Beyond Small Groups: New Opportunities for Research in Computer-Supported *Collective* Learning

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Abstract: CSCL research has focused on understanding and designing collaborative learning in diverse settings and configurations with support of computers. Within this research, however, most efforts have concentrated on studying small group configurations and thus examined what we would like to call 'collaborative' learning (i.e., the abilities needed to participate and support collaborations of typically two to five people). Much less emphasis has been placed on studying massive communities and participation in large groups prominent in today's social networking sites and online gaming cultures that would shift the focus to 'collective' learning (i.e., the abilities needed to participate and support collaborations in massive groups). In this paper, we identify key dimensions of collective learning, present observations of online and local participation in one open-source Web 2.0 community with over 630,000 members, called Scratch (scratch.mit.edu), and outline a research agenda for computer-supported *collective* learning.

Introduction

Research in CSCL, by its very name, has focused on understanding various dimensions of group work such as productivity of different group arrangements (Engelmann & Hesse, 2010), design of scaffolds (van der Pol, Admiraal, & Simons, 2006), argumentation practices (Scheuer, Loll, Pinkwart, & McLaren, 2010) and interactions between online and offline collaborations (Birchfield & Megowan-Romanowicz, 2009). With some exceptions (e.g., Fields & Kafai, 2009; Guzdial & Rick, 2006), there is one assumption about collaboration underpinning many of these efforts, which is the idea that collaboration happens in small groups, often of dyads and triads, as they engage in computer-supported collaborative tasks. For the most part, the focus of this research has been to understand and develop what we will refer to as *collaborative* learning because it emphasizes the abilities to participate in small groups whether online or offline or in combinations thereof.

Recent developments, however, suggest new forms of collaborations are developing in online communities (e.g., Boyd, 2008; Shirky, 2008). One striking feature of these communities is their size and collaboration that can take place among hundreds, if not thousands, of members. Consider the millions of contributions to entries in the Wikipedia or to programs in Linux (Benkler, 2006), the interactions of members of fan fiction sites where thousands of writers create new stories and participants provide constructive feedback (Black, 2006), or the participation in guilds in multiplayer online role-playing game communities with millions of players (Gee, 2003). We have chosen to call this type of collaboration *collective* learning because it emphasizes the abilities to participate and perform in collectives and thus might be different from participation in small groups. Our concept of collective learning is inspired by recent research in different communities: the work of social scientist Pierre Levy on collective intelligence (1997) examining the potential of intellectual contributions from large groups; the work of gaming researcher Jane McGonigal (2008) observing self-organized coordination among players in collective gaming; and the work of media scholar, Henry Jenkins (2006) studying participatory culture in networked communities. Taken together, this body of work converges, helping us to recognize that large-scale communities can promote new forms of opportunities, as well as challenges, for learning together.

As increasing numbers of learning communities in K-12 and higher education move online, so too grows our need for understanding how to engage large groups of learners effectively in these networked communities. The starting point for our investigation on collective learning is a simple question: Does the size of the group matter? We realize that there will be no simple answer because massive communities such as social networking sites, virtual worlds, and multiplayer online role-playing games are each organized around different purposes and practices and thus participants have different incentives for joining and collaborating with each other (see also Hung, Lim, Chen, & Koh, 2008). We begin with a review of what research has identified as key features of collaborative learning in small and large groups. We then draw upon research and our knowledge of one such large-scale networked community, called Scratch (scratch.mit.edu), to describe and articulate the different dimensions of collective learning. In our discussion, we outline the emerging challenges and opportunities for research in computer supported *collective* learning.

Background

The work in CSCL draws upon hundreds, if not thousands, of research studies that have investigated various aspects of collaboration, 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 (O'Donnell, 2006; Webb & Palincsar, 1996). The research on computer supported collaborative learning, as documented in the *International Journal of Computer-Supported Collaborative Learning* (ijCSCL), has built on this substantial body of research and provides compelling evidence that collaboration can be arranged and even fostered in instrumental ways via computer support, albeit with a focus on what we would like to call *collaborative* learning – the ability to interact in and contribute to small groups. By contrast, the research on *collective* learning – the ability to interact in and contribute to large groups – is only now beginning to build such a body of work. We call this collective learning because groups are described by being in a particular space such as a virtual world or gaming community and often focused on tasks such as contributing to a collaborative repository.

To date, only a few studies in *ijCSCL* have tackled aspects of collective learning by designing wiki activities for university classes (Guzdial & Rick, 2006) or studying an afterschool gaming club participating in a tween virtual world with over 1.5 million players (Fields & Kafai, 2009). Some researchers have begun to conceptually map out issues of understanding collaboration and learning in Web 2.0 communities (Dohn, 2009) as well as to identify issues of trust building (Gerdes, 2010), while others have argued against adopting these models for school communities (Hung, Lim, Chen, & Koh, 2008). The size in number of participating members in these online communities is indeed impressive, especially considering that the possibility to interact with hundreds of thousands, if not millions, of others across geographical boundaries is unprecedented in history. This is particularly true for youth who might have connected at most with hundreds or thousands of others in their local communities and schools. Research is now showing that participation in these online communities can provide rich opportunities for learning to solve complex problems and for learning to collaborate with others in large groups (boyd, 2008; Gee, 2003; Ito et al., 2008). Yet it is unclear what it means to participate effectively in large-scale groups, to develop and foster a sense of community and belonging, and to design for collective learning interactions.

Closest to issues associated with collective learning is the work on Computer Supported Intentional Learning Environments (CSILE) (Scardamalia & Bereiter, 1991) and other studies following the knowledge forum tradition, since they examine how students' knowledge-sharing, knowledge-construction, knowledge-creation, and knowledge-assessment (e.g., Ares, 2008; Eddy, Chan & van Aalst, 2006; von Aalst, 2009) come into play. Most CSILE implementations have operated within a classroom environment, sometimes connecting students from other classes or previous years, and thus are far away from the size of social media communities today. Despite this, Scardamalia (2002; see also Zhang, Scardamalia, Reeve, & Messina, 2009) articulated early on the need for collective cognitive responsibility describing it as the "conditions in which responsibility for the success for a group is distributed across all the members rather than being concentrated on the leader" in addition for taking on responsibility "for knowing, what needs to be known, and for insuring that others know what needs to be known" (p. 2). Concepts such as collective cognitive responsibility indicate that interactions in these online communities could have different constraints and affordances due to their massive number of participants, unstructured and structured groups with concurrent asynchronous and synchronous nature of interactions, ongoing persistence of online life in absence of individual presence in addition to the nature of collaborative tasks and contributions. To better understand what collaborative vs. collective learning in a large-scale networked community looks like, we will first use an illustrative case study of Scratch community to examine some of its features in context before highlighting similarities and differences between these two paradigms of social interaction.

Computer-Supported Collective Learning in Networked Community of Scratch

We have chosen as a case study one open-source Web 2.0 application, called Scratch (scratch.mit.edu), to illustrate different dimensions of both collaborative and collective learning. Scratch is a media-rich programming language that allows youth to design, share, and remix software programs in 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 1a). 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. Since its public launch in May of 2007, the Scratch website (http://scratch.mit.edu) has been the primary means for users to share their work with one another (see Figure 1b). With over 1.2 million registered contributors and over 630,000 projects shared to date, the Scratch website is a vibrant online community with over 1,000 new projects being uploaded every day. It is possible to use Scratch as an individual programming tool or in traditional small groups formats (e.g., pair programming) but the website facilitates remixing and open-source like sharing of programs with others across time and space. In the following section, we review prior work on the emerging Scratch community and reframe this work with respect to our paper's central thesis: collaborative versus collective learning.

Figure 1. (a) Screenshot Scratch Interface and (b) Screenshot of Scratch Website.

We first present the typical activities that are organized collaboratively and collectively within the Scratch community. Each of these activity structures occur simultaneously within the community serving separate ends and potential contribute to separate types of learning experiences. In order to better articulate the differences between collaborative and collective learning, we have compiled a table (see Table 1) that highlights the key differences and similarities between collaborative and collective learning. It's important to note that our example, the Scratch community, affords both types of learning simultaneously, and while layered, each has its own distinctions.

Collaborative activities include mostly goal-oriented activities. Typically in the classroom, these would include small group work, team projects, discussion groups and so on. Outside the classroom, collaborative activities include playing board games, most platform style videogames with members of your family, sitting on committees, or playing in a rock band. In the Scratch online community, collaborative activities typically revolve around the production of particular types of Scratch projects by a small group of individuals that have commonly met one another in the online environment. One study focused on observations of a small collaborative group within the Scratch community called "Green Bear Group" that had formed spontaneously on the Scratch website by three children ages 8, 13, and 15 (Aragon et al., 2009). Over time, this group expanded and was later joined by over a dozen other members. They posted their projects on a gallery and members vote on which projects to further develop since each member brought different skills such as music, graphics or editing to the group. Based on an analysis of comments on the gallery as well as a survey, researchers observed found 19% of comments related directly to the job that needed to get done, 49% on socio-emotional aspects such as socializing and personal discussions, and 32% on contextual aspects such as arranging how to organize work, system administration and hardware issues. This suggests that collaborative groups do more than just getting the job done, they can also provide social and emotional support. Moreover, while bearing similarities to collaborative groups found in many assigned classrooms, what distinguishes these types of online collaboratives from regular groups are that they're self-organized and with flexible roles.

Collective activities, by contrast, include larger groups of individual with participation that is less goal-oriented and revolves more about sustained, enjoyed participation within the community over time. These types of activities although sparse in classroom settings, are common particularly in online affinity groups and in the arts. In the performing arts in particular, collective activities are common including African dance circles or orchestra performances. Wikipedia, Facebook, and Massively-Multiplayer Online Games are examples of collective activities where there may be some goal-oriented activities that drive participation but the community is driven by many individuals making modest contributions or participating peripherally and by a few intense participants. Within the Scratch community, this move toward membership in a large-scale community like Scratch can be a complex interplay between how young software designers develop personal agency with programming and gain status as experts amongst their peers. For instance, we followed two 12-year old participants, Lucetta and Matthew, as they learned the programming software Scratch and then joined scratch.mit.edu both in an after-school club and in a class as part of a four-month long ethnographic study (Kafai, Burke & Fields, 2010). We found that the web community furthered both Lucetta and Matthew's membership in a programming community in different ways. Lucetta friended other users, commented on projects, and uploaded her own projects, taking advantage of the social community on the site. This fit her cooperative social style, mixing with others while sharing an interest in Scratch. In contrast, Matthew embraced the potential of remixing, though there were other aspects of participation that he did not take up such as sharing his own project for validation and feedback from the community. However, Lucetta's initial resistance to migrating online and Matthew's own reluctance to upload his club project to the Scratch website, also suggest that establishing membership in a larger programming community is not as easily achieved as we had hoped. This suggests that navigating the collective community can accommodate an array of participation strategies and that there is a range of ways to participate in the collective and that it's probably necessary to learn about how to participate in collective activities in ways that might be initially uncomfortable. For example, what's lost or gained in Matthew and Lucetta's participation? What are the learning benefits of each of their participation

strategies? How might we teach them to participate in collectives in new ways, identifying with new practices? Moreover, what's the potential role that schools can play in this landscape?

Table 1: Collaborative vs. collective learning.

	Collaborative Learning	Collective Learning
Group size is…	Small groups with less than 5 individuals, and more typically 2-5 individuals	Large groups of more than 5 individuals; can involve whole class instruction, frequently groups of 30-40 or possibly even hundreds or thousands of individuals that embrace a common set of practices and ways of participation
Typical Activities include…	Also includes mostly goal-oriented activities (i.e., a group assignment in a course). Small group work; Team projects; Discussion groups; Board games; Platform Video games; Committees; Rock bands	Affinity groups; Wikipedia; Dance Circles; Massively Multiplayer Online Games; Sports teams; Orchestras
Time is…	Often relatively short, task-based time periods that can be either synchronous or asynchronous and is usually organized by the group leader.	Often needs to happen over long periods of time with cyclical patterns or trends of involvement that can be further analyzed. Most often this is asynchronous but there may be spurts of synchronous large-scale activity. Less organization to the way in which time is organized in the collective. The web-master has the most immediate impact on the organization of time (e.g., calling for work on a certain theme) but the community can arrange happenings as well (e.g., flash mobs).
Leadership is…	In classroom communities, it is often centralized (e.g., a teacher directs activity).	In online communities, leadership is emergent, decentralized, and distributed among a large group of individuals; Collective leadership is also an inherent to the role that designers play in shaping the online community but also co-constructed in the community.
Division of Labor is…	Usually prescribed; roles of either group leader and participants. Participants usually take on the same role in the group with one leader emerging from the group. Absenteeism affects the group. There is a need for every member to take on a strong role in the group – if one or more members are reticent members, the group's goals can be compromised.	Members take on one role to fill a legitimate community need within the larger group. Absenteeism affects the collective less until it becomes widespread. Roles are un-prescribed and fluid – individuals can inhabit a range of roles but don't take on all roles. Newcomers can be peripheral participants in the activity without affecting the collective goals.
Knowledge is…	Distributed among a small group of individuals that commonly have some face-to-face interaction. Less institutional history (i.e., course assignments are repeated year after year in the course with little communication among students)	Collective knowledge, by contrast, by de facto is stored on the main site or with links to other off-site information (perhaps a how-to webpage) and is readily accessible to the community to have large-scale impact. Collective knowledge is also distributed among individuals, commonly separated in time and space. Knowledge usually has some institutional memory as old-timers remain in the group, and CSCL Communities typically create shared artifacts to share tips with other.

The entire Scratch community, however, is not made from simply small collaboratives and individuals participating in the collective activities fostered by the website. There are also collective groups (i.e., large affinity groups) that work to produce work of a similar interest over an unspecified period of time. For example, and within the online community, similar themes emerge and spread quickly among members with similar interests, including projects around the Japanese manga character, Naruto, projects inspired by Logo Art, and other popular videogames. We have also observed the emergence of large-scale collectives in local contexts around the use of Scratch. For example, a sub-community of 30-40 Scratch programmers in South LA began making Scratch projects based on Low Riders—highly personalized cars often characterized by having low suspensions and original paint and hubcap designs (Peppler & Kafai, 2007). This local affinity group worked to produce a number of Low Rider Scratch projects over the course of a year. While working almost entirely offline, this community looks similar to affinity groups that have emerged within the online community as well.

Moreover, new practices emerge at the collective level that are simply not possible in small collaborative groups. For example, a particular form of participation within the Scratch is called "remixing", taking existing Scratch projects and changing them before uploading them back to the website. It has been argued that remixing is a key practice in today's networked culture in support of our knowledge production. Crediting ownership consists of referencing the intellectual origins of "text" used in media productions. For instance, remixing Scratch projects (i.e., taking an existing project and modifying code or graphics) is a common practice in the larger Scratch community; in fact, over 40% of all projects posted on the web site are remixes of existing Scratch projects (Senivirate & Monroy-Hernández, 2010) and this number has been steadily increasing since its launch. The culture of remixing in Scratch itself is not without fraught as positive and negative comments are prevalent. In an after-school club, Scratch programmers ages 10-12 years were adamant that their fellow programmers credited the origins of programs that they had remixed and posted online. While Scratch programmers initially were concerned about others taking their programs, they also came to understand

the remixes as a form of recognition that represented attention they received from others (Kafai, Burke, & Fields, 2010).

In addition to the differences in group sizes and types of activities that collaborative and collective groups tend to engage in, there are several additional distinguishing features about collaborative learning versus collective learning, which we summarize here in the ways that collectives organize time, community leadership, the division of labor, and knowledge, which are further described below and draw upon the examples mentioned above. In collaborative groups, time is often organized in relatively short intervals in a typically synchronous but sometimes asynchronous fashion. Additionally, time is usually organized by the group's leader, which makes goal-oriented deadlines. For example, a project leader might organize a time for the group to meet or a deadline for materials to be received as in the case of the Green Bear Group. By contrast, time within a collective is more open and with cyclical patterns or windows/ opportunities for involvement at an upcoming event or happening. Most often though time in collectives is asynchronous and not deadline oriented. For example, online communities typically have round the clock involvement of its members, so that no matter what time you login there are always large groups of individuals in the environment. Time in the collective also demonstrates patterns of activity, which allow for trends to emerge over time with little intentional coordination from its members. While in the Scratch community there is no unified effort to post projects on a certain day or time around a specified theme, there is nevertheless certain trends or memes that spread quickly within the community similar to the Low Rider creators mentioned above. For example, there was a sudden posting and remixing of Mother's day projects in May 2010.

Leadership within collaborative groups usually falls upon a single individual or small group of individuals. While some aspects of this type of top-down leadership can still be seen in collectives, leadership is also distributed among its members, emergent, and decentralized. For example, the online community was tweaked by its designers to highlight "Top Remixed Projects" to promote more remixing within the community. After doing so, the number of projects claiming to have remixed another project went up substantially as well as the number of projects that were created as tools for others to build on and remix went up substantially (as is the case with projects like side-scrolling game engines). Individuals also began to make new types of projects that could be remixed and to advertise and compete for these slots on the homepage in ways that were unexpected by the webmasters. Similarly, prior studies in MMOs have demonstrated this type of emergent leadership and use of tools in unexpected ways that the designers hadn't intended.

Accordingly, the division of labor is quite different within these two types of groups. Within a collaborative group, members all take on particular identities within the group as the programmer, the designer, musician, and editor with a distinct contribution to the group's production goals. These roles are usually prescribed by the teacher or group leader and somewhat stagnant over the course of the project. Absenteeism also highly affects the group. There is a need for every member to take on a strong role in the group because if one or more members are reticent members, the group's goals can be compromised. Within the collective, members take on a role to fill a perceived need within the community. Absenteeism also affects the collective less until it becomes widespread as there are multiple individuals with similar expertise available to fill in and knowledge is dispersed amongst its members. Roles are also un-prescribed and fluid. Individuals can inhabit a range of roles but don't necessarily take on all roles and newcomers can be peripheral participants in the activity without affecting the collective goals.

Lastly, knowledge is public and well distributed among members of the Scratch community. This is most visible when you look at the community as a whole and seeing it growing and changing in many ways over time. One might wonder whether expertise grows over time in these informal communities, and, indeed it does. Based on data from the South LA field site of Scratch users, pre- and post-test analyses revealed that youth learned about the big ideas of computer programming as well as visual/multimodal media arts production over the course of two years in absence of direct instruction (Maloney, Peppler, Kafai, Resnick, & Rusk, 2008). These analyses were consistent for individual learning as well as community learning (i.e., new members were being apprenticed into the community to produce more sophisticated work over the course of the study). This body of research demonstrates that the collective can generate competence in a domain in the absence of direct instructions and what is traditionally thought to be subject area expertise. In fact, the corpus of projects growing on the Scratch website at exponential rates reflects a similar growing understanding made more accessible by the fact that any project can be downloaded, analyzed and easily remixed to enable new generations of members to achieve tasks like creating side-scrolling gaming engines more quickly and easily than the ones prior.

Discussion

In this paper we examined different dimensions of participation in massive networked communities. We return to our initial question: does the size of group matter? As expected, there is no simple answer to this question. Collective learning is really about the development of a new community of practice over time (Lave and Wenger, 1991). This is particularly true for a community like the Scratch online community, which has only emerged in the past few years. As a result, specific notions of what it means to share work and start new projects

evolve in this community. But we also do know that practices around sharing information and collaborating have evolved differently than in other programming communities such as StarLogo or Alice where remixing pop culture texts like Naruto or Manga is not core to participation in the community. While some aspects, for instance the voluntary forms of peer production and contribution for the common good, suggest that new forms of collaborations are emerging, others such as the formation of small groups and issues of intellectual ownership suggest very much a continuation of previous collaborative practices. We have organized our discussion around the following four main themes: groups, designs, ethics, and research in collective learning environments. This list is by no means comprehensive but it serves as a promising starting point for thinking about new research opportunities in computer-supported collective learning.

Our first theme focuses on the group as the main unit of analysis. This has been a focal point in collaboration research, and to some extent, continues to be a focal point for research in massive communities as we observed in the formation of smaller groups in Scratch online and offline communities. It is clear that we need more research to understand how such groups are being formed, who decides to join, and how these groups continue working together, and also when and why they fail in their efforts. We also need to better understand differences in group formation and how this relates to the nature of artifacts produced. For instance, in many gaming communities players organize in guilds to engage in quests. These guilds are highly structured organizations where players assume different roles and contribute to the success of the mission (e.g., Gee, 2003). Contrast this with the free formation of the "Green Bear Group" in Scratch that set out to design games. Here members contributed based on their expertise but roles could change based on needs. The traditional collaboration research (Cohen, 1994) as well as CSCL research provides us with little information about the dynamics of unstructured group collaborations as prevalent in many massive communities. We can say that one aspect of collective learning is to assume multiple roles; these roles are not prescribed though members are valued and recognized in the community for their particular abilities. Such changes in participation are also part of communities of practice and often assumed for successful collaboration in small groups. Perhaps it is the prescriptive nature of assigned roles in small group collaboration that make it difficult for members to adopt the fluidity needed to function and perform and larger collectives.

Technical designs are equally important in studying collective learning since massive networked communities are artifacts, meaning that structures and features are designed by programmers and modified through community use. There are multiple feedback mechanisms and documentation notes that can be integrated and made accessible to participants. For instance, we do not understand which features lead members to contribute productively to large efforts and which ones might hinder such contributions. While some of these, such as recognizing heritage in remixed projects are social issues, they also involve technical solutions. For instance, in Scratch, the system automatically keeps track and makes visible such lineage. On the other hand, we have participants who are playing a growing role in content production, in the case of many virtual worlds such as Second Life, even are the main content producers for the community. How much of this control is ceded to participants is something that needs to be considered in the setup of these community as well as the technical prerequisites of lay designers themselves, in particular when we talk about younger participants.

We also need to consider issues about ethics that invariably come up in the context of collective production, sharing and commenting and are particularly relevant in the context of schooling that still favors individual recognition. What does it mean when members contribute to a larger project, how is this recognized? What about remixes that take up existing projects and modify them – a practice very common in networked communities? In a recent ijCSCL article, researcher Gerdes (2008) raised the issue of developing trust that surely plays a growing role in massive communities where participants do not know each other and perhaps never meet face to face.

Finally we need to expand our repertoire of research methods in describing and analyzing collective learning. Studies of gaming and social network communities (Boelstorff, Taylor, Nardi & Pearce, in press; Hine, 2000; Williams, Yee, & Caplan, 2008) reveal an unhealthy split in either quantitative or qualitative research approaches. For instance, survey methods and statistical data mining seem to drive many efforts in coming to grips what engages members in these communities. On the other end, we have ethnographies of single massive community (see Boelstorff, 2008; Taylor, 2006) that inform us with a fine-grained detail of cultural practices and activities. Of course, others have complained about this dichotomy and argued for a mixed methods approach (Williams, 2005). In our view it is not just about juxtaposing data sources and analytical methods but also about developing ways that integrate both in a productive manner. As a case in point, we have suggested and employed connected ethnographies that make use of the data mining and reduction in large data sets to identify particular participants based on their contribution profiles and to cross reference and develop these through in-depth ethnographies (Kafai & Fields, in press; see also Reimann (2009). Such analyses leverage the explanatory potential of each method and allow us to contextualize cases within larger community trends.

All of these features come into prominence when we think about the design of massive intentional learning or knowledge building communities (Scardamalia & Bereiter, 1991) that design for collective learning. In the case of Scratch, we have started collaborative design challenges in the online community that invite

members to work together on programming projects. Our efforts focus on understanding how groups and collectives form and interact across global and local Scratch communities and how to better design and support computer-supported collaborative and collective learning. Our observations suggest that it might be worthwhile to think about the second C in CSCL not just as collaborative but also as collective learning. It's not just a simple matter of involving larger numbers of participants but also of considering the nature of activities, the roles that participants will assume, and the performances or artifacts that present the culmination of efforts to effectively design and study collective learning environments. We suggest that CSCL researchers step outside the boundaries of small groups and begin to consider alternative arrangements. Both collaborative and collective learning technologies, activities, and environments that we design are greatly influenced by how we think about learning as a socially situated activity. Size does matter – we just need to know how and when to engage in collective vs. collaborative learning.

References

Aragon, C., Poon, S., Monroy-Hernandez, A., & Aragon, D. (2009). A tale of two online communities: Fostering Collaboration and Creativity in Scientists and Children. In *Proceedings of the ACM Creativity and Cognition* Conference, Berkeley, CA.

Ares, N. (2008) Cultural practices in networked classroom learning environments. *International Journal of Computer Supported Collaborative Learning, 3*(3), 301-326.

Benkler, Y. (2006). *The Wealth of Networks: How Social Production Transforms Markets and Freedom*. New Haven and London: Yale University Press

Birchfield, D. & Megowan-Romanowicz, C. (2009) Earth science learning in SMALLab: A design experiment for mixed reality. *International Journal of Computer Supported Collaborative Learning, 4* (4), 403-421.

Black, R.W. (2008). *Adolescents and Online Fan Fiction*. New York: Peter Lang.

Boellstorff, T. (2008). *Coming of age in second life: An anthropologist explores the virtually human.* Princeton, NJ: Princeton University Press.

Boellstorff, T., Nardi, B., Pearce, C. & Taylor, TL (in press) (Eds.). *A Handbook of Ethnographic Methods for Virtual Worlds*. Princeton, NJ: Princeton University Press.

boyd, d. (2008). Why Youth (Heart) Social Network Sites: The role of Networked Publics in Teenage Social Life. In D. Buckingham (Ed.), *Youth, Identity and Digital Media* (pp. 119-142). Cambridge, MA: MIT Press.

Brown, A., & Campione, J. (1994). Guided discovery in a community of learners. In K. McGilly (Ed.), *Classroom lessons: Integrating cognitive theory and classroom practice* (pp. 229-290). Cambridge, MA: MIT Press.

Cohen, E. G. (1994). Restructuring the classroom: Conditions for productive small groups. *Review of Educational Research, 64*, 1-35.

Dohn, N. (2009). Web 2.0: Inherent tensions and evident challenges for education. *International Journal of Computer Supported Collaborative Learning, 4*(3), 343-363.

Eddy, Y.C.L., Chan, C., & van Aalst, J. (2006). Students assessing their own collaborative knowledge building. *International Journal of Computer Supported Collaborative Learning, 1*(1), 57-87.

Engelmann, T. & Hesse, F.W. (2010) How digital concept maps about the collaborators' knowledge and information influence computer-supported collaborative problem solving. *ijcscl* 5 (3), pp. 299-320.

Fields, D. A. & Kafai, Y. B. (2009). "U wanna go to the moon?" A connective ethnography of peer knowledge sharing and diffusion in a tween virtual world. *International Journal of Computer-Supported Collaborative Learning, 4*(1), 47–68.

Gerdes, A. (2010) Revealing preconditions for trustful collaboration in CSCL. *International Journal of Computer Supported Collaborative Learning,* 5 (3), 345-353.

Hill, M. B., Monroy-Hernández, A., & Olson, K. (2010). Responses to Remixing on a social media sharing website. *Fourth International AAAI Conference on Weblogs and Social Media*.

Hine, C. (2000). *Virtual ethnography*. London: Sage Publications.

Hung, D., Lim, D., Chen, V. & Koh, T. S. (2008) Leveraging Online Communities in Fostering Adaptive Schools. *International Journal of Computer Supported Collaborative Learning,3*(4), 373-386.

Jenkins, H., Clinton, K., Purushotma, R., Robison, A., & Weigel, M. (2006). Confronting the challenges of participation culture: Media education for the 21st century. White paper. Chicago, IL: The John D. and Catherine T. MacArthur Foundation.

Kafai, Y. B. & Fields, D. A. (forthcoming). Understanding Player Participation and Practices in Virtual Worlds: A Proposal for Qualitative Analyses of Log File Data. In D. Thomas (Ed.), *Research methods in virtual worlds*. Cambridge, MA: The MIT Press.

Knobel, M. & Lankshear, C. (2009) Wikis, digital literacies, and professional growth *Journal of Adolescent & Adult Literacy*, *52*(7), 631-634.

Leadbeater, C. & Miller, P. (2004). The Pro-Am Revolution: How enthusiasts are changing are economy and society. London: Demos.

Levy, P. (1997). *Collective intelligence.* Cambridge, MA: Helix Books.

McGonigal, J. (2008). 'Why I love bees: A case study in collective intelligence gaming' in K. Salen (Ed.), *The ecology of games: Connecting youth, games, and learning* (pp. 199-228). Cambridge, MA: MIT Press,

Maloney, J., Peppler, K., Kafai,Y., Resnick, M., & Rusk, N. (2008, March). *Programming by choice: Urban youth learning programming with Scratch*. Paper presented at the SIGCSE 2008 Conference, Portland, OR.

Monroy-Hernandez, A. & Resnick, M. (2008). Empowering kids to create and share programmable media. *Interactions*, *15*(2), 50-53.

O'Donnell, A. M. (2006). The role of peers and group learning. In P. Alexander & P. Winne (Eds.), *Handbook of educational psychology*, 2nd Edition. Mahwah, NJ: Lawrence Erlbaum.

Osterman, K. F. (2000). Students' Need for Belonging in the School Community. *Review of Educational Research, 70*(3), 323-367.

Peppler, K. A. & Kafai, Y. B. (2007). From SuperGoo to Scratch: Exploring creative digital media production in informal learning. *Learning, Media, and Technology*, *32*(2), 149–166.

Reimann, P. (2009) Time is precious: Variable- and event-centered approaches to process analysis in CSCL research. *International Journal of Computer Supported Collaborative Learning, 4*(3), pp. 239-257.

Resnick, M., Maloney, J., Author 2 Rusk, N., Eastmond, E., Brennan, K., Millner, A., Rosenbaum, E., Silver, J., Silverman, B., & Author. (2009). Scratch: Programming for all. *Communication of the ACM, 52*(11), 60-67.

Scardamalia, M. (2002). Collective cognitive responsibility for the advancement of knowledge. In B. Smith (Eds.), *Liberal education in a knowledge society* (pp. 67–98). Chicago: Open Court.

Scheuer, O., Loll, F., Pinkwart, N., & McLaren, B. M. (2010) Computer-supported argumentation: A review of the state of the art. *International Journal of Computer Supported Collaborative Learning, 5* (1), pp. 43-102.

Senivirate, O. & Monroy-Hernández, A. (2010). Remix culture on the web: A survey of content reuse on different user-generated content web sites. *Web Science Conference*. Raleigh, NC.

Shirky, C. (2008). *Here Comes Everybody: The Power of Organizing Without Organizations.* New York, NY: Penguin Press.

van Aalst, J. (2009) Distinguishing knowledge-sharing, knowledge-construction, and knowledge-creation discourses. *International Journal of Computer Supported Collaborative Learning, 4*(3), pp. 259-287

Webb, N. & Palincsar, A. (1996). Collaborative learning. In D. Berliner (Ed.), *Handbook of Educational Psychology* (pp. 345-413), New York: Macmillan.

Williams, D. (2005). Bridging the methodological divide in game research. *Simulation & Gaming, 36*(4), 1-17.

Williams, D., Yee, N. & Caplan, S. (2008). Who plays, how much, and why? Debunking the stereotypical gamer profile. *Journal of Computer Mediated Communication*, *13*(4), 993-1028.

Zhang, J., Scardamalia, M., Reeve, R., & Messina, R. (2009). Designs for Collective Cognitive Responsibility in Knowledge-Building Communities. *The Journal of the Learning Sciences, 18(*1), 7-44.

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