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COLLABORATIVE AGENCY IN YOUTH ONLINE AND OFFLINE CREATIVE PRODUCTION IN SCRATCH

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Few studies have focused on how youth develop agency to organize and participate in online unstructured creative collaborations. This paper describes and analyzes how youth programmers organized collaborative groups in response to a programming "Collab Challenge" in the Scratch Online Community and in an accompanying workshop with high school students. The analyses focused on modalities of online collaborations, determined the breadth of online participation, and examined local teens' awareness of the online community. The discussion addresses youth's collaborative agency in these new networked contexts, studies the role that online social awareness plays in completing tasks, and makes recommendations for the support of online programming communities.

Keywords: Collaboration; online community; programming.

1. Introduction

Much attention has been given to the growth and success of online communities in relation to education. Observations of gaming communities and networks suggest that collaboration among hundreds, if not thousands, of members can be a productive context for learning. For instance, Gee (2004) points to game affinity spaces as sites where people share interest-based knowledge, ideas, projects, and other content in distributed ways that value a wide variety of participants and their contributions. Other studies have pointed to the social production of knowledge in gaming forums (Steinkuehler & Duncan, 2009), mod forums (Hayes & Gee, 2010), or cheat sites (Fields & Kafai, 2010) as an important new literacy for youth. In general, Greenhow, Robelia, and Hughes (2009) see Web 2.0's "affordances of interconnections, content creation and remixing, and interactivity" (p. 249) as key opportunities for learning that combine creative production and social relationships.

Yet while millions of youth of all ages participate in online communities where creative production is possible, relatively few young people participate in some of the richest opportunities available there. Surveys point to different levels of engagement of online youth participants (e.g., Hargittai, 2010; Lenhart, Purcell, Smith, & Zickuhr,, 2010). While many youth are "hanging out" and "messing around" on these social sites, relatively few venture into "geeking out" and engaging in more creative forms of content and software production (Ito et al., 2009). The sites which have drawn the most attention in regard to motivations for participating in creative production are adult-populated open-source software communities like Linux and Sourceforge, or knowledge production communities like Wikipedia (e.g., Benkler, 2006; Healy & Schussman 2003; Lakhani & Wolf, 2005; Murray & O'Mahony, 2007; Raymond, 1999; Reagle, 2008; Tapscott and Williams, 2006; von Hippel, 2005). Yet little is known about how to engage and support *youth* in the types of online creative productions that Web 2.0 offers.

By design, this is an exploratory paper with the goal to understand what it means for youth to collaborate in online creative productions. Online creative production refers to the voluntarily organized collaborative design of content such as software, games or graphics through participation with others in web-based communities such as Wikipedia, Newgrounds, and others. While some of these productions can be original work, more often these are remixes of content or materials already available in online communities. Examples of such productions include fan fiction (Black, 2009) in which writers repurpose novels such as *Harry Potter* and create new story lines, often in collaboration with others. In some instances, creative content might emerge out of these collaborative interactions that could provide rich materials for research on the group creative process (Sawyer, 2007). But in this paper the focus will be on the collaborative interactions and processes that group members engage in through design.

This study focuses on youths' interactions and contributions in the context of online creative production, identifying the initiative or leadership that is necessary to organize collaboration in such online communities where participation is voluntary, size of groups varies, and members often have different expertise and might not know each other

(Zhang, Scardamalia, Reeve, & Messina, 2009). While some have argued against the adoption of these models of collaboration as incompatible with traditional school communities (Hung, Lim, Chen, & Koh, 2008), this study considers how self-organization and participation in online collaborative design activities can promote collaborative agency – the ability to choose collaborators, organize work, and design together in an unstructured context where roles, tasks, and people are not specified. We consider collaborative agency to be a key 21st century skill needed to participate in the many networked opportunities available in new media and professional groups (for other skills see Jenkins, Purushotma, Clinton, Weigel, & Robison, 2006). Youth need to develop the ability to marshal and organize co-creators, distribute work, and complete challenging tasks that require multiple people with diverse specialties to complete.

The Scratch Online Community served as a test bed for this investigation (Resnick et al., 2009). With currently over 2 million projects and 10 million views a month, Scratch is by far the largest youth online programming community and provides a compelling example of online creative production by youth. Groups, or *collabs*, as Scratch members call them, have emerged on the website, where members from all over the world work together to collaborate on Scratch projects. An open, collaborative design activity called the Collab Challenge was developed and implemented to address the following exploratory research questions: What is the breadth and nature of online creative collaboration in response to a site-issued Challenge? What types of modalities did online and offline unstructured collaborations exhibit? To what degree are local teams aware of online community and how does this affect their collaborative production? During the two-month time period of the Collab Challenge, the research focused on groups who worked together exclusively on the Scratch Online Community as well as groups who worked together face-to-face in a local workshop. The multi-modal data collection included observations of online interactions on the Scratch site as well as video documentation of offline group interactions and debriefing interviews with team members. The discussion will review dimensions of online creative collaborations and suggestions for improving such online collaborative work of youth.

2. Background

The goal of this investigation is to contribute to the knowledge base on unstructured, self-organized collaboration—a topic that has received little, if any attention in collaborative learning research (Cohen, 1994). Most of the literature on collaborative learning has examined the factors and arrangements of structured collaborations, including the nature of various group arrangements such as reciprocal teaching or jigsaw techniques, interactions with members of different gender, race, ability, and experience, and causes for success and failures of group work (for overviews see O'Donnell, 2006; Webb & Palinscar, 1996). This literature provides us with important insights on how to set up small groups inside and outside of schools. Yet little is known about what youth need to learn in order to collaborate effectively in such situations when the choices of collaboration, partners and topics lie on the students (Kafai & Peppler, 2011). Though a

few studies have begun to map out issues of understanding collaboration and learning in more distributed Web 2.0 communities (Dohn, 2009), including examining issues of trust building (Gerdes, 2010) and studying knowledge diffusion across and within local and virtual worlds (Fields & Kafai, 2009), much more needs to be done to understand the challenges of successful creative production in such unstructured environments.

One notable exception is the research in the Knowledge Forum tradition (Scardamalia & Bereiter, 1991) that has examined different aspects of students' construction, sharing, and assessment of knowledge (e.g., Ares, 2008; Eddy, Chan, & van Aalst, 2006; von Aalst, 2009) as they work together in structured or unstructured groups. Though a far cry in size from today's social networking sites, Knowledge Forum researchers have engaged whole classes of students in science inquiry while contributing to a communal online database. Most of the Knowledge Forum research has focused on arranged small groups contributing to a class-wide communal database with recent studies also including open and flexible, or opportunistic, groups. In the latter studies, researchers found that students' knowledge building and engagement was equally successful in both opportunistic and arranged collaborations (Zhang et al., 2009).

Outside of classrooms, only a few studies have examined large-scale communities for creating online collaborative learning opportunities such as studying wiki design activities for university classes (Rick & Guzdial, 2006) and the factors that hinder student collaborations in wiki-like science activities (Forte & Bruckman, 2007). Though primarily about young adults rather than children, Luther and colleagues' recent research on online creative collaborations is particularly informative about how adult participants form, design, and share their work in groups, also called collabs (Luther & Bruckman, 2011; Luther, Caine, Ziegler, & Bruckman, 2010). They found in their studies on Newgrounds.com that collabs were successful when they had leaders that assumed responsibility for coordinating work and had a high degree of communication among those who voluntarily joined the effort. Notably, successful collabs were those that were more structured and involved more planning, often with a central leader coordinating the entire collaborative process. Likewise, a case study of the Green Bear Group (Aragon, Poon, Monroy-Hernandez, & Aragon, 2009) a collab formed in the Scratch community, had a high level of within-group communication, with 51% of comments on the discussion forum related directly to the job that needed to get done and to contextual aspects such as arranging how to organize work, system administration and hardware issues; the other half of comments were directed toward socio-emotional aspects such as socializing and personal discussions.

All of this earlier work carefully observed voluntary online collaborations in large-scale communities as they engaged in the knowledge practices of sharing and producing media (Zhang, 2009). These online creative collaborations are indicative of what others have called communities-of-practice (Wenger, 1999) but with a Web 2.0 focus as they are "continually improving knowledge objects in the form of ideas, theories, designs, work plans, and so forth" (Scardamalia & Bereiter, 1999 in Zhang, 2009, p. 276). The theoretical framework for studying and designing online creative collaborations then

builds on the work of knowledge building communities as developed by Scardamalia and Bereiter (1991, 1999) and learning through design as developed by Papert and others (1980, 1991). The concept of "collaborative agency" articulates learners' efforts for searching out, organizing and distributing responsibilities in collaborations with others as they create collaborative artifacts. It shares much common ground with collaborative collective responsibility, a term coined by Scardamalia (2002), to explain students' achievements in learning to understand the "conditions in which responsibility for the success for a group is distributed across all the members rather than being concentrated on the leader" (Scardamalia, 2002, p. 2). Collaborative agency emphasizes the active role that learners take on in constructing communities that not only build knowledge but also design artifacts that can be shared with others. The proverbial "objects-to-think-with" (Papert, 1980) becomes "objects-to-share-with" representing products and ethos of collaboration and learning in the communities.

To map out the dimensions of collaborative agency, the first two research questions were exploratory in nature: "What is the breadth and nature of online creative collaboration in response to a site-issued Challenge?" and "What types of modalities did online and offline unstructured collaborations exhibit?" The questions focus on the type of unstructured online and offline collaborations undertaken by youth participating in the online collaborative Challenge to understand better how participation and creative production were collaboratively organized across settings in which youth found themselves working together. The third question "To what degree are local teams aware of the online community and how does this affect their collaborative production?" focuses on groups gathered face-to-face and specifically addresses the "awareness of contributions" that Zhang and colleagues (2009) found to be relevant in understanding students' participation in a communal database. Earlier research has indicated (Kafai, Fields, & Burke, 2010) that such an awareness, in particular what concerns the larger online community, cannot automatically be assumed but seems to be critical in how participants learn to navigate and work in the online space. While knowing the audience for youth contributions has surely been recognized as relevant in other contexts such as writing (for an extensive discussion see Magnifico, 2010), it appears that it might play a special role in online technical communities where contributions define recognition and, by extension, membership. Taken together, the answers to these three research questions allow an initial look at collaborative agency, the initiative or agency that group members need to develop successful collaborations to organize creative work and foster a sense of belonging in a distributed online environment.

3. Context, Participants, and Methods

The main context for this research is the Scratch (Monroy-Hernandez & Resnick, 2008) website (http://scratch.mit.edu) which lets members share their work with one another (see Figure 1). With over 2 million projects shared since its public launch in 2007, the Scratch website is a vibrant online community with over 1,000 new projects being uploaded every day. Scratch is a media-rich programming language that allows youth to

Figure 1. Screenshot of Scratch website.

design, share, and remix software programs in the form of games, stories, and animations. Scratch uses a familiar building block command structure (Resnick et al., 2009), eliminating thorny debugging processes and the risk of syntax errors (see Figure 2). Furthermore, programmed objects can be any imported two-dimensional graphic image, hand-drawn or downloaded from the Web, to further personalize each project. This makes it particularly amenable to an array of novice programmers wanting to build their own software and engage in the participatory culture.

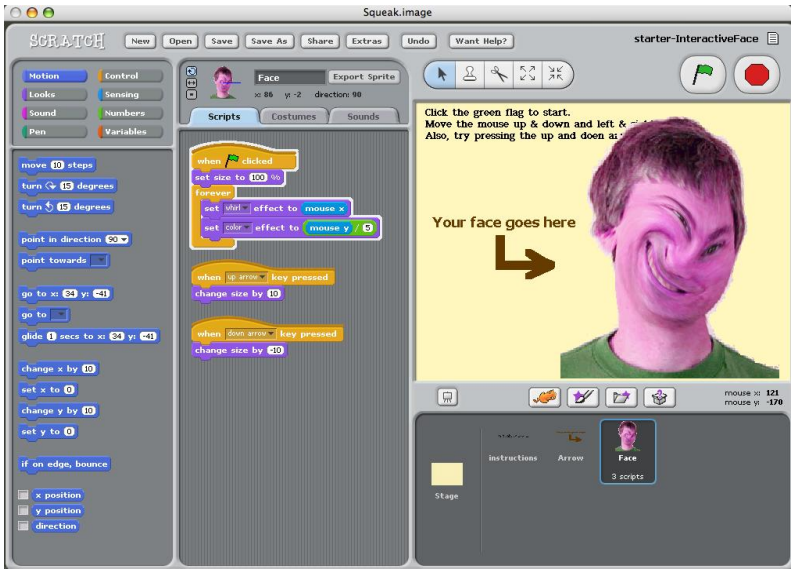

Figure 2. Screenshot of Scratch interface.

Figure 3. Screenshot of Collab Challenge.

The Collab Challenge (http://info.scratch.mit.edu/collabchallenge) was run from January to early March 2011 (see Figure 3). Open to the entire community, the Collab Challenge had three requirements: (1) teams needed a minimum of two participants; (2) teams had to integrate three unique, pre-selected images into their projects; and (3) teams had to upload an initial draft midway through the competition to receive constructive feedback from the Scratch team before submitting a final project three weeks later (for more details, see Kafai, Roque, Fields, & Monroy-Hernadez, 2011). Both draft and final projects were exhibited in a select gallery where participants could view and comment on each other's projects. Teams who creatively integrated these three disparate images using their own original ideas and coding sequences had their projects "featured" on the Scratch homepage, a highly-coveted status in the scratch.mit.edu online community.

Within the Scratch Online Community, researchers collected information on Challenge members' prior experience on the online community and self-reported gender, age, and location. Multiple versions of projects were collected in addition to comments written about the projects, relevant discussions in the online forum, and statistics about the projects that included number of views, "love-its" (a measure of how much people like the project), and remixes. The submission of a completed project was considered a simple and easily accessible indicator of successful group work. Obviously there are other aspects that need to be taken into consideration when assessing the success of online creative collaboration. For that reason, participants' overall Scratch website activity was analyzed including their history of sharing projects and commenting on others' projects online. During the review process, the research team asked questions

about team formation and collaborative process. Based on looking at these data across the 26 groups who turned in final projects, three groups who exhibited different styles of collaboration and who collaborated solely online were selected as case studies for further analysis. These three groups' processes of collaboration were studied more carefully through sequential documentation of their creative, collaborative process, with special attention to leadership, distribution of work, and mode of communication (forums vs. project spaces). Changes in the posted project, forum discussion, and discussion on project galleries as well as the histories of the individuals in the online Scratch community were taken into account in this analysis. This illuminated the richness and diversity of three groups' collaborative agency and design processes.

In addition, a second focus of data collection included observations of participants working together face-to-face in an after school workshop at a science museum that worked with a local high school. In these face-to-face workshop sessions 21 high school freshmen (aged 14-15) who had signed up for the Scratch workshop worked in self-chosen small groups to program and submit projects to the Collab Challenge. Within the workshop sessions, the data for the study included observations of group work in field notes by three different researchers, videos from two cameras focused on individual groups, post-interviews with all participants, and weekly artifact collection of participants' ongoing projects (for more details, see Kafai, Fields, & Burke, 2011). Case studies of individual groups were created by looking at the kinds of collaboration they engaged in over time. Further, coding based on grounded theory (Charmaz, 2000) was conducted across the data to look for different types of distribution of work (sharing together, exchanging projects, modularized distribution - see Tables 1 and 2), leadership (single leader, multiple leaders, changing leaders), and communication (to whom comments were directed toward, content of discussion [e.g., ideas or problem solving]), mode of communication (in person, over email, etc.), as well as responses of the local students to the Scratch online community. Codes were compared across time and across groups to look for cross-case findings as well as unique attributes of individual groups. This made some commonalities across groups visible, like the fluid, changing roles within groups. It also illuminated differences between groups. The goal of these analyses was to understand the inner workings of these opportunistic small groups, the role of the Collab Challenge structure, and the influence of the Scratch online community (especially the constructive comments) in groups' project development and awareness of broader audiences.

4. Findings

This section describes first the breadth and depth of participation in the Collab Challenge—namely, who participated, how Scratch community members became engaged in the Challenge, and what qualities of collabs strengthened their collaborative work. The latter are summarized in themes of leadership, communication, and distribution of work across the three case studies of online collabs who worked together solely in the online Scratch community as well as the six groups who worked together in

the after-school workshop. Finally, the responses of those students in the local workshops will be detailed to describe their relationship to the broader Scratch community during the Challenge.

4.1. *Community participation in collabs*

The Scratch community includes quite a number of different groups who work together, with most of these forming organically and recruiting members around common interests such as game design or storytelling (Roque, Fields, Siegal, Low, & Kafai, 2012). The call for the Collab Challenge thus was the first of its kind. A total of 52 collabs (139 participants) registered to participate in the Collab Challenge in January 2011. Each of these 52 collabs submitted a first draft of their project for the Challenge in mid-February, and 25 submitted a final version by the end of March. These 52 collabs represent the core of subsequent analyses. The projects created by these collabs include a variety of genres. Most popular were games (38), interactive objects that operated through mouse clicks or key strokes (9), animations (8), stories (6), operating systems (1), and projects that included multiple genres like a game and or music coupled with interactive objects (12). Unlike Luther and colleagues (2010) who found that only 13% of collabs on Newgrounds with medium to high forum activity succeeded in completing a finished project, a full 50% of the Scratch collabs who submitted an initial version of a project to the Collab Challenge succeeded in submitting a final version. This is an encouraging success rate though needs to be taken with caution given the small number of reference points and difficulty of collecting this information from other sites. Nonetheless, it suggests the potential of a lightly structured Challenge environment in which all participants received constructive feedback on drafts and had pre-established deadlines to help define and tier goals.

The Challenge was open to the global Scratch community and participating Scratch members (from self-report) came from 15 countries. Groups had an average of 2.6 participants – most were groups of pairs but there were also a number of groups with three to seven individuals. Of the 139 participants, 125 of them had Scratch accounts and 34 of them self-reported as female (27%). The mean self-reported age was 17 (std=9.6) with a median age of 15 and mode of 13. Of the remaining 14 participants who did not have their own Scratch accounts, ten came from one school using one user account and some Scratch members recruited local friends who did not have Scratch accounts, meaning that the Challenge recruited participation from individuals who did not have prior experience on the online site.

4.1.1. Engaging newcomers and re-engaging old-timers alike

Overall the Collab Challenge appears to have drawn a range of members from the broader Scratch community. The number of new participants who joined the Collab Challenge suggests that the Challenge drew newcomers into deeper participation in the online Scratch community. Twenty-two participants joined the Scratch Community for the first time within a week of the Challenge being announced or during the Challenge.

Half (11) of these members were a part of the local face-to-face workshop, but the remaining eleven new members appear to have been motivated to join by participating in the Challenge. An additional 36 members had only been in the Scratch online community for three months prior to the start of the Challenge: relative newcomers to the community. This means that just less than half (41.7%) of the Collab Challenge participants were relative newcomers to the community.

The Challenge also appears to have re-engaged "old-timers," more experienced members of the Scratch Online Community. Sixty-seven (48%) of the Challenge participants had been on Scratch for more than three months, and most of these, most (62) had been on Scratch for six months or more. Comments made by some of these more experienced Scratchers suggest that the Challenge stimulated renewed interest in participating in the online community. For instance, one Scratcher who had been with the community for over two years expressly thanked the team for hosting the Challenge:

> I want to personally thank all of you for throwing the Collab Challenge. Taking the time to create this has allowed me to work with some of the best scratchers - something that I think we all appreciate. I hope that you continue to do more challenges like this one in the future.

Another experienced Scratcher said that the Challenge pushed him/her to go deeper into Scratch and to learn more than one could by oneself:

> Yeah, this is the first time I saw the Scratch Team create a contest so I went all out. Usually, I don't have to put too much thinking into my projects – the scripts are already in my head and I just code it up in Scratch. However, this project really pushed me. And it's the only collab project I've ever finished.

From these and other comments, the design of the Challenge, including the collaborative requirement, structure, and deadlines, appears to have encouraged some senior members to make something better than they could by themselves and to go deeper in both participating in the community and programming with Scratch in general.

Another way that the Challenge involved Scratchers in the online community was providing a high number of "views" on the projects submitted to the Challenge. These views were much higher than the average project on Scratch received. The average/median of views for initial projects submitted to the Challenge was 97.5/53, while the average/median of views across all Scratch projects was 3/0. The average views went up to 157 views for collabs that submitted a second version. Add to this the minimum of two comments from the Scratch Design Team and the many comments (uncounted) projects received from the general Scratch community, and this suggests that the Challenge was a way for all participants to receive more attention from the broader community than they might have on their own.

This was especially true of featured projects — those 14 projects that were selected to appear on the front page. Being featured allowed some members and groups who otherwise would never have made it to a prominent space on the home page of Scratch.mit.edu to receive a great deal of attention from the community. As one Scratcher commented, "Other than this I have never been on the front page, and I've been posting projects for almost 2 years! Just work hard and you'll get there." Several other Scratchers among the top 14 collabs also commented with excitement that it was their first time to be on the home page. A further sign that participating in the Challenge drew members deeper into the Scratch community is how many of them responded to comments left on their projects. Twelve out of the 14 featured collabs responded to comments with "thanks!" or responses to how they were going to work on their project, and put the Scratch Team comments in their project notes. The only two featured collabs who did not, were members of the local workshop who were very new to the online community. Overall, Challenge participants received an unusual amount of attention and opportunities to interact with online community members as part of the process of the Challenge. For many Scratchers, this provided an authentic audience for their projects and seemed very meaningful for them.

4.2. *Collab organization and leadership*

One goal of the research was to look at the range of ways that collabs worked together within the relatively unstructured environment of the Collab Challenge. In studying how collabs worked together, three themes emerged both ground-up from the analysis of local and online collabs and top-down from the work of Luther and colleagues (2010): leadership, communication, and distribution of work. Six case studies of collabs who turned in both initial and final versions of their projects were selected for further analysis: three collabs who worked together solely online and three from the after-school workshop who collaborated both locally and online. Each of these cases illustrates different types of leadership, styles of communication, and modes of work distribution. These case studies showcase the range of different styles of collaboration, online as well as offline. In addition, the analysis describes ways that some groups shifted their styles of collaboration over the duration of the Collab Challenge. These forms of collaboration demonstrate some of the ways that collaborative agency began to develop within the collabs as they figured out and even shifted the ways they worked together in order to complete a project.

4.2.1. *Online collab case studies*

A Benevolent Dictatorship: Coolio Collab. The Coolio Collab provides an example of a group whose dynamic leader, TheWizard, was a central point for the vision, communication, and organization of work. For two years, TheWizard stood out as one of the most prominent members of the Scratch community who shortly before the Collab Challenge had announced he was going to scale down his participation on the website until the release of the new Scratch version. However, a few days after the Collab

Challenge was announced, TheWizard came back and posted an invitation for people to join "TheWizard's Coolio Collab" where he described that he got inspired by a "truly good game idea," a mix of an RPG and a fighting game. TheWizard enticed potential collaborators to his vision through his own personal celebrity, suggesting that teammates would gain popularity because most of his projects "get to the top ranked lists" on the front page. Once he approved applicants to join the group, including two relatively new members (less than three months on the Scratch site) he gave them several options of different tasks they could work on. Five people formed the group and they went through more than 30 versions before finishing the game, communicating largely on the Scratch forums. TheWizard carefully orchestrated the whole effort, contributing almost half of the comments on the forum thread, directing members to what they should work on, and pulling their work together himself into the whole project. Each member worked on a game character or aspect of the project that TheWizard assigned, and TheWizard took responsibility for the overall vision and the final gathering of the individual pieces into a whole. Coolio Collab's project was well received by the community at large and was arguably one of the most sophisticated projects submitted to the Challenge. This form of centralized leadership is very similar to what Luther and Bruckman (2011) found in studying adult collabs in Newgrounds. While every member of the collab contributed in visible ways, the group's organizational model was primarily centralized and dependent on a strong, dynamic leader.

A Team Effort: Angelic Collab. In contrast, the collaborative processes of the Angelic Collab demonstrated how one collab achieved success through a shared leadership model that spread the responsibilities of organization, decision-making, and development across its members. Like TheWizard's Coolio Collab, "The Angelic Collab" formed in the website discussion forums initiated by another experienced Scratch user Archangel. Its seven members were spread across three countries. While Archangel facilitated the group collaboration, the communication, decision-making, and work were distributed across all group members. Ideas and decisions were negotiated by the group based on the feasibility and likelihood of advancing the team in the Challenge. Occasionally, a member would summarize the ideas and ask members to vote and reach a consensus to move forward, showing that many members were taking responsibility for the group's creative production, what Scardamalia (2002) described as "collective cognitive responsibility." To develop the project, members split themselves up based on their interests and skills into graphic artists and programmers. Programmers remixed each other's projects to add their update to the ongoing development, while graphic artists shared images or animations through Scratch projects that programmers later integrated. Members coordinated their exchanges and remixing through the website discussion forums, regularly summarizing their efforts and tasks to keep everyone in sync. In the end, they produced one of the Challenge projects that received the most attention from the community with over 1500 views.

A Friendly Partnership: Sunday & Fashionista519. Though Coolio Collab and the Angelic Collab were groups of five and seven members, most collabs were groups of two. Leadership, communication, and distribution of work appear to be much easier to negotiate in pairs, as was the case with Scratch members Sunday and fashionista519. When the Collab Challenge was announced, experienced Scratch user Sunday from the United Kingdom asked her Scratch friend fashionista519, who was from the United States and who she "met" five months before in the Scratch Online Community, to collaborate on a project. When they began exchanging ideas for the Collab Challenge, they both expressed a mutual interest in making a 3D game and converged on a story line involving a Samurai Warrior. Fashionista519 worked on developing graphics for the game while Sunday led the programming. Both showed equal dedication to their project development, meeting often online and sharing the responsibilities of the project making. To develop their project, they took turns adding code and assets to the main project, exchanging the project back and forth through remixing (downloading, editing, and re-uploading). Unlike "TheWizard's Coolio Collab" and "The Angelic Collab", they communicated and coordinated through their comments on various versions of the project that were gathered in a Scratch website gallery that held all their project versions. Whenever they spoke about their project progress, they also used that time to converse about their lives and their other interests. While both were excited at the prospect of having their project featured, working together on their project also became a social activity for the two friends.

4.2.2. *Local workshop collab case studies*

The 21 participants who worked together in the local after-school workshop formed teams largely based on prior friendships. Few directions were provided on how groups should work together at the beginning, in order to see how styles of collaboration emerged. In all, the students formed six groups with groups of six, five, and four members plus three groups of pairs. About half of the participants had prior experience with Scratch from an earlier eight-hour workshop; the remaining participants were completely new to Scratch. This difference between novice and expert played a significant role leadership styles and distribution of work and reiterates observations in earlier research of youth software design teams (Kafai, Fields, & Burke, 2009).

The Expert as Benevolent Dictator: BFP. The largest of the local workshop groups, BFP (five girls and one boy) formed based on prior friendships. The sole male member Thomas was a fairly proficient Scratch user, but the remaining five girls had never used Scratch before. The girls turned to Thomas as the de facto leader, a position that he did not seek but which he took up willingly. Initially, the group made all decisions together and asked Thomas to do all the coding. Later, the five novices began to take more responsibility for editing the appearance and code of particular characters in their movie, demonstrating a growing sense of collaborative agency as they took stronger roles in the creative production of the project. Then they sent their coded characters to Thomas so

that he could integrate them into the larger project. Thomas took sole responsibility for integrating and coding the various characters. The resulting project was an amusing set of figures assembled upon a beach, whose appearance was loosely tied to a narrative of singer Katy Perry disguised as a man on an evening stroll along the water. Though Thomas may have had the most visible role in the project, all BFP members took collective pride in the project's positive reception in the online community, again demonstrating a growth in the sense of collaborative ownership of the finished product.

The Team of Experts: Brickbreaker. The "Brickbreaker" collab consisted of four boys who shared an interest in gaming and who all had prior experience with Scratch. Initially started as a group of three who knew each other from their "homeroom" at school and joined by a fourth member later, personal connections played a large role in the team's formation. The core trio knew each other closely from school and much of their work on the project occurred during shared lunches and study halls, making for a group effort across multiple spaces of interaction, but largely excluding the fourth member in these supplemental working times. In the workshop, the Brickbreaker team worked together around a single computer in the workshop with all members making suggestions for developing the project. Outside of the workshop, the members worked on the project by exchanging the project by email and taking turns working on it. At this point the group demonstrated collaborative agency in working together and separately so that the project moved forward, monitoring and keeping up with each other's work. Toward the end, one member, Jack, took responsibility for finishing the project, emerging as a leader in the final stages and shifting the group's work from a more distributed to centralized collaborative model. The team used the three requisite images to create a variation of the classic brick-breaker game, which was ultimately selected as a "featured" project at the site.

Expert-Novice Partners: Mage-Battle. "Mage Battle" consisted of two self-professed "gamers" who shared a strong mutual dislike for group work in any form. Nonetheless their pairing came easily based on their common interest in video games and shared antipathy toward school-based collaboration. Lucas, the more experienced member, took on the role of "programmer" while Lawson, new to Scratch, accepted a supportive role as the "graphics illustrator". Operating under the assumption that programming represented a more sophisticated skill-set than manipulating graphics, Lawson was happy to let Lucas take the lead. Lucas himself established his own prowess at the outset of group selection, creating a sample project on his own time as a means to "advertise" his skills using Scratch and setting the vision for the project, which Lawson joined. Between the pair, Lucas largely set the group's internal deadlines and offered Lawson consistent feedback on the sprites he had generated. The pair worked independently on their tasks while sitting next to each, and often Lucas drew Lawson into the overall project by soliciting feedback from his partner, though Lawson rarely contributed his own ideas without solicitation. Their two-player combat game between wizards and demons was chosen as

one of the projects featured on the Scratch website for its use of intricate graphics, ascending levels, and accompanying soundtrack.

4.3. *Fluid styles of collaborating within groups*

This study set out to discover models of collaboration in an unstructured environment, and some of these models are described in the case studies above, including having a central leader, broadly distributing work, or having a solid partnership. However, when looking across the online and local collabs, it became apparent that many of the collabs shifted their collaboration modes during the project creation process. This was especially apparent in the face-to-face groups where data on their moment-by-moment decisions were more available. Initially three primary patterns of distribution of work emerged from analysis: 1) splitting up work between individuals, 2) sharing one computer and working together the whole time, and or 3) exchanging a project back and forth between members as they took turns working on the project. These collaboration models are shown in Table 1.

Table 1. Work distribution models among local collabs.

Work distribution models	Description
Sharing one computer	All work is done on a single computer with one person operating it. The whole group makes decisions together while the person with the computer enacts the decisions.
Distributed across people	Individuals within the group each take up a section of the project and work on it.
Project exchange	Individuals take turns working on the project one at a time, passing it on to another member after one has finished a task.

However, these models often shifted within groups over the course of the project. For instance, BFP moved from having one person (Thomas) work on the computer while the group shared in the decisions of what the project would be like, to breaking the project into smaller pieces (individual characters or sequences of events) and distributing them among the individual members to work on. Later the members sent their pieces to Thomas who again served as the central integrator of the project. In contrast, Brickbreaker began by having one person operate a computer (trading turns in being the person operating the computer) during workshop time while outside of the workshop individual members took turns working on the project before sending it on for someone else to work on (project exchange). A full table of which groups used which of the three collaboration models is shown in Table 2.

Table 2: Shifting work distribution models amongst local collabs.

Local collab group (# members)	Initial work distribution models	Later work distribution models	Other work distribution models
BFP (6)	Sharing one computer	Distributed work	
Brickbreaker (4)	Project Exchange	Sharing one computer	
Epic Myth (2)	Sharing one computer	Sharing one computer	
Mage-Battle (2)	Distributed work	Sharing one computer	
ProjectOne (5)	Distributed work	Sharing one computer	Project Exchange *(outside of the workshop)*
Shuriken (2)	Sharing one computer	Project Exchange	

A review of the collabs who worked solely online also reveals that on occasion, group collab styles shifted. Though Coolio Collab had a strong central leader, work was initially distributed among members such that everyone contributed something; in the end TheWizard integrated all of the projects together. Using a somewhat different combination of models, Angelic Collab also used a distributed work model but in addition utilized project exchange, carefully coordinating who was doing what by posting to the forum. Though Luther and Bruckman (2011) identified a central leader as a key to collab success, these case studies demonstrate both a range of models of working together successfully as well as the shifts in these styles as different needs arose. These shifts are indicative of the collaborative agency that group members displayed in taking on responsibility and initiative to identify multiple ways they could work together in order to complete a creative project.

The timeline of the Collab Challenge had multiple built-in deadlines and this led groups to take responsibility for figuring out how best to work together. In two instances where the work seemed ill distributed among group members, one researcher spoke privately to the de facto leaders (e.g., Thomas of BFP), suggesting that they try to draw in the other members more. It is unclear whether this made a difference, but the distribution of work within the groups shifted afterward, with the other members taking more responsibility for programming and project work. If students are supposed to be aware of and take responsibility for making sure that their group work is effective, then the students in these groups who completed final versions of their projects succeeded in that aspect. This is not to say that groups worked seamlessly or that every member contributed equally. Rather, in completing the open-ended programming projects, the

groups managed the distribution of work at different times in the ways they found more effective. They evaluated how well they were working and, for the most part, shifted to become more effective. It appears that the mid-workshop initial submission deadline with feedback from the online community assisted with this self-evaluation.

4.4. *Audience awareness: projects in relation to larger programming community*

One other important result of the local youths' participation in the Collab Challenge was their growing awareness of the broader Scratch online community and their sense of participation in that affinity space. Since these youth were largely new to Scratch (about half of them had learned it in a series of four, two-hour workshops two months earlier), it is interesting to understand their emergent impressions of this larger affinity space and to what degree they felt a sense of connection to it. Through their participation in the Collab Challenge, students came to view the Scratch online community as a "cool" place with programming projects that interested them and a community of people who provided constructive feedback. Further, some groups began to situate their projects in relation to the Scratch community, developing a sense of the community as both audience and resource.

First, students saw themselves participating in an online community that was valuable because of the quality of projects and potential of the constructive criticism. As Chase remarked, "I like participating in the [Collab] project because I got to contribute to the cool projects on the website." Like Chase, many youth felt good about their project posted next to others. This was a form of participation in a community that they valued. Further, most youth also expressed that the online Scratch site was a place where they could receive positive, constructive feedback on their projects and find examples of projects that were helpful to their programming. For instance, as William summarized,

> "Well, I really like the community of Scratch online because … it is always really helpful to have positive feedback instead of continual accusations like 'Make this better' or 'Just do it--I don't really know how you're going to and I'm not going to help' which is sometimes the case on different forums like that. But on the Scratch website it's a lot more helpful."

To William and many of the students, the Scratch site was a place for positive, constructive feedback that made them enthusiastic about the community. Looking at students' projects, it is clear that the constructive comments not only built enthusiasm but also influenced the quality of the projects. Based on the comments, all the groups improved their projects, tweaked programming, improved story lines, made games more playable, and added instructions. In sum, most workshop members began to understand the ethic of the Scratch community as an exciting, constructive, project-sharing site, and through posting projects began to situate themselves as participants in the site.

Finally, a few groups expressed a growing awareness of the Scratch online community as an audience. For instance, the Brickbreaker group researched the different types of their classic game on the Scratch site, and built their game to improve on the existing versions on the site. As John expressed, "we just liked the idea of [that game] and we saw what worked and what didn't work." Many groups also added project notes or instructions on how to activate/play their projects after receiving feedback that the mechanisms were not obvious to online members. This moves from "awareness of contributions" (Zhang et al., 2009) to responding to the online community as an authentic audience and involves what Magnifico (2010) argues is critical thinking about communicating ideas to a group of people. Since the online community is a programming audience, this has meaning for how youth adapt to the ways of viewing and kinds of programming in the Scratch online community. The Collab Challenge's provision of constructive feedback on draft projects and the ability of the students to look at and study other collab submissions to the Challenge began to build an awareness of the Scratch audience that shaped students' projects. This illuminates the role of a broader community in smaller, unstructured group collaboration.

5. Discussion

This study presented initial findings on how youth engaged in online creative collaborations by participating in a design challenge in the online Scratch community. While the submission of a completed project was considered the prime indicator of successful team work, others process indicators such as engagement of different community members or work distributions were considered in studying the processes of online creative collaborations. The observed collaborations included various participants from the online community, ranging from new recruits to older members. Participants in "successful" collabs assumed agency as they negotiated multiple roles and made adjustments to designs and collaborations as they provided and received feedback on programming designs. In addition, some youth negotiated these responsibilities not just in local contexts but also in the online context of the larger Scratch community. This type of needed participation in online technical production was called "collaborative agency" to highlight that it is youth themselves who need to make choices about who to work with, how to contribute to work, and how to deal with issues very much like the youth and adult volunteers in the collabs studied by Luther and colleagues (2010) and Aragon and colleagues (2009). The following section reviews online creative collaborations and suggestions for improving such online collaborative work of youth.

5.1. *Understanding online creative collaborations*

This focus on collaborative agency of learners is a distinct departure from most of the research on collaboration that has focused on identifying arrangements and features that would make small groups productive in their collaborations. Of course, participants in small groups also need to assume responsibility for their contributions in order for the work to be successful. But the constraints under which they do so actually assign teachers

more of the collaborative agency because they set up groups, organize roles, and distribute work. Participating in collabs that post projects in an online community asks youth to assume this agency because their collaborations extend into a broader social network. Others as well have commented on how rare these types of unstructured collaborations are in classroom settings even though they provide equally meaningful experiences in what it means to work together (Cohen, 1994). The inclusion of students participating in a local Scratch workshop provided a first glimpse of the dynamics in such peer-led collaborations as they connect to online communities as well as how to use an online-based challenge in a local educational setting.

How did youth collaborate when given no instruction on how to do so and few structures for supporting their work other than two deadlines and a single constructive feedback? The analyses parallels Luther and colleagues' (2010) model of centralized leadership where a core leader provided a vision for a project, directed the majority of the communication, and distributed the work among team members. However, the analysis further revealed other models with more distributed leadership, communication, and work decisions shared among pairs or larger groups. Further, in several groups the model of work distribution shifted depending on stage of project, level of interest, and expertise of members — ranging from exchanging a project, splitting up a project and bringing it together at the end, and working all together at the same time on one computer. This exploratory research suggests that deeper analysis of a broader range of groups along the lines of leadership, communication, and distribution of work could provide multiple models of successful collaborations that could change depending on project needs. It also implies that collaborative agency means having the ability to shift practices, leadership, and communication as needed in a project. It is not enough to pick a model, youth must learn to identify whether a type of collaboration is working and change it to something more successful as needed in different stages of a project.

These findings further suggest that successful collaborations need to be judged by more than just the completion of a project; in fact, various dimensions of the collaborative process seem to provide the most fertile ground for further empirical investigations of what constitutes success. By the same token, examining not only successful but also failed collabs might provide further insights on where the group design process might go awry. For instance, prior research on small group face-to-face collaboration illustrated that a combination of socio-cognitive factors was responsible for the failure of smart groups (Barron, 2003). In particular, the lack of establishing a "joint problem solving space" (Barron, 2003, p. 307) was often responsible for students not succeeding in their collaborative efforts. Such intangible aspects of collaborative interactions might be equally instrumental in successful online creative collaboration where group members often need to coordinate their efforts more explicitly and deliberately.

Though the analyses did not include failed collabs, an area for future research, the study of successful collabs revealed the difficulty of collaborating in the Scratch site, which itself does not explicitly support collaboration. Many of the successful collabs had

to work around the website infrastructure to achieve their goals. For example, collabs that coordinated through the forums had to communicate in a linear, single level thread that contained a mixture of responses and posts they managed themselves. This provides an awkward way to communicate. Further, a common form of distributing the work among smaller groups of members (groups of two to three which formed the majority of groups in the Collab Challenge) was to take turns remixing each other's projects (project exchange), creating a bottleneck as others had to wait for one to finish. This model became especially difficult in larger groups, leaving many members with nothing to do while one person edited the project. Even the local workshop group Brickbreaker found this mode of work distribution challenging and ended what had been an equitable distribution of work with one person doing all the finishing touches on the project. Findings like these provide rich insights for online community designers who wish to foster online creative collaboration and suggest features such as designing better ways to exchange smaller assets such as images, sounds, levels, and scenes, manage internal discussion, and co-create more seamlessly.

Youths' awareness of this larger community played an important role in how they thought about the improvements of their programs. The online community can become a potential audience as well as a place of belonging to a collective of programmers (and how they think, program, and provide feedback). As Magnifico (2010) elaborates in regard to writing, thinking about audience requires critical reflection on "how to align themselves with these practices and values, portray themselves as members, and communicate these ideas to an outside audience" (p. 180). Applying concepts of audience to programming opens up possibilities for how a massive online programming community can influence students locally. This latter aspect should not be taken for granted as previous research indicates that leveraging the Scratch website as a means for participants to share their own work with wider audiences and download others' creations is not always an easy and obvious step (Kafai et al., 2010).

5.2. *Improving online creative collaborations*

The findings generate suggestions for how to support and further research online creative collaborations of youth. It appears that recognition in its various guises, from simple presence to constructive feedback, provides some of the most powerful incentives for collaborative production and gives a starting place for facilitating membership in online programming-based communities. Such recognition, in fact, is a key element in online creative collaboration since no financial and other rewards are exchanged (Benkler, 2006). It might be helpful to investigate further the various dimensions on how recognition can be conceptualized and automated in online contexts, from giving and receiving constructive feedback to showcasing final designs to further successful participation in collabs. For instance, a recent study by Monroy-Hernández, Hill, Gonzalez-Rivero, and Boyd (2011) indicates that automated crediting in remixes was less successful than personal acknowledgments. Nonetheless, there might be other aspects in providing recognition or soliciting feedback that could be generated by systems. Perhaps projects

on the Scratch site (or other sites) could be identified as drafts so that interested members could leave appropriate constructive feedback. Further research might also be needed to understand better the criteria along which participants in these communities judge contributions and productions.

The structure of the Collab Challenge with initial submission, Design Team comments, final submission, and "featuring" on the home page, did seem to provide some support to youth successfully collaborating to create innovative projects. The fact that half of the collabs who submitted an initial project also completed a final version suggests that these design elements had some helpful impact on the collaborative process. These design structures were set up by the organizers of the Collab Challenge and created the collaboration space for youth. Just like face-to-face collaboration activities can be designed to structure and support interaction between members, there is an instrumental need to investigate further the critical structures for online creative collaborations. Design elements such as timelines can provide guidelines along which team members can organize work.

Furthermore, helping members to find potential collaborators might be equally important in not only supporting but also broadening online creative collaborations among youth. In the current version of the Scratch online site, most members transformed the discussion forum of the Collab Challenge into a space to find others interested in collaborating with them on a project. This re-purposing of the space shows some of the ingenuity and flexibility youth adopt in navigating online spaces; by the same token it also limits participation to those who are knowledgeable and comfortable enough in this space to undertake such steps. In further iterations of initiating online creative collabs one might consider designing specially designated connect spaces that would make the process of finding collaborators more transparent to all. The design of such spaces could allow new and old as well as local and distant, members of the community to reach out and connect with each other.

Ultimately, the Collab Challenge became not only a context to initiate and study collaboration by choice but also a way to engage Scratch members more deeply in their community: oldtimers came back to join collaborations while newcomers became members of the larger community by having their projects featured. This finding might explain the larger appeal that online creative collaborations have for participants. Amidst all the academic benefits of collaborative work that have dominated research and practice discussions for so long, it points to the motivating dimension of collaboration that has been neglected. On a surface level, the presence of audience for sharing work might provide a simple answer, but perhaps on a more profound level the striving for affinity (Gee, 2003) might be a better explanation on why participants are willing to contribute and share their work and help with others. In designing and researching online creative collaboration, these aspects deserve further investigation as to broaden access and participation in technology-rich activities for all youth.

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