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Potential roles of CSCL in transforming Groups of Learners into Communities of Practice

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Abstract. Creating communities of practice among children has been easier in informal athletics than it has been in other areas, but some think it is essential for helping children to gain identities as learners and practitioners of serious thinking. Essential to creating a community of practice is the ability to collaborate and communicate together. Collaborating and communicating around practices may be essential to developing community and individual identity. This paper presents findings from a study of the roles the computer can play in supporting face-to-face collaboration, communication, and learning about practices in an informal science-learning environment aimed at learning some basics of chemistry through cooking. We report on the effects and affordances of three kinds of supports built into the software and propose some additional computer support help young learners need while working and learning together. Our observations suggest that these kinds of computer support for face-to-face collaborative learning have the potential to play an important role in transforming groups of learners into communities of practice.

Keywords: Communities of practice, identity, informal learning environments, cooking, chemistry, communication, face-to-face collaboration, children

INTRODUCTION

Creating communities of practice among children has been easier in informal athletics than it has been in other areas, but some think it is essential for helping children to gain identities as learners and practitioners of serious thinking (Nasir, 2000). Indeed, helping children to think more like scientists and to understand the relevance of math to their lives is regularly noted as lacking in our (US) educational system (Tyson, 2004). While a number of reforms in science education are currently under way to remediate these problems, and many have found ways to engage students in the classroom (Tyson, 2004), little work to date has studied how we can encourage more of our children to think scientifically or mathematically on a regular basis outside the classroom. Nasir (2000) suggests that a feeling of identity as a scientific or mathematical reasoner is needed for this. Some have hypothesized that if we can engage learners in contextualized real-world practices in the context of a community of practice that they feel they belong to (e.g., Westheimer, 1998; Lave, 1993; Wenger, 1998), we might see transformation in learners' interest and understanding of science as well as see them take the initiative to think scientifically as opportunities arise in their everyday living. But a community of practice (CoP) is not simply a temporary coming together of individuals around a particular goal. Rather, it is "a persistent, sustained social network of individuals who share and develop an overlapping knowledge base, set of beliefs, values, history and experiences focused on a common practice and/or mutual enterprise" (Barab et al, 2000). The most often cited examples of CoPs are naturally occurring and informally constructed upon the inspiration of their members. Cognitive apprenticeship (Collins, 1989) has been used as an approach to engaging learners in real-world practices as a community of learners, but Barab and Duffy (2000) suggest that while cognitive apprenticeship situations help learners learn practices, they fall short in promoting identity in that they most often don't actually engage learners in an authentic community of practice. Lave (1993) and Wenger (1998) suggest that identity is formed as learners in a community of practice learn through participation in authentic community activities and move toward becoming central to the community's activities. Barab et al (2000) challenge us to explore what happens when we take the next steps beyond cognitive apprenticeship and specifically try to help learners build and sustain communities of practice that have a real relationship with communities of practitioners, in an effort to help learners develop a "sense of identity and belonging, affirmation, commitment to the group, strong bonds, and the development of both common purposes and collective responsibility" (Barab, 2000). It is hoped that participants will think about sustaining their community or extending the practices beyond the learning environment, taking the initiative and developing a disposition (Bereiter, 1995) towards engaging in more sophisticated ways with the world around them.

This is the challenge we take on in our Little League Cooking (LLC) project. LLC is an informal after school initiative. Learners actively participate in cooking and baking, with the goal of learning principles behind successful cooking. Needed for that learning is understanding of the science behind the cooking and its techniques. We want all learners to come to appreciate the role that well-structured investigation plays in becoming an expert chef and expect that members will eventually begin to identify themselves as cooks, bakers, kitchen chemists, food safety experts, or scientific reasoners. Over time, we hope that communities of practice for each will evolve, each with scientific practices appropriate to its goals.

Through this project we seek to answer a variety of questions: In what ways can one facilitate the development of a community of practice? What activities and resources does the learning group need to establish practices, rituals, and goals? What roles can the computer play in facilitating this transformation? The literature tells us that being able to work together and sharing experiences are prerequisites to community building (Lave, 1991). We thus begin by focusing on how the computer can help face-to-face groups effectively collaborate and focus discussion while participating in physical hands-on project activities and how computer support during those activities and during reflection activities that follow can help focus discussion and promote sharing of experiences across groups afterwards. Based on our initial implementation of Little League Cooking, this paper describes some answers to this last question.

STUDY DESCRIPTION

We've taken a design-based research approach to learning about the interactions that take place in the natural context of an after school environment to shape the identities of middle school learners. The study presented here took place after school in the small kitchen of a K-12 private school with seven participants in fifth through eighth grade. Learners worked in groups of 2-4 students to prepare recipes and participate in chemistry exploration. Our initial study ran for 4 sessions over a two-week period.

ACTIVITIES

The curriculum for this study focused on the different effects that eggs have in cooking and baking. Day 1: After an introduction, two small groups of learners each made brownies, one group using 2 eggs and one using 4 eggs (all else the same). Each group used a laptop with the LLC software loaded and paper copies of their recipe. During the cooking activity, students recorded observations in the LLC software and took pictures of key phases in the cooking process. While the brownies were in the oven, learners traced the evolution of the brownie batter from individual ingredients to a smooth batter and the roles eggs played in the transformation. They took the brownies out of the oven but waited to compare and eat them until the next day. Day 2: As they were tasting the brownies, learners made comparisons between the 2-egg and 4-egg brownies on appearance, taste and texture. They noticed that the 4-egg brownies were taller and more like cake, and they wondered why. After making the brownie comparison, each learner received a water bottle, oil, water, and an egg. Then conducted an experiment where they explored how eggs make water and oil mix based on the instructions centrally located on the software. Following the experiment, the groups viewed a brief PowerPoint about the structure and function of egg proteins. We then asked them to reflect as a group on the role eggs played in the water bottle experiments and the brownies based on this new understanding of eggs. Day 3: One group received a recipe to make two kinds of eggs: boiled and scrambled. The other group received a recipe to make meringue topping for a chocolate pie. Again, while the groups cooked, they noted observations in the LLC software and afterwards reflect on the entire experience while relating it to what they learned previously. Day 4: The learners participated in individual and group interviews.

SOFTWARE DESIGN

The Little League Cooking software is based on a tabbed notebook theme with each tab representing an activity in the study curriculum. The notebook is built on top of Swiki (Guzdial, 2000) software. Each page shows material (e.g., the steps in a recipe); has prompts and reminders for engaging in the activity (e.g., how to stir), making observations (e.g., what to look for, when to take pictures), collecting data, and/or interpreting data; and has spaces for learners to enter answers, notes, and observations. The software also provides facilities for quickly uploading the pictures learners take during cooking and chemistry activities. The networked affordances of the coweb offer learners the opportunity to look at one another's cooking observations, reflections, and pictures. Within the framework of the notebook, the software provides three types of computer support for collaboration and learning: (1) conversation prompts, (2) assistance with defining roles and (3) documenting the shared experience.

DATA COLLECTION AND ANALYSIS

We wanted to answer 3 questions: (1) For each role in supporting collaboration that we built into the software, how effective was it, and how did each play itself out? (2) What collaborative and communicative behaviors did the children engage in well, and what roles did the computer play in helping that happen? (3) What additional needs with respect to collaboration and communication did children have (both within and across groups) that other software might support? We collected video of each group at work and discussions between groups, collected the artifacts learners created (written and pictures), interviewed participants, and took field notes. Video data revealed group interaction, computer use, and conversations. The artifacts that students created (cooking notes, cooking reflections, chemistry reflections (written and drawn), and presentations) added to the video data to create a more complete picture of the interaction and the origin of written responses. Field notes were of interesting collaborative moments, conversational exchanges, surprises, and descriptions of activity sequences. In addition, small group and individual learner interviews were used to elicit feedback and opinions on the intervention and their experience.

RESULTS AND ANALYSIS

The LLC software prompted conversations within groups by asking them simple questions or prodding them with inquiry statements; requiring the learners to make explicit their experience, understanding, and misconceptions. Conversational prompts accompanied by textboxes were embedded in the software-based recipe and activity reflections for them to record their thoughts. The presentation creation activity also prompted students to talk with one another by asking them to summarize their learning experience for the roles eggs played in cooking. Koschmann (1994) and Guzdial (1995) suggest that learners articulating their understanding, misconceptions, and reflecting on their experiences are essential to effective learning and instruction. Since communication is also essential for collaboration sparking conversation through explicit articulation became a crucial part of making this study effective. The group's process of formulation for what to write in the answer textbox was often the result of the person at the computer reading aloud the prompt and asking the other group members what they thought. Members of the group would then make their contributions. Some contributions were unique while others built onto or disagreed with those already mentioned. The discussion would end with the computer person summarizing the major points and recording them in the software.

Prompting the learners to think about whether something important is to be gained from the step, experience, etc. replaces silence and unproductive conversations with scientific conversation. Thus, when conversations spark from them it enriches the learning experience for the group and its members. Stahl (2002) suggests that group learning is the definitive measure of Collaborative learning. As a direct result, key concepts were highlighted and reinforced increasing learners opportunities to connect the cooking to the chemistry. The conversations also facilitated the development of group knowledge as learners that typically did not participate were encouraged to participate by the comments of others. The varying participation of members contributed to the content and focus of the discourse ensuring that the collective knowledge of the group was more than the sum of each individual member.

Although prompts were instrumental in getting the learners to talk about the science, the majority of conversations were based around non-scientific competitions. Competitions often arose from students comparing their dish to the other groups' dish both during and after the cooking process. We would like to harness the competitive nature of the learners to support the development of their scientific reasoning skills. We could do this by providing a software tool to support their competition by allowing students to make arguments from qualitative as well as quantitative data to move the competition and discourse scientific soundness.

Without the physical constraints provided by having a single computer in each group to help define the learner's roles through coordinating the activities within the group, the conversational prompts would have been unsuccessful. There were four roles learners can assume in the program: (1) head chef, (2) computer person, (3) camera person, and (4) assistant chef. In the first cooking activity we had computer print outs of the recipes and a software version of the recipe on the laptop for the computer person to record observations. This proved to be unsuccessful at coordinating the efforts of the group as individuals with the recipes didn't worry about answering the questions prompting them to record observations. Each member of the group did their own thing as if they were the only one cooking. In the next activity we took away the paper based recipe and made the computer the major source from which activities were originated and coordinated. This proved to be a better means for facilitating collaboration as the compute person became the major coordinator of activities because he/she had the information. Thus other individuals in the team looked to the computer person for future direction or sought the computer for direction. This encouraged the other members of the groups to report on what they were doing which was a catalyst in learners defining their roles. In one group a student assumed the role of camera person and even though he often imposed on the head chef's role he found it appalling for others to even consider taking pictures. This example is not an isolated example as it was repeated in other groups where individuals would see the person struggling with their role and instead of assisting them they halted their activity until the person could catch up. We recognize that this could be problematic and will look into ways of remedying the lack of shared responsibility, however it is worth citing that learners are really taking ownership of their roles and those of others.

Stahl (2002) suggest that computers can provide support for, "overcoming the limitations of human short term memories and of paper-based aides to generating or sharing drafts of documents." The third support for collaboration and learning we discuss has taken advantage of this opportunity by providing support for learners to document their shared experience. While preparing their dishes, the students took pictures of the food they were preparing. The pictures were later incorporated into the LLC software with students' recipes and observations, providing them with an archive of their shared experiences. This turned out to be extremely useful for enhancing and sparking conversations among them. It led students to discuss what steps were important to observe and take pictures of. Once the students had completed an activity, this archive served to enhance later conversations. They were used for supporting evidence when discussing causes of the results students' observed. Students often referred back to their observations and pictures to answer that experiment's reflection questions. They also used documents of their shared experiences to help one another. For example, if a student missed a day of the program, other students were able to use archives to give that student a detailed description of what went on in the previous day. The software should therefore produce artifacts that make it easy for them to pull artifacts from previous experiences to illustrate key concepts.

Although archives of shared experiences were useful within groups, we found that when students had discussions with other groups, they were not inclined to use the software to support their arguments or share stories. We believe this is because the software did not provide sufficient mechanisms for students to present their archives to others. We are currently designing a group discussion tool that allows students to easily display multiple archives of an experiment (i.e. recipe observations, pictures, reflections, etc.) in one screen. This tool would also allow students to easily swap the archives in view to support the dynamic nature of conversations. We also found that the software did not provide the students with any support for documenting "ah-ha" moments or individual prior experience as a part of their shared experiences. In "ah-ha" moments, students suddenly understood concepts that they previously did not. These moments were important to the students' understandings as well as to the experience. We therefore feel that a persistent, free form tool that allows the students to write notes in any format they would like, as well as add visual images would be extremely useful to the LLC community. Likewise, we found that students were excited to share their prior experiences, prior knowledge, and the cooking techniques they were familiar with. When this happened, the entire group used the information to answer questions and guide their techniques. It would be useful for students to have some space in the software to document and modify these pieces of knowledge brought by different group members. This would provide the students with a group repository and a sense of ownership of the information they possess together.

In analyzing the roles that the software played in LLC, we have future plans to keep aspects that worked well, make modifications to some, and completely get rid of others. We plan to keep the software's support for prompting and enhancing conversations. Because the activity presentations did not work well, we will completely get rid of the software's support for this and replace it with a new discussion tool for discussions in between groups. We are also designing new comparison and free form tools to further enhance conversations and collaboration.

CONCLUSION

We found that the software was useful for helping learners to share prior knowledge and to document shared experiences, for helping students to have meaningful conversations, and for facilitating roles in the community. Facilitating roles in CoPs is important because each member of the community will have "different interests, make diverse contributions to activities, and hold various viewpoints." (Lave, 1991) Therefore, it is important that learners are able to create their identities in the community by distinguishing their roles based on their own personalities, abilities, and experiences. The software situated in the environment of LLC provided structure that the students needed to define their roles and coordinate their activities.

Meaningful conversations are crucial to the formation of CoPs because they engage, focus, and shift attention, they bring about coordination, they support communal forms of memory and reflection, and they signal membership (Lave, 1991). It is therefore important that students engage in conversations within and across their groups. We found in this study that students were more likely to engage in scientific conversations when competing or comparing and contrasting their results with other groups. We therefore suggest that support in the software for enhancing competitions and comparisons would aid in nurturing the formation of a CoP.

In CoPs, the goal is to move focus away from teaching and toward structure of community resources (Lave, 1991). Documenting shared experiences moves us a step closer to this goal. Software support for sharing prior knowledge would also enhance the structure and content of their community resources. This structure of community resources helps learners to develop a view of what the whole enterprise is about (Lave, 1991). The literature also states that where circulation of knowledge among peers and near peers is possible, it spreads exceedingly rapidly and effectively (Lave, 1991). Communal use of stories is essential to the fashioning of an identity (Lave, 1991). The software's ability to enhance conversations and document shared experiences and prior knowledge makes it an effective tool for helping students to establish identities as investigating chefs. Thus, our goal of having middle school students learning science through cooking is implicitly realized, supported, and sustained in a way that is personally meaningful to the learner.

We look forward to further iterations on the Little League Cooking software. We plan to enhance to the Little League Cooking software in the aforementioned ways. We are also adding components to help students with designing their own cooking experiences in the form of a Retry Day. From our studies last semester, we were not able to completely decipher which things worked (or did not work) because of the software and which things were successful (or unsuccessful) because of the activity contexts. Questions also remain about integrating the software with the hands on activities in Little League Cooking. We would like to design our software to fit in as a part of a complete system of students learning to be investigators in this after-school environment.

REFERENCES

Barab, S. A., and Duffy, T. M. (2000) From practice fields to communities of practice, in Jonassen, D., & Land, S. (Eds.). *Theoretical Foundations of Learning Environments*. Lawrence Erlbaum Associates, Publishers, 25-55.

Bereiter, C. (1995). A dispositional view of transfer, in McKeough, A., Lupart, J., & Marini, A. (Eds.). *Teaching for Transfer: Fostering Generalization in Learning*. Mahwah, NJ: LEA.

Collins, A., Brown, J., & Newman, S. (1990). Cognitive Apprenticeship: Teaching the crafts of reading, writing, and mathematics. In Resnick, L. (Ed.), *Knowing, learning, and instruction: Essays in honor of Robert Glasser*, Lawrence Erlbaum Associates, Inc, Hillsdale, NJ, 453-494

Guzdial, M., (1995) Software-Realized Scaffolding to Facilitate Programming for Science Learning, *Interactive Learning Environment*, Vol 4, Issue (1), 1-44

Guzdial, M. (2000) Recognizing and Supporting Roles in CSCW. Proceedings of CSCW 2000 (Philidelphia, PA), ACM Press.

Lave, J., and Wenger, E. (1991) *Situated Learning Legitimate Peripheral Participation*, Cambridge University Press, New York, NY.

Lave J. (1993) The practice of learning. In S. Chaiklin & J. Lave (Eds.), *Understanding Practice: Perspectives on Activity and Contex*, Cambridge: CUP.

Nasir, N. S. (2000) "Points Aint Everything": Emergent goals and average and percent understandings in the play of basketball among African American students. *Anthropology and Education Quarterly,* 31, 3.

Stahl, G. (2002) Introduction: Foundations for a CSCL community. Proceedings of CSCL 2002 (Boulder, CO), Lawrence Erlbaum Associates, Inc, 1-2.

Tyson, H. (2004) Overcoming structural barriers to good textbooks. (Online), November 19, 2004. The National Education Goals Panel. http://www.negp.gov/Reports/tyson.htm

Wenger, E. (1998) Communities of practice: learning as a social system. *The Systems Thinker*, 9, 5.

Westheimer, J. (1998). *Among school teachers: Community, autonomy, and ideology in teacher's work*. Teacher's College Press, New York, NY.