't have more than 10. That would be interesting to compare.

This also made her reflect on how learning to use new types of blocks in her projects made her feel really happy.

> I know that when I started using clones, that was like a big accomplishment for me because I could use like clones and less sprites and that made me really happy because it was like more difficult coding.

She wondered about the project with the maximum scripts as well, and as she was thinking, she reasoned with herself as to why it was that particular project.

> That was one of my guesses, I didn't know it was that one specifically, I thought it could have been, well actually, when I think about it now, it makes sense, because the other one I thought that could have been, just had very long scripts. But I didn't necessarily know that specifically.

Other things that surprised her were the first project she favorited, number of people who remixed her project, and the map visualization.

> I feel that I remembered or I could kind of like guess which ones, umm but like the first project I favorited, I didn't remember that, and then when it popped up, I was like Ohhhhh!

### 5) Reflecting on their growth over time

This is the most prominent theme of all. All of the children expressed that watching their *memories* helped them see how far they've come since the time they first started. The responses ranged from a feeling of proudness, nostalgia, and even reflections on their evolving personal identity. Some of the Scratchers shared about how building on their experiences, they are now teaching other young people in their schools and communities about Scratch and creative coding.

> *When I first created the welcome project, I had not come out like as having any other gender or any other sexuality. So I think as I've grown and become a different person, and have done new things, that I really changed and it's kind of awesome to see how much my life has changed for the better and how I think I've helped new people by just being myself.*

> **I felt really kind of proud because it's kind of amazing to see how far I've come**. *It's not my first account so it's just amazing that I've done so much in that short amount of time.*

> *I see some of my like older projects with the older art, the older coding. And, I see like my newer projects that I am proud of, really proud of. You know you can sort of see the change in all of them. You can see the older projects and the newer ones. You can see how you've improved and grown. You know just makes you think back and think of how much you have improved and how much Scratch has helped me learn and grow with all these different skills, you know art and coding. For my very first project, like I wasn't very good with art and now I'm really sort of more confident and I enjoy it more and coding, I'm more confident with that.*

### Scratcher story: Avery

Avery is 17 years old. She joined Scratch in 2016, but has been using the offline version for couple of years before she joined. She has shared 37 projects on Scratch. Avery expressed how watching her *memories* was sentimental for her.

> *It was really nostalgic you know. Like seeing all my old projects listed there, and then like seeing how I've grown so much through Scratch, like how my projects have evolved over time, that was really cool to see.*

She also reflected on the role of other Scratchers in providing her encouragement to keep going further.

> *One of my first followers was the person who provided me encouragement to keep making projects and really gaining confidence in my projects I guess so that I would continue doing stuff on Scratch.*

Avery shared how Scratch has been a big influence in her life, and has led her to do things that are very meaningful for her.

> *It gives me a warm and fuzzy feeling you know, it's been a big part of my life for the past year I guess.* ***Because of Scratch, I've gotten involved with this programming class at my school where I teach kids how I use Scratch,*** *and that was pretty special you know, because like Scratch was the root of everything pretty much.*

### 6) Feeling inspired to do more

Many Scratchers expressed how looking at their journey made them feel inspired to create and share more projects, try new things on Scratch, and actively engage with the community. A couple of children reflected on how they had not been very active on Scratch recently because of school, but watching their memories made them feel like participating more actively. Other Scratchers who saw some repeated projects in different categories, expressed that this makes them want to share more projects so that they can see different types of *memories* in their video.

> *The video reminds me of how fun it is to be on Scratch. I think it definitely encourages me to keep on Scratching which is pretty important I think.*

## Scratcher story: Jordyn

Jordyn is 16 years old. She joined Scratch in 2015, and has shared 70 projects on Scratch. Through watching her *memories*, Jordyn reflected on her own progress, and how that makes her want to keep going further.

> *I started out kind of not really knowing too much and just kind of experimenting, doing bunch of different things. Then my work became like streamlined and I became more I guess knowing what I'm doing and so it showed how at the beginning all the kind of stuff that I was experimenting with and all the different things that I was trying out, and then how like now like I know a bit more about how to use all the different things and stuff like that. So that's very cool to see that progress. Progress between how I started and how I am now.*

> **Looking at how far I've come and looking at all the stuff that I've done in the past kind of makes me want to make more stuff in the future.**

She acknowledged how she was not very active on Scratch recently but watching her *memories* inspired her to get back on it again.

> *I haven't really been on Scratch a lot recently. I mean like I have been on it but I haven't really been making a lot of things because of school and stuff but I guess watching this kind of makes me really want to go back and get really, really into it again.*

## Reflection tools as gears that set conversations in motion...



I refer back to Papert's gears once again, but this time, to their actual meaning. In talking about them, Papert mentioned, "*I found particular pleasure in such systems as the differential gear, which does not follow a simple linear chain of causality since the motion in the transmission shaft can be distributed in many different ways to the two wheels depending on what resistance they encounter.*" I find in his description of gears, the description of what reflection tools should be like. The purpose of a reflection tool is to not be sufficient in itself, but rather to act as a catalyst that can set in motion reflective conversations. Through the interviews I had with children, I found *Scratch Memories* to be the starting point that evoked children to reflect on their journey and share their stories with me. Like the motion of the gears, the stories children shared did not always have a linear or direct connection with what they saw in their video, but the video set in motion their reflections in many different directions that were unique and personal to each young person.

# 4.2 Children sharing back as **designers**

Towards the end of the interview, I asked children what they might like to add or change in their *memories*. Almost all of them initially expressed that they would not like to change anything, and that the stories presented covered all of the important milestones in their journey.

> *I can't really think of anything else that would be different that I wanted. I think it included everything that I want to share about my journey with someone.*

Upon further thought, children reflected on other stories they would have liked to see in their video, as well as suggested some features that could be added to the tool. Some of them also critically reflected on the design of the tool, and made thoughtful remarks on how this can be a meaningful tool for all Scratchers by thinking about the different phases of their own journey. I highlight some of the common suggestions that emerged and the critical observations children made about the tool.

*Common Suggestions*

**Studios:** A studio in Scratch is a collection where users can put multiple projects based on a theme. Many Scratchers expressed that it would be interesting to see studios they helped create as part of their video. As was evident through children's responses in interviews, studios play in important role in how they interact and collaborate with other Scratchers in the community. However, the data about studios at the time was not available through the Scratch API, and hence the stories about studios could not be generated by the tool.

**Project they spent most time on:** On seeing different insights about their projects in the video, many children wondered whether the tool could also reveal the project they spent the most time on (in creating), and expressed that it would be interesting for them to know about it.

**Memories from multiple accounts:** It is common for children to have more than one account on Scratch. Several Scratchers expressed that they would like to see their *memories* from multiple accounts together, as that would give a more accurate picture of their journey.

**Customizing their *memories*:** Some Scratchers expressed that it would be nice to make their *memories* even more personal by having a way to include thank you messages for other Scratchers in the community. Others thought it would be exciting to add the projects that are personally special to them. One of them expressed that although one of their favorite projects was shown in the video, it could be interesting for it to be identified as their favorite project. Another wondered about the cons of customizing by thinking of a case when someone might change the text of the story from 'this is my *first* project' to 'this is my *worst* project'.

**Comments:** Some Scratchers felt that the personal parts of their journey also include the discussions they had with other Scratchers in the form of comments. They further reflected that although adding comments directly would not be a good idea, but it could be interesting to highlight the person that you have exchanged most number of comments with. Others expressed different reasons. For example, one of them said, *"I think one interesting thing to look back on is what you said, like comments and stuff, coz your voice changes so much. I'm pretty sure in my old comments, I had like no grammar! I think it's interesting to see that, it really shows how you've changed. Especially when you're really young…so me and my brother were looking at the stuff that we posted years ago, and were like - What! Was that me! Let's just throw it out, no one must ever look at that :)"*

### Critical Observations

I was amazed at how children thoughtfully reflected on different aspects of the design and the core ideas behind the tool.

- For instance, one of them reflected on the delicate balance between showing numbers and statistics alongside the more personal stories in the tool. She commented, *"I think it's a good balance here, because it doesn't say, oh you have this many followers, or you passed this amount of likes, it's more like you connected with these people, and I think remixes is not really so much of an achievement, but more of a nice thing, you are kind of spreading your ideas and collaborating, which is nice. The first people who followed you is more of a support sign than a numbers thing. So I think, when it comes to that, it's quite good and balanced."*

- Others expressed that having their journey shown as a video makes it more personal and intimate to the Scratcher as compared to a dashboard showing specific facts. One of them also shared that the video gives more insight about a Scratcher than their profile page on Scratch, which shows the hard facts of what they've done, but not their stories and journey.

- Another important observation made by children was on the role *Scratch Memories* could play in encouraging Scratchers to not unshare their initial projects as they gain more experience, as they can now see those projects as part of their progress.

- One of the things that I really appreciated was the perspectives children brought that I could never have thought on my own. For instance, one of the participants shared, *"I would may be include the things that didn't go so well, like if they ever made a mistake or said something mean, and then show something that was really nice and really helped someone, so that they can be shown that things changed, like not all people stay the same, and even if you make a mistake, you can always do something to make it better, you know. I feel like that would be really nice, coz some people on Scratch feel upset about themselves and if they were shown that things can improve, that would be really helpful for them."*

Another wondered about the impact of including stories about achievements, such as being *front page curators*, that often are applicable to a smaller portion of the community. They shared, *"Like things on the front page, I know people get very excited about that, I mean obviously I get excited about it too, so that could be recognized, but at the same time, I don't think people should be focusing on that, because creating projects is kind of very personal fun thing to do, and just to get followers is not the right reason why you should enjoy making projects so it could be recognized, but it also might make them focus on that more so it could go either way."*

- When it came to sharing their *memories* video with others, there were multiple views based on personal preferences of the Scratchers. Most were excited by the idea of sharing their *memories* and being able to see others' *memories*. One of them felt that their journey is more personal to them, and that they might consider sharing it on special occasions to celebrate a milestone. Others felt that most people would love to have their *memories* video on their profile but there should be a way for the Scratcher to disable it, if they want to.

By involving children in thinking about the design of the system, many new ideas and avenues for future work have opened up, such as adding other types of stories and visualizations, exploring how might children want to personalize their memories, and supporting ways for children to share their memories with others within and outside the Scratch community.

# 4.3 Sharing memories together – new research directions

In addition to the interviews, I also shared *Scratch Memories* at three public Scratch events by having a booth where anyone could come in, and enter their username to watch their *memories*. Over 50 people (including children, parents, and educators) interacted with the tool at these events. I want to highlight one particular incident from these experiences that really expanded my thinking about how the tool can be used in ways that I had not initially conceived.



At one of these events, I shared *Scratch Memories* on a big screen and invited Scratchers to come on the stage and enter their username. One girl volunteered, and as soon as the video started, other children in the big hall started clapping and cheering. The girl who was seeing her *memories* on the stage started dancing (Figure 23). It was quite a sight. After that, everyone wanted to come up to see, as well as share their *memories* with others in the room (Figure 24). This was an insightful moment for me. Up until now, I had thought of *Scratch Memories* as a personal reflection tool for children, but this particular experience made me look at it as a medium for children to celebrate their *memories* together.

I may be wrong, but in my experience, I have never seen children celebrating each other's scorecards or dashboards, or being eager to share them with a room full of people. I hope that *Scratch Memories* and the girl that is dancing with joy can inspire others to design experiences that evoke similar joy in any learning context.

The story of this day doesn't end here though. After I ran out of time on the stage, a group of girls who all happened to be from the same school surrounded me to watch their *memories* together (Figure 25, next page). It turned out that the first project favorited by the girl on the left was made by the girl on the right, and she was both surprised and elated to see that. This was another powerful moment for me . It opened up an exciting new direction for the research that could explore the interconnected trajectories of young people, and reveal such surprising connections to them. This can especially be meaningful for educators who can use this tool to celebrate and recognize the diverse learning trajectories of children in classroom settings.

On the next page, as promised, I share more smiles of children through pictures of them while seeing their *memories* (the photo and video release forms were signed in advance for the events by the parents/guardians).
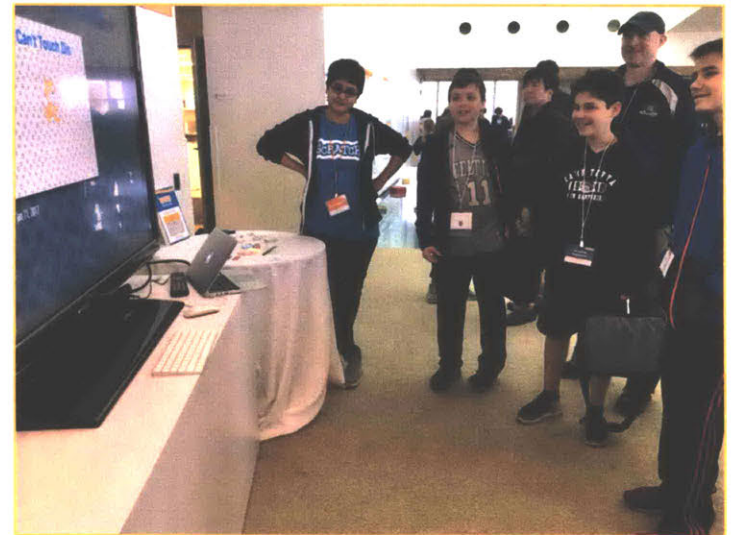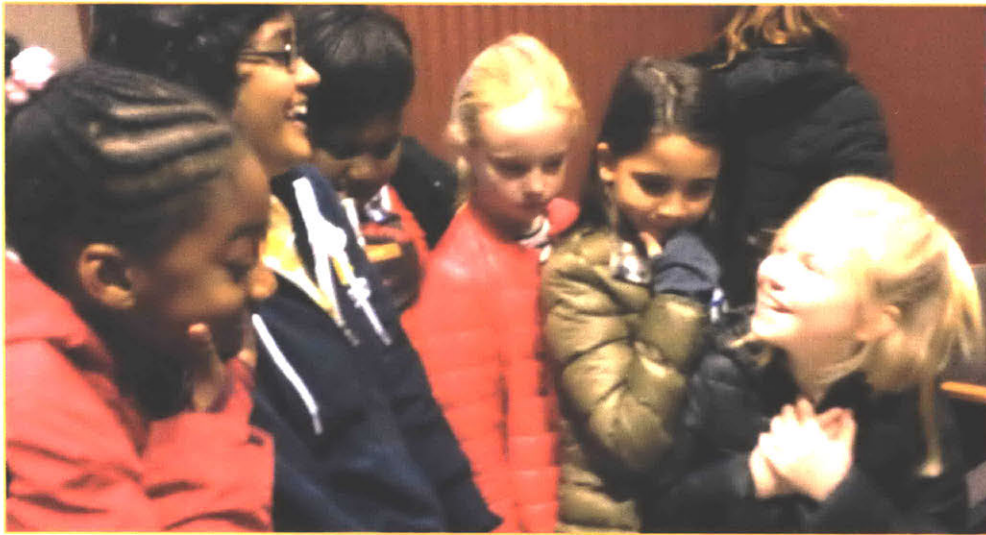
Figure 25: Reactions of children watching *memories* together

# 5. Reflect

I use this phase to reflect on both the technical limitations and the affective challenges that I see in my work on *Scratch Memories*. I highlight the new opportunities for extending *Scratch Memories* in meaningful ways in future. Finally, I propose three core guidelines that I believe can support others in designing learner-centric reflection tools and experiences using data.
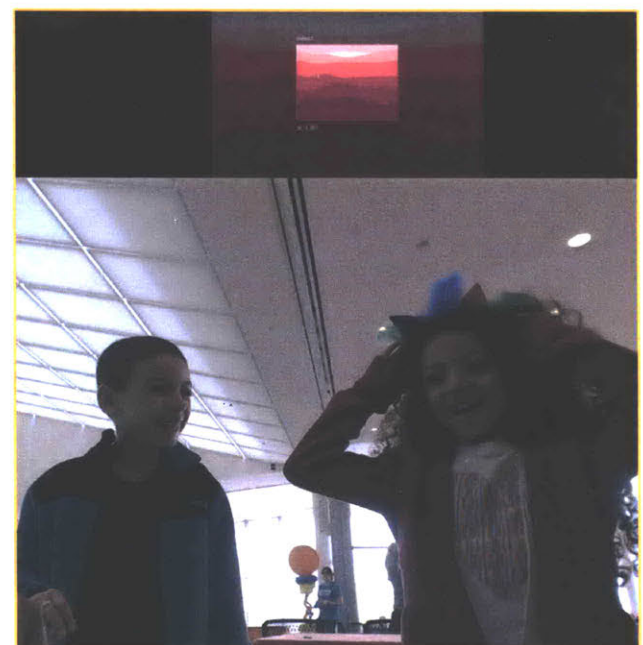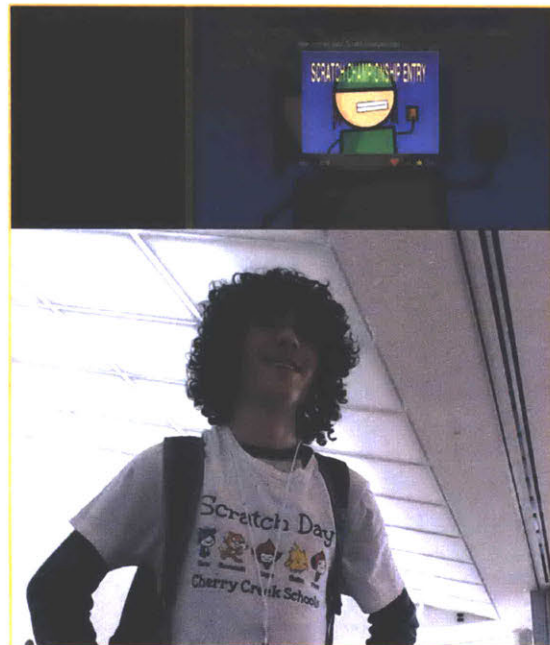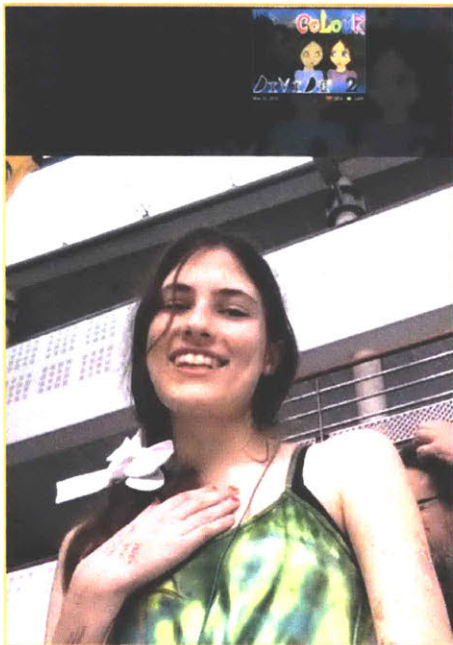
# 5.1 Challenges and opportunities

As I shared *Scratch Memories* with children and observed their stories revealed through the tool, I was able to reflect on the both the *technical limitations* of the tool as well as what I call the *affective challenges* that surfaced during children's interactions with the tool. I make a distinction between the two as the latter cannot be resolved by tweaking the tool in any way, they are deeper issues that need careful considerations from many different points of view. I highlight these limitations and challenges below:

## Technical limitations

- *Scratch Memories* currently generates stories based on the data available from the Scratch API. The data about studios, comments, and other types of public activity of the user is recorded but is not all yet available through the API. Over time, as these API routes are developed, the tool will be able to generate a richer variety of stories for the user.

- Currently, the user cannot pause or interact with their *memories*, as the stories are being dynamically generated in the application. In the future, I hope to develop an interactive version that can be made available once the user has seen the auto generated *memories*. The users will then be able to move through their journey on their own pace and possibly interact with the projects from within the application.

- The tool only works for Scratchers who have shared projects on Scratch. If a project was shared earlier but unshared at the time of interacting with the tool, that project will not be part of the video.

## Affective Challenges

During my observations of children interacting with the tool on the Scratch Day held at MIT recently, I noticed a couple of children who felt embarrassed about few of the projects that appeared in their video. They even placed their hands on the screen to cover them. It puzzled me initially as I thought that the system is only showing the projects that they have shared publicly on their profile. The difference in this case though was that they were seeing their *memories* in an open space with other people watching their video — including people whom they didn't know.

I bring this issue as just in the previous section, I had discussed how sharing together turned out to be a wonderful opportunity for children to celebrate each other's journey, but this experience seemed to suggest otherwise. As I reflect further on the issue, I realize how it's important to be sensitive to children's personal preferences around sharing, and to be careful to not make assumptions. Children's journey on Scratch is like their creative portfolio — there might be projects they are proud of, and others that they might think do not represent their best work. Certainly, giving the ability to the user to *customize* their *memories* can be one way to address this issue. More importantly, however, before using *Scratch Memories* to engage children in sharing about their journey in group settings, the values that should be considered are the same as that apply to creating any kind of 'safe space'. That implies creating an environment where children feel comfortable to share their *memories* with others, and where they do not see their *memories* as a way of judging themselves and drawing comparisons with others, but rather as a way to celebrate themselves and connect with others.

In my experiences, I have seen a child celebrating the story saying that *1 Scratcher remixed their project*, and another one brushing off the fact that *5 Scratchers remixed their project*. For whom should the

tool be designed? The child who was excited that there is one person who got inspired by their project, or the one who got upset that only 5 people remixed their project. Should the numbers be shown or not? Every time I share *Scratch Memories* with a child, I worry and struggle about these emotional challenges. The roots of these different reactions run a lot deeper than what can be addressed by the tool. But I still believe…

there is always room to be more *careful*, more *caring*, and more *creative* in the design of such reflection tools and experiences for children.

As a small example, I wonder if instead of only showing the number, I show a collage of the remixed projects including the names of the people who remixed the user's project. May be that way the focus will shift away from a number to the diversity of ways the Scratcher's project inspired others in the community. As I had shared in my *create* phase, every small design choice plays a big role in creating an experience that is meaningful for children. I hope to continue working on the 'small' design choices in *Scratch Memories*, while simultaneously exploring new ideas, questions, and opportunities for extending this work. I highlight some of these possible opportunities below:

## Opportunities

- **Customization**: Adding customizability to *Scratch Memories* needs several careful considerations — what level of customizability should be added? Should there be a list of personalized stories that children can choose from? Or, can they construct and design their own stories, choosing their own projects, text, and flow. This would further raise moderation issues around the content. Another aspect of customizability is about the design of the tool. Is it better to keep the design constant so the experience of *Scratch Memories* stays uniform for all the users in the community, or can children add their own illustrations or music? Although these issues require more thought, through my experiences observing children interact with the tool, my inclination is towards having *Scratch Memories* as a uniform experience for all Scratchers. That way, members of the community will be able to easily identify with each other's journey. However, I do believe generating a richer variety of stories with children's data, giving them a way to enable and disable some of these stories, and adding ways for them to select the people they want to thank are some of the ways that can greatly add to the experience of *Scratch Memories* for children, while avoiding any pitfalls of customization.

- **Inspiration**: Currently, as I had mentioned in the *play* phase, the tool is designed to skip the stories that are not generated for the Scratcher and show other types of stories in place of those. The next step in this direction is thinking about how *Scratch Memories* can be used to suggest and inspire people to explore the things they haven't yet tried on Scratch. This experience, however, needs to be integrated in ways that are meaningful and playful, and not forceful by design. The point here is not to *tell* children to follow a Scratcher, or remix a project, it is to *share* with them new possibilities that they may not know of, so they can decide if that's something that might be interesting for them to try next.

- **Generalization**: The word *memories* in the context of Scratch can take many different forms. There is the *memories* about children's whole journey, but there can also be *memories* celebrating children's *Scratchiversaries*, that is, their memories on Scratch for the past year. There can also be *memories* generated to celebrate friendships on Scratch. For instance, celebrating the times two people liked each other's projects or commented on each other's profiles, or when they were a part of the same studio etc. As one of the children suggested to me, there can also be *memories* generated for studios on Scratch, it can become an interesting way to explore the studios for Scratchers. I hope to explore these interesting extensions of *Scratch Memories* to engage and connect Scratchers in new ways.

# 5.1 Three Guidelines

for designing learner-centric reflective experiences with data

**Be Careful**

**Be Caring**

**Be Creative**

*We have to be careful about what we look for.* Are we looking for children's experiences in their data or for the data in their experiences? The tools we design for children with data should not be about data, but about children. Unless we value the breadth and depth of children's creative learning experiences, we would end up looking only at the data that projects our own narrow perspectives about what their learning should be rather that what it is.

*We have to be careful about what we are using children's data for.* Are we using it to empower children so they can discover new possibilities for themselves? Or, are we using it to put constraints on their imagination by charting pre-determined learning paths for them?

*We have to be careful about providing judgments with data.* Is too many blocks a sign of confusion, or a sign of tinkering?

*We have to care about what children value.* Understanding what children value, takes time, care, effort, and thoughtfulness. Developing reflection tools that can reveal the things they value, even more so. But, *children deserve nothing less.*

*We have to care about what is valuable for children.* Is it valuable for them to feel confident in expressing themselves creatively? Is it valuable for them to reflect on their own thinking? Is it valuable for them to feel free to experiment with new ideas? If the answer is yes, we need to *evaluate* if the tools we design are supporting children in all of these meaningful ways.

*We have to care about what will make children feel valued.* We should use data to design experiences that bring joy to children, that help them feel valued, and that help them feel proud about themselves.

*We have to be creative in how we design data-driven tools for children.* Dashboards and stars and badges are not the only way data can be presented. Children are creative geniuses. As designers, we need to up our game if we want children to deeply engage with the things we make.

Digital learning platforms afford so many new opportunities for designing novel and personal reflective experiences for children that were previously not possible in physical learning contexts. *We have to be creative in how we leverage technology for supporting children.*

The things children create with code are exciting, fun, and playful. *We have to be creative in designing tools that reflect children's playful spirit.* That doesn't mean adding more color to the dashboards. Children cannot be manipulated. We have to build authentic experiences that they can truly resonate with.

# 6. Imagine

**90** ***Explorable Explorations:***
\- ***Scratch BlockArt***
   **(A tool for visualizing children's colorful computational patterns)**

I feel emotional and excited at the same time. This is the last phase of my thesis, but the first phase of a new spiral of my creative journey. I deliberately chose black as the color for this phase, because it makes me think that I am back to sketching ideas on a blackboard, and that allows me the freedom to imagine and explore new directions for my work. I use this phase to introduce and share my newest *explorable exploration, Scratch BlockArt* — a tool I am developing to visualize the colorful computational patterns in children's creations on Scratch, keeping in mind of course, my data *values*.

# 6.1 Explorable Explorations

Before I dive into my *explorable explorations,* I want to describe what the term *instance* means in object-oriented programming (OOP) *(this may seem out of place, but I do have a good reason).*

Loosely speaking, in OOP, the word *class* represents a blueprint of a thing. This blueprint represents the thing but is not the thing itself. You cannot touch it or manipulate it, you just know what it will look like. It is an abstract thing. When you build it, you make an *instance* of that thing. Now, you can touch it, manipulate it, and give a name to it. It is something concrete. For example, suppose you have a *class* House. Your own house is an *instance* of *class* House. Your sister's house is another *instance* of *class* House. The *class* House describes the concept of what a house is, and the specific, concrete houses are its *instances.*

I find interesting parallels of this terminology in my own work — the 'data *values*' I introduced in the first *imagine* phase can be thought of as a *class* that represents the bigger concept and ideas that inform my work, and the 'tool' *Scratch Memories* can be seen as a concrete *instance* of this *class.*
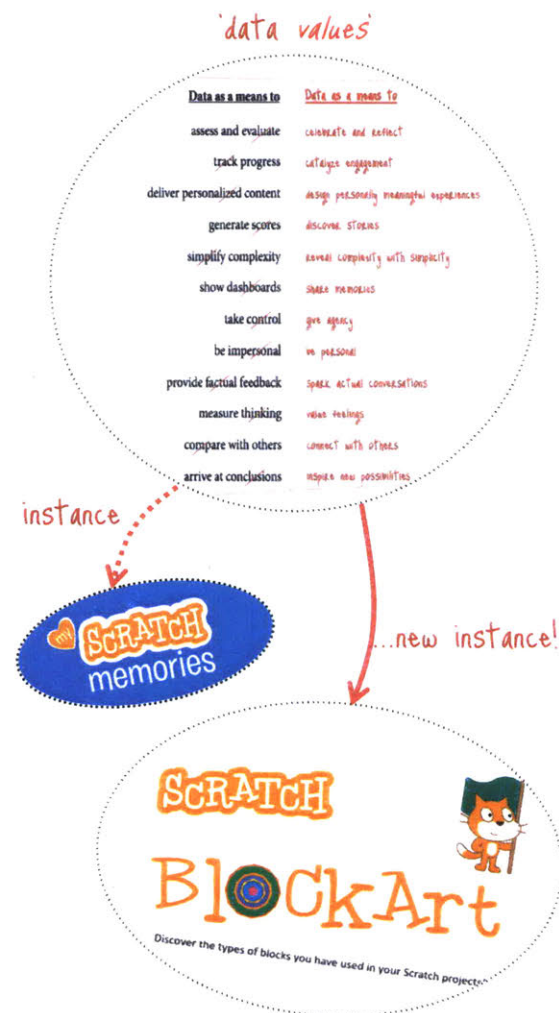


Figure 26: Designing new tools as *instances* of the *class* of 'data *values*'

Thinking about my work in these terms opens up new possibilities for imagining other such meaningful *instances* that inherit the same core values from the *class* (Figure 26). This brings me to the newest *instance* that I am still in the process of creating, and really excited to introduce here – *Scratch BlockArt.*

A side note if you are curious....

One might wonder, how am I choosing to share something that I am still in the process of creating. *Scratch BlockArt* isn't a 'finished' tool yet, but it isn't just an 'idea' either. I'm still exploring, but my *explorations* are now concrete entities that are *explorable* by children, hence the term, *explorable explorations.* It is a remix of the popular term and style of interactive reading and learning experiences, called 'explorable explanations' [46]. It was originally coined by Bret Victor, describing its goal as to change people's relationship with text – *"People currently think of text as information to be consumed. I want text to be used as an environment to think in"* [47]. In the same spirit, I want children to be active explorers in my explorations — exploring new ideas and possibilities, both for themselves, and for me, in ways that only they can.
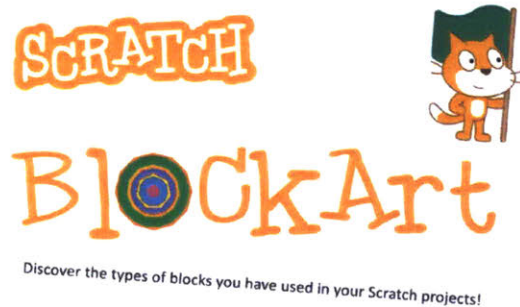
# Scratch BlockArt



Figure 27: *BlockArt* web interface

*BlockArt* is a new web-based visualization tool designed to let children discover and reflect on the diverse programming styles and patterns in their own creations on Scratch. As discussed earlier, existing tools and approaches often utilize data about the types of programming blocks used in individual projects to generate dashboards that evaluate children's creations based on limited criteria. With *BlockArt (Figure 27)*, I hope to present an alternative to such narrow and impersonal approaches used in presenting insights about children's projects.

In Scratch, the code for a project is constructed by snapping blocks together (Figure 28). The blocks are divided into different categories, such as *Motion, Looks, Sound* among others. For e.g., the *Events* category comprises eight different types of blocks (Figure 29). As can be seen, each category is identified by a specific color. I make use of this colorful categorization to visualize the different types of blocks used in a project. Although *BlockArt's* design uses the new colors of the categories in Scratch 3.0 (the soon-to-be launched latest version of Scratch), its current implementation is based on the slightly different categorization of blocks in Scratch 2.0. This was done to accurately visualize the code for projects created with the earlier version. For any Scratch username, the tool dynamically fetches data about a user's shared projects from the public API, and then analyzes the types of blocks used in each project to generate a visualization revealing the Scratcher's diverse computational patterns.

With the colorful Scratch environment as my playground this time, I'm excited to share two of my iterations (so far!) on *Scratch BlockArt*. This time though, I ask you to wear your *explorer hat*, as I (quickly) take you through my ideas, design decisions, and surprising outcomes in the process of creating another playful and meaningful reflective experience for children. I hope you'll discover something new as you explore my *explorable explorations*.
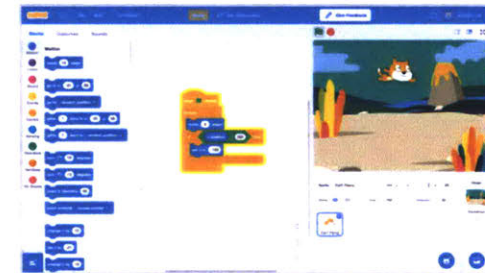


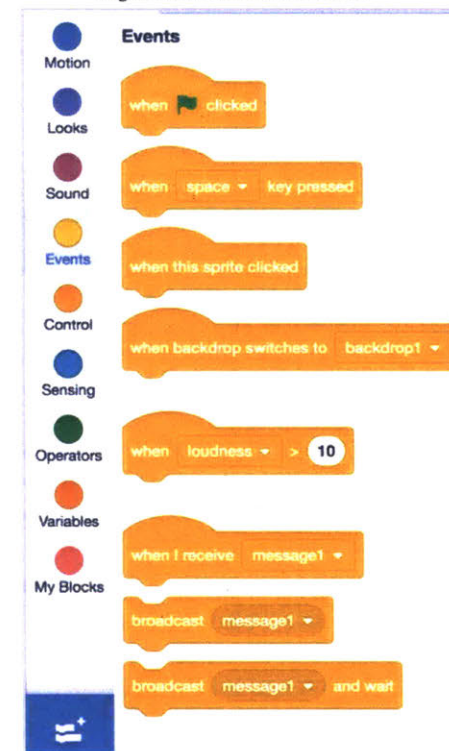Figure 28: Scratch 3.0 editor



Figure 29: Blocks in Events Category

# Iteration **1**
## *Making Spirals out of Blocks*
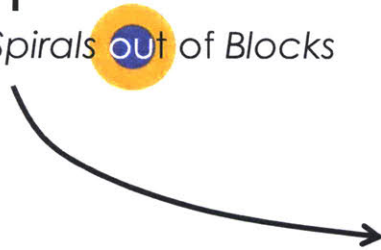
Let's jump right into my first iteration. Figure 30 shows a screenshot of the scrollable visualization generated by *BlockArt* upon entering a Scratcher's username (@AwesomeOcean) who has shared 144 projects on Scratch.

Okay, you are probably wondering…

…This is cool, but what is this?

Each colorful symbol made of concentric circles is a representation of the code of a project shared by @AwesomeOcean on Scratch. The projects are sorted according to the date they were shared in the community. To make it easy to refer to them, I call these symbols, *spirals* (because they look like *spirals* to me!).

Next, let's zoom in on one of these *spirals* to see what it represents (Figure 31), as well us explore other features of the visualization.



Figure 30: *BlockArt* visualization generated for a Scratcher

**2**

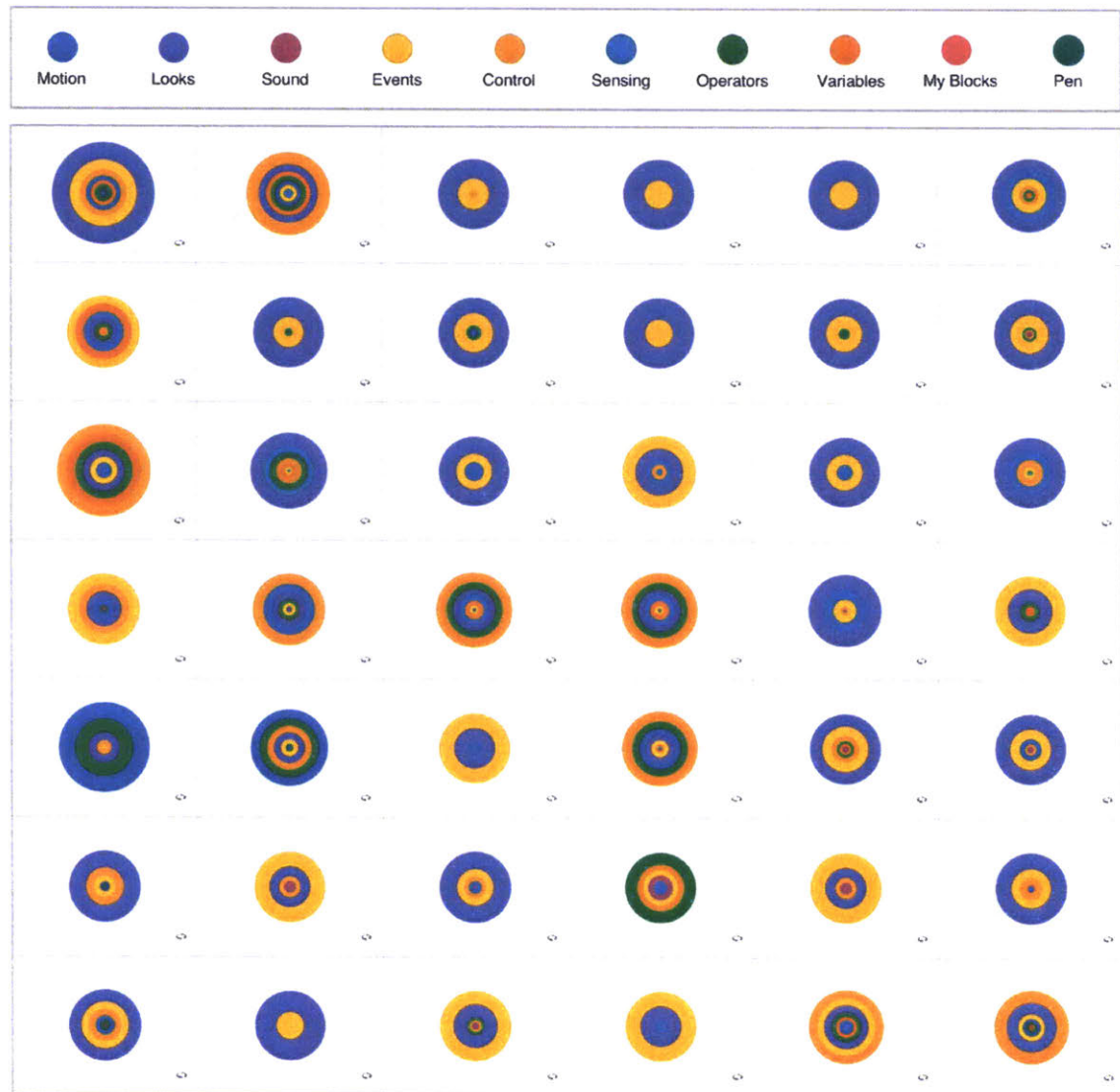The **order** of circles gives an overview of the frequency of blocks used from different categories (outermost being the most used category). The **thickness** of each circle represents the relative number of blocks used from that particular category.



**1**

The **colors** indicate the categories of blocks used in a project. For e.g., this project uses blocks from Looks, Events, and Control category.



(A snapshot of part of the actual code of this project showing the blocks used from the three categories.)

**3**

The user can **toggle** between the *spiral* and the thumbnail of the project it represents.



**5**

If a project does not use any code blocks, instead of skipping that project, the same is indicated with an **empty** circle, as it may be helpful and interesting for the Scratcher to be able to toggle and see those projects.



**4**

The total number of blocks used in each project are mapped with the **radius** of the *spiral*. So, for projects with large number of blocks, the *spirals* are bigger and more prominent.
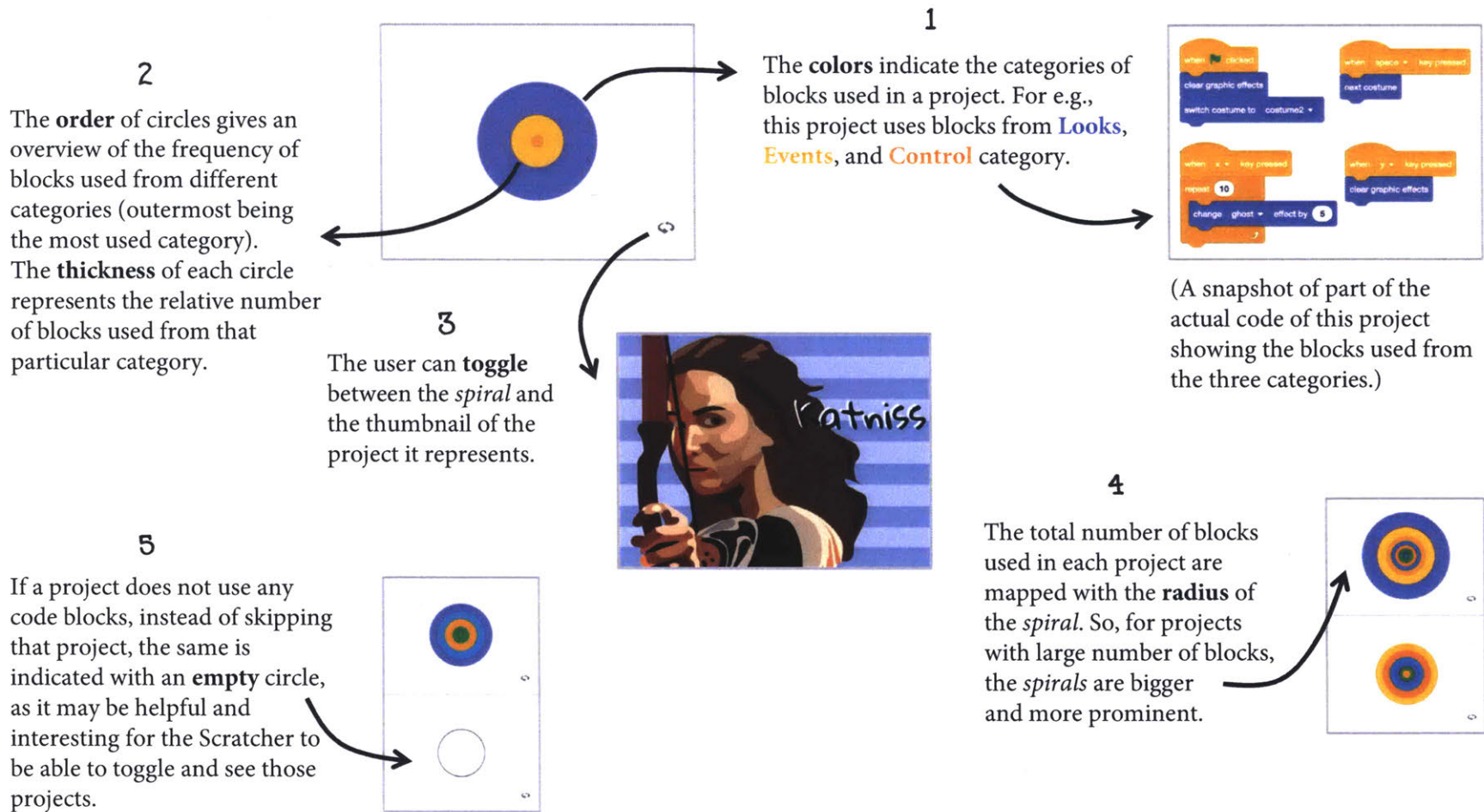


Figure 31: Exploring features of *BlockArt*

**Revealing overall patterns:** Figure 32 shows snapshots of scrollable *BlockArt* visualizations generated for projects shared by two different Scratchers. Through this visualization, it is easy to spot overall patterns showing the different programming styles of these two Scratchers. The one on the left, for instance, uses Looks (purple) category more, whereas the one on the right shows projects with higher usage of blocks from Operators (green) category. Children can find it interesting to visualize and discover such patterns about their projects.
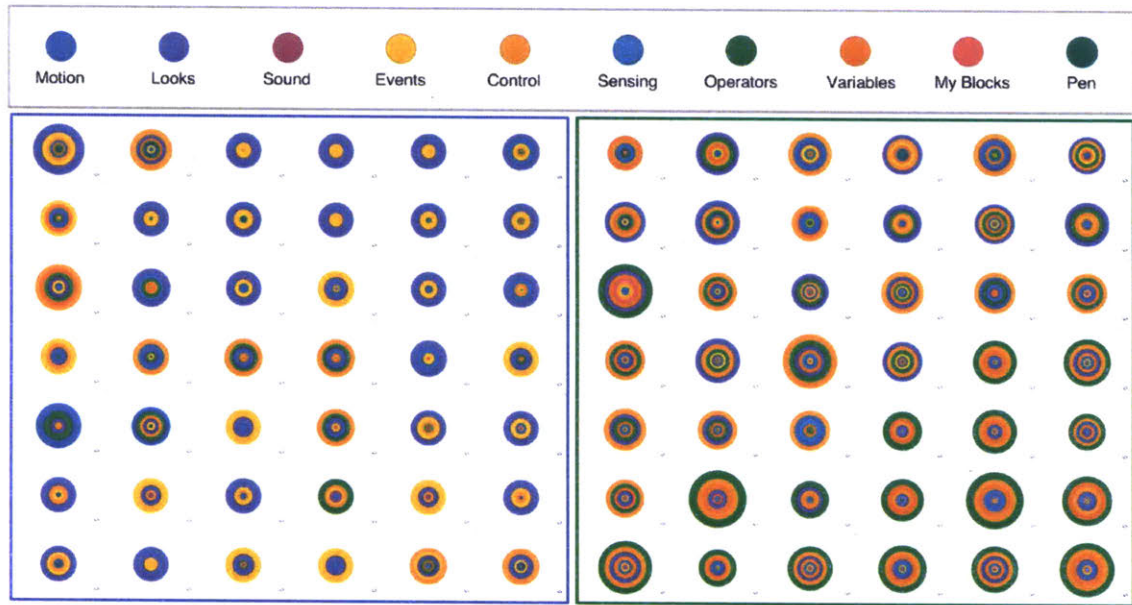
**Revealing specific patterns:**
The tool can also be used to reveal specific patterns about children's computational trajectories. For instance, one of the Scratchers I had interviewed for *Scratch Memories* had shared with me how at one time, she was really into creating logos for other members in the community. When I saw her *BlockArt*, I was surprised to see this pattern reflected in her visualization. As shown in Figure 33, all these spirals look the same, and hence it can be intriguing for the user to click through them and reflect on a particular stage in their creative journey.

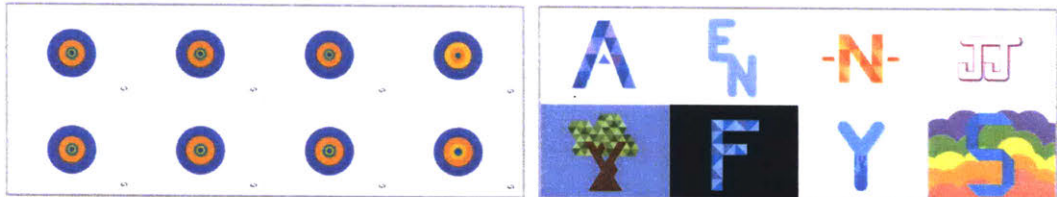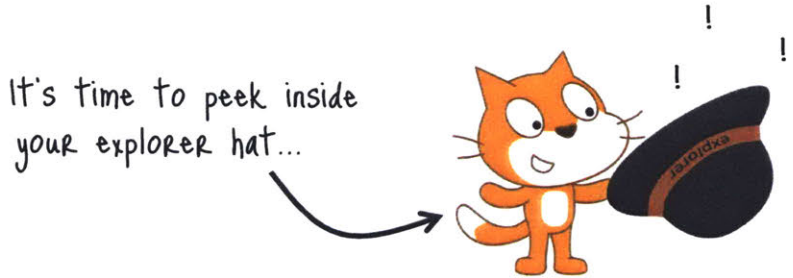Before moving on to the next iteration, in keeping with the earlier tradition…



Figure 32: Revealing overall code patterns with *BlockArt*



Figure 33: Revealing specific patterns in a Scratcher's trajectory

It's time to peek inside your explorer hat…

So, what is the point behind making *spirals* out of *blocks*?
…one might wonder.

## The point is actually to make creations out of children's data rather than datafying children's creations.

Although it may seem convenient to quickly assess a Scratch project based on the score generated by a tool like *Dr. Scratch*, it is important to understand that the programming blocks children use in their projects are closely linked with their interests and motivations behind creating that project. Assessing children's individual creations by reducing them to a quantitative score without taking into account their personal context, and the rest of their trajectory, raises serious questions around what is being assessed, and what is the role of such methods in supporting children's learning. With *BlockArt*, my goal is to flip this approach by designing visualizations that transform the data about children's computational projects into colorful creations that can spark their curiosity, and enable them to reflect on their own work in completely new ways.

In this first iteration, instead of showing exact numbers through bar charts or pie charts, I explored creative ways of revealing patterns about children's projects that are easy to interpret. Tying the image of the actual creation with the visualization of its code has also been a critical design choice for the tool. Seeing the thumbnails can spark children to reflect on — how they programmed their project; why they did or did not use certain categories of blocks; which of the projects have similar *spirals*; why are they similar; do they reuse their own code; and many other such personal insights that children can find interesting to discover through their *BlockArt*. In using colorful *spirals* to represent the code of a project, my idea was to give each project a creative computational identity of its own. I realized though that the *spirals* were good for revealing overall patterns, and also for getting the user's attention on the projects with more number of blocks (that is, the ones having bigger *spirals*), but the **spirals were not able to fully reflect the uniqueness and diversity of children's individual creations**. In addition, they revealed the categories of blocks used in a project, but not how many different types of blocks were used in each category. This brings me to my second iteration, that I'm really excited to share.

## Iteration 2
## A **H**undred ways to code

*Surprised?* I was too.

In this iteration (Figure 34), I used concentric polygons instead of concentric circles, and that changed everything. As I had mentioned, along with the categories of blocks used in a project, I wanted to represent how many different types of blocks were used in each category. I thought of using polygons, and mapped the number of sides in each colored polygon representing the category to the number of unique blocks used in that category. The implementation was not trivial, as I had to consider several different types of cases mathematically to make sure that the visualization correctly represented the code of the projects. The first time I ran my code to see the outcome, I was pleasantly surprised to see that now every project had a creative personality of its own. Again, to make it easy to refer to them, I call these new symbols made of concentric polygons, *bolygons* (because blocks + polygons = *bolygons*!). Let's zoom in some of the *bolygons* now (Figure 35), and explore other features that I added in this iteration.
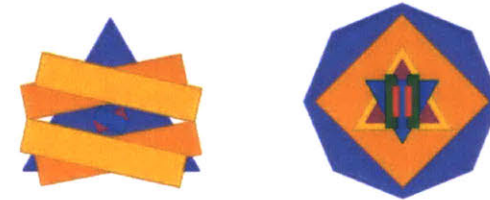
Figure 34: New iteration of *BlockArt* using polygons for visualizing the project code
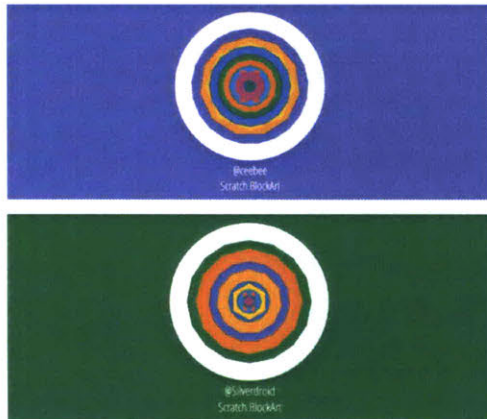
96

The **number of sides** in each overlapping polygon shows the number of unique blocks used in that category. For e.g., in this project, there are 8 different types of motion blocks used, 11 types of control blocks, 12 looks, 4 events, 7 operators, 5 variables, 4 sound, 2 my blocks, and only 1 type of block used from the sensing category.

The **order** of polygons indicate the same aspects as the first iteration.

On the top of the individual project *bolygons*, the system also generates a total *bolygon*, that **visualizes the data for all projects combined**. This is the reason, the shapes are more circular, because across all the projects, the user has used almost all types of blocks in each category.

The **background** below is the same color as the **dominant category of blocks**, the Scratcher has used. On the top, for instance, it shows that the Scratcher has used Looks category the most. On the bottom, it shows the **Operators** category as being the most used category.

What if there are **same number and type of blocks** used from two different adjacent categories? To handle this case, the adjacent polygons are **rotated** so that both categories are visible, and can be seen as having equal number and type of blocks. In the *bolygon* on the left, the control and events categories, each contain same number of total blocks and 2 types of unique blocks. In the *bolygon* on the right, the sound and motion categories contain same total number and 3 unique types of blocks in each category, and hence the triangles are rotated.

If a project is a **remix**, the system is programmed to denote it by placing this symbol next to the project's *bolygon*.

The user can directly click on the *bolygon* to **toggle** between the project thumbnail and the *bolygon* view.

Figure 35: Exploring the new features added in second iteration of *BlockArt*
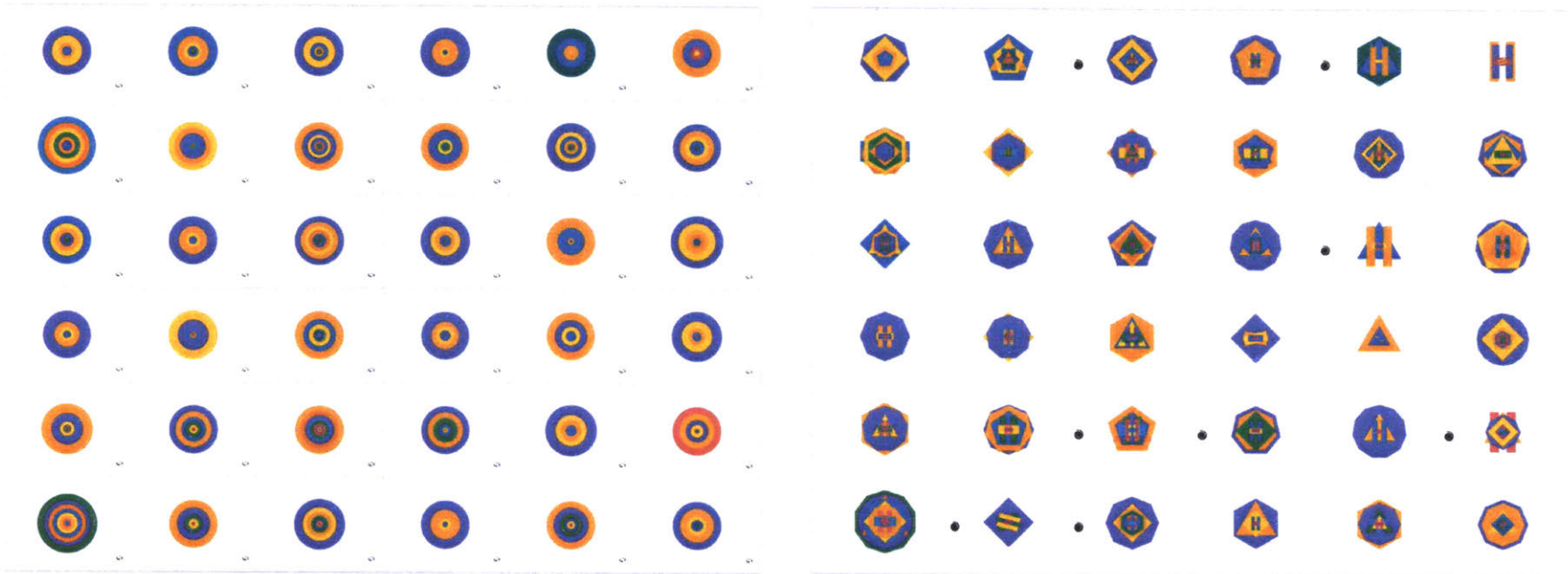
Figure 36: Comparing the two iterations of *BlockArt* (Left – *Spirals*; Right – *Bolygons*)

## Revealing a hundred ways children create their Scratch projects

Through this iteration, I was able to bring alive the uniqueness and diversity of children's colorful computational creations on Scratch. I think about Loris Malaguzzi's *hundred languages of children* again, and see this tool as a way of revealing the *hundred* different ways Scratchers program their unique creations. I was surprised to see how each project looked different from the other, and had a unique identity of its own (Figure 36). This is just a beginning, but I think these visualizations can open up new avenues and possibilities for how data can be seen as an expressive medium, and how we can utilize it to make delightful experiences that invite children to explore their creations, ask their own questions, and discover new insights about their learning styles and computational trajectories.

In these ways, I see these colorful *bolygons* as *objects to think with* [38] for children, objects that represent the things they make with love, and objects that I hope they will love.

I currently imagine a lot of new possibilities for *BlockArt*. Amongst these, I am interested in exploring the social component of *BlockArt*, thinking about how these visualizations can be used to help connect Scratchers in new ways. For e.g., What if a total *bolygon* representing a Scratcher's coding style is placed next to their profile icon in the online community (for those who choose to share) (Figure 37). It can be interesting for children to find new people to connect with, based on their programming styles.

The *bolygon* of the project can also be placed on the project page to give insight into project's code when other users are viewing that project (Figure 38). It can give a quick glimpse into the making of the project and make others curious to explore the code of the project. Scratchers can also find it interesting to see the *bolygons* for their friends' projects, and discover new connections and similarities in one another's styles. These are just few of the potential possibilities and next steps for exploring the social component of this work. Overall, I see *BlockArt* as both a new type of visualization tool and a new approach towards utilizing learner data in creative online communities — one that can support and further empower children's learning, creative self-expression, and social participation.

As a designer, with *BlockArt*, I am interested in exploring concrete and creative ways to show how data can be viewed not as a means to assess and evaluate, but as a medium to connect and engage with learners, and to provide them the agency to be in charge of their own learning. As a researcher, I am excited to share the tool with millions of young creators in the Scratch community and see what they notice, what more they might want to see, and how the tool might help shape their understanding, and further influence their creative coding styles. My hope is that as children reflect on their *BlockArt*, they might be inspired to tinker with new ways of creating their projects, to push their own boundaries, and in the process, add more sides and color to their *bolygons*.
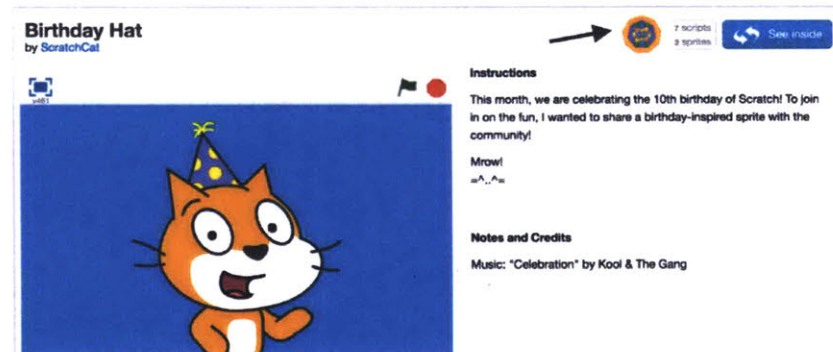


Figure 37: *Bolygon* on a profile page



Figure 38: *Bolygon* on a project page

\*\*\*\*\*

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# Afterword

# A personal note...

I have always liked making things that make people smile, that make them feel special, and that help me express that they are special to me. In my personal context, these things have taken many different forms over the years — I have created personalized birthday cards for friends, wrote a song for my niece's first birthday, designed a photo book about my nephew's first year adventures, wrote a poem for my mom's 50th birthday, the list is long…and now, of course, includes the Scratch projects that I make to celebrate the special occasions in the lives of the people I love. The joy (sometimes tears of joy) that I see on people's faces when they see my little gifts, has always given me immense joy.

As I reflect on the things I have created for children in this work, I realize that what I have really been doing all this while is trying to make similar little gifts for children — gifts from Scratch to Scratchers, gifts that make children smile, that make them feel special, and that let them know that their journey on Scratch is special, what they create is special, and how they support and inspire others is special. If there is only one message that others who care about children, learning, and technology can take away from this thesis, I want it to be this — **use technologies to gift children experiences that make them *smile***.

Thank you for engaging with my creative journey. I hope it made you smile. For me, I want to end with saying what Jordyn said — *looking at how far I've come and looking at all the stuff that I've done in the past kind of makes me want to make more stuff in the future.*

With lots of happy *memories…*

Shruti Dhariwal

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