ACTIVITIES AND FINDINGS
This section describes the major activities and findings from Year 1 of the project. The project teams from MIT and Harvard prepared this section jointly, since we worked together closely on project activities throughout the year, with PIs Resnick (MIT) and Benkler (Harvard) providing guidance to graduate students working on the project. Our other collaborating team, led by PI Kafai from University of Pennsylvania, submitted a separate report.

1. Describe the major research and education activities of the project
We are studying how cooperation in decentralized networks can serve as the basis for fundamental changes in learning and education – transforming what we learn, how we learn, where we learn, and who we learn with. We are focusing especially on how new forms of cooperation can foster and support the development of computational thinking.

As an experimental testbed for our observational studies, we are using the NSF-funded Scratch learning network, where young people (ages 8 and up) program and share interactive stories, games, animations, and simulations, using a specially-designed graphical programming language. The Scratch learning network has doubled in size since we wrote the proposal for this project: there are now more than 850,000 registered members in the network.

Our Year 1 activities can be divided into four major categories: conceptual frameworks, observational studies, design interventions, and field experiments.

Conceptual frameworks
In our proposal, we discussed two main components of computational thinking:
• concepts (e.g., conditionals, events, looping, parallelism, variables, lists)
• practices (e.g., debugging, remixing, abstraction, incremental design)
Through our studies in Year 1, we decided that these two components did not capture the full range of what we consider as computational thinking. So we added a third component, called perspectives, to our framework, focusing on the ways computation can provide a new lens for thinking about the world and about yourself – for example, seeing yourself as a designer, understanding how ubiquitous connectivity opens new possibilities, and feeling empowered to ask questions about technical objects in the everyday world.

At the same time, we continued to evolve our frameworks for thinking about cooperation, refining our taxonomies of how and why young people use networks for cooperating with one another. For example, we developed a categorization of different types of remixing:
• inspirational: based on ideas (but not code or assets) from another project
• **incremental**: small changes to personalize or fix bugs
• **component**: reusing specific code, images, or sounds from original project
• **restructuring**: major revisions from original project

We used this categorization as a framework for analysis in our research studies.

**Observational studies**
Throughout Year 1, we observed activities and interactions among Scratch community members, using both qualitative and quantitative approaches to study cooperation patterns of community members. Here, we describe two examples of our observational studies, focusing on **remixing** and **cooperative gaming**.

**Remixing.** We list “reuse and remix” as one of four key Computational Practices in our framework for Computational Thinking, and we designed Scratch to support and encourage this practice. Members of the Scratch learning network can download any of the 2 million projects on the website, view and modify the project’s graphics and code, and upload the remixed version back to the website. Since the launch of Scratch in 2007, about 2 million projects have been shared in the community, and roughly 30% of these projects are remixes of other projects.

![Figure 1: Example of a remix tree](image-url)
For his dissertation research, MIT graduate student Andres Monroy-Hernandez is studying the role of remixing in the Scratch community. He is organizing his research around three themes: the structural properties of remixing, the functional role of remixing in cultural production and learning, and participants’ evolving attitudes towards remixing.

For example, as part of his work on the functional role of remixing, Monroy-Hernandez is studying “remix trees” in Scratch to gain a better understanding of how ideas, assets, and techniques spread through the Scratch community – and how different forms of remixing contribute to this process. Figure 1 (previous page) shows an example of a remix tree originating from a Scratch game called The Jumping Monkey. The original project has been viewed only 200 times, but the tree of remixes based on the project have been cumulatively viewed more than 20,000 times. These remixes added new programming techniques, new graphic assets, and new game strategies. Two of the remixers ended up forming an online team (self-described as a “company”) to collaborate on the design and development of new games.

Cooperative Gaming. One surprising development in the Scratch learning network has been the emergence of large-scale cooperative gaming activities. In designing the infrastructure for Scratch, we did not explicit provide support for such activities. But youth members of the online community appropriated existing structures for their own purposes, turning forums (intended for discussions among community members) into a site for cooperative text-based games, and turning galleries (intended as a way to aggregate and display sets of related projects) into a site for role-playing games.

MIT graduate student Ricarose Roque, along with colleagues from University of Pennsylvania, has studied the nature of cooperation in Scratch role-playing games (RPGs). In these games, participants program animated characters in Scratch and add the resulting projects to a common gallery, and they use the comments section of the gallery to describe the actions and interactions of the characters. Roque found more than 5000 galleries hosting RPGs. The largest RPG (titled Anthros Unite) includes more than 1000 contributors, more than 2000 projects, and more than 600,000 comments. We have found RPGs a fruitful context for studying large-scale cooperation (with many participants contributing to a shared enterprise). Themes in our research include: the decentralized self-organizing structure of RPGs, the multiplicity of cooperation and participation styles in RPGs, and gender participation in RPGs.

Gender participation. As part of our research to broaden participation, we have begun to study the gender participation in the Scratch learning network and to investigate ways in which we can increase the participation of young women in computational activities. While 37% of the Scratch website’s registered users self-report as female, they demonstrate high levels of activity. Currently, six of
the top ten project creators are female and seven of the top ten project commenters are female. In gallery comments, nine of the top ten commenters are female (reflecting, in part, the high level of female participation in RPGs). However, in the discussion forums, three of the top ten posters are female. We are investigating the reasons for the wide variance in the level of female participation across different activities.

**Design interventions**

Over the course of Year 1, we have designed several new features and activities in the Scratch learning network to encourage and support (and facilitate the study of) cooperation in the Scratch community. Our most significant design interventions this year have focused on what Scratchers call “collabs” – groups of people collaborating to produce a Scratch project. Together with our colleagues at University of Pennsylvania, we organized two extended activities, called **Collab Challenge** and **Collab Camp**, that provided a framework for Scratchers to work together in collabs, and provided us with opportunities to study the nature of cooperation within collabs.

**Collab Challenge.** In January 2011, we announced a Collab Challenge on the homepage and discussion forums of the Scratch website. To participate, Scratchers needed to form collabs (teams) with at least two people, register their collab on the website, submit a draft project within a month (to receive feedback from members of the Scratch Team), and then submit a final project three weeks later. We required a two-step submission process (with feedback on the first submission) to cultivate the development of the Computational Thinking practice of iterative design. Once final projects were submitted, members of the Scratch Team selected a subset of the projects to feature on the Scratch homepage. Selection was based on three criteria: originality of the project; creativity of art, music, and animation; and elegance and sophistication of the programming code.

More than 50 collabs submitted draft projects for feedback, 25 collabs submitted final projects, and 14 projects were selected to be featured on the homepage. We collected and analyzed a wide range of data, including multiple versions of projects, comments about projects, project statistics (number of views, love-its, remixes), and discussions in online forums. Two papers based on studies of the Collab Challenge were accepted for presentation at the 2011 International Conference on Computers in Education.

**Collab Camp.** We decide to organize another collab activity in August 2011, but shifted the name to Collab Camp rather than Collab Challenge. This shift was intended to encourage a playful, exploratory (rather than competitive) approach. We selected the theme of “interactive stories” for Collab Camp, and we posted several sample projects as examples of interactive stories (and as possible starting points for remixing).
In organizing and studying Collab Camp, we put more emphasis on the role of constructive feedback in collaborative design activities. We selected several members of the Scratch community to serve as “collab counselors,” and we supported them in learning to provide constructive feedback on projects submitted to Collab Camp. Also, for Collab Camp participants in the Boston area, we organized a face-to-face meetup where they could share ideas with one another and learn strategies for critiquing one another’s projects. We will be analyzing the results of Collab Camp to gain a better understanding of how to foster constructive feedback among participants in the Scratch community.

Field experiments
We organized some focused experiments with selected members of the Scratch community to explore how different design choices influence attitudes and approaches towards cooperation. For example, we conducted an experiment to study whether the content and tone of notification messages influence the social dynamics around remixing. Each time a Scratchers’ project was remixed, the Scratcher was randomly assigned to receive one of six messages (or, for the control group, no message at all). Scratchers in one category received a “grateful” notification saying “Congratulations! Your project has been remixed. Sharing your work is a generous thing to do and a great thing for the Scratch community.” Scratchers in another category received a “neutral” notification saying simply “Your project was remixed.” Scratchers in other categories received messages focusing on reputation (“People respect your work and get inspired by it!”) or fairness (“The community is about sharing and it is fair to let others use your projects”). We are investigating whether the difference in notification messages influences attitudes and behaviors related to remixing.

2. Describe the major findings resulting from these activities
In this section, we describe several results and findings from our research activities in Year 1.

Credit and attribution
As part our research on people’s attitudes towards remixing, we investigated how project creators react when other people remix their projects. In particular, we compared the effects of two different forms of credit and attribution: attribution automatically generated by the Scratch system (i.e., “This project is based on a project by <name>”), and credit written personally by the remixer in the notes section of the project. We found that project creators respond much more positively (that is, they are much less likely to get upset about their project being remixed) if they see a message written directly by the remixer compared with a message automatically generated by the system. These results were reported in a paper at the 2011 CHI conference entitled “Computers can’t Give Credit: How Automatic Attribution Falls Short in an Online Remaking Community” (Monroy-Hernandez et al., 2011).
**Organizational structures for collaboration**

In a study of the collaborative approaches used by the groups that submitted projects to the Collab Challenge (described above), we identified and analyzed three successful organizational structures, which we described as:

- **Benevolent Dictatorship**: centralized and dependent on a strong leader, but other members enjoy participating.
- **Team Effort**: shared leadership model that spreads the responsibilities of organization, decision-making, and development across its members.
- **Friendly Partnership**: mixture of project development and social activities, with interactions fluidly shifting between Scratch project and other interests.

These results were reported in a paper “Collaboration by Choice: Youth Online Creative Collabs in Scratch” (Kafai et al., 2011), to be presented at the International Conference on Computers in Education.

**Gender participation in role-playing games**

While only 37% of the registered members of the Scratch online community self-report as female, we found an even gender distribution among participants in role-playing games (RPGs), one of the most social and cooperative activities in the community. Within each RPG, participation tends to predominantly male or predominantly female. In a study of one female-dominated RPG group, we found that young women were constructing a small sub-community of their own, developing their own norms, roles, and practices, to safely explore and dive deeply into their role-playing interests. We submitted these results to AERA 2012 in a proposal called “A Clubhouse of Their Own: A Role-Playing Game Society in the Scratch Programming Community” (Roque et al., in review).

**Gender participation in collabs**

We found that a higher percentage of young women participated in our Collab Camp activity (39%) compared to our Collab Challenge activity (27%). We believe that a number of our design decisions contributed to this increase:

- We renamed the activity from Collab Challenge to Collab Camp to emphasize a more cooperative (rather the competitive) style of interaction.
- In Collab Camp, we asked participants to contribute interactive stories, whereas most contributions to the Collab Challenge were games.
- For Collab Camp, we focused more of our promotion efforts through projects and galleries, parts of the website with higher levels of female participation than the discussion forums.

In the coming year, we plan to do further study and analysis of which design decisions factored into the higher female participation in Collab Camp.

**Designing for cooperation**

Based on the results of our Year 1 studies, we have begun to redesign the Scratch learning network with new features and structures to support and encourage cooperation. For example:

- We developed a new project editor that facilitates remixing by allowing people to drag-and-drop images, sounds, code, and sprites across projects.
• We redesigned the project notes with an explicit credits/acknowledgements tab to encourage remixers to give credit and personal thanks to others.
• We added a new abstraction mechanism to the Scratch programming editor so that people can create and share procedures with one another.

We will be testing these new features with members of the Scratch learning community in the upcoming year.

3. Describe the opportunities for training, development and mentoring
Graduate students at the MIT Media Lab have played key roles in all aspects of this project. Under supervision of MIT PI Resnick and Harvard PI Benkler, graduate students: studied collaboration among members of the Scratch online community, organized activities to foster collaboration among community members, developed frameworks for analyzing collaboration patterns, wrote papers based on research studies, and presented results at conferences. We believe that these activities provide an excellent interdisciplinary learning experience for students across multiple fields (computer science, psychology, child development, education, economics, and design).

4. Describe outreach activities your project has undertaken
Outreach is an integral component of this project. The Scratch online community (http://scratch.mit.edu) has more than 850,000 registered members, and all software and activities on the site are available for free. As described above, we have organized activities (such as the Collab Challenge and Collab Camp) to help young people learn strategies for cooperation and to help them develop as computational thinkers. As part of the overall Scratch initiative, we have offered dozens of workshops and presentations to educators over the past year, including a three-day Creative Computing workshop funded by Google’s CS4HS (Computer Science for High School) program.

CONTRIBUTIONS

Contributions within Discipline
This research is making important contributions to the fields of educational technology and cooperative learning. It is providing insights into how young people cooperate in large-scale decentralized networks, their attitudes and motivations related to cooperation, and their development of computational-thinking skills and capacities necessary for productive cooperation and creative learning.

Contributions to Other Disciplines
Our research on cooperation in large-scale decentralized networks is relevant to a wide range of disciplines, including computer science, economics, and psychology.
Contributions to Human Resource Development
The Scratch learning network helps young people (ages 8 and up) develop essential 21st century learning skills: thinking creatively, reasoning systematically, and working collaboratively. As young people create and share projects in the Scratch online community, they learn important mathematical and computational ideas, while also gaining a deeper understanding of the processes of design and problem solving.

Contributions Beyond Science and Engineering
Success in today’s society and economy requires the ability to think creatively, reason systematically, and work collaboratively. The Scratch learning network is helping young people develop those capacities.

PUBLICATIONS
