Co-Design for Learner Help-Giving Across Physical and Digital Contexts

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Abstract: With the growing integration of technology in the classrooms, learners can now develop collaboration skills by applying them across diverse contexts. While this represents a great opportunity, it also brings challenges due to an increased need to support individual learners across multiple learning activities. We propose a technology-enhanced learning ecosystem called UbiCoS that supports learner help-giving during face-to-face collaboration and across three different digital learning environments: an interactive digital textbook, an online Q&A forum, and a teachable agent. In this paper, we present a first step in the development of UbiCoS: five co-design sessions with 16 learners that give insight into learners' perceptions of help-giving. The findings provided us with technology-related and curriculum-related design opportunities for facilitating learner interaction across multiple platforms.

Introduction

Computer Supported Collaborative Learning (CSCL) is becoming ubiquitous in part due to the increasing presence of technology in formal learning environments, creating learning scenarios which involve multiple activities distributed across physical and virtual spaces. For example, learners in a classroom may move from having a face-to-face discussion surrounding the speed of a moving car, to watching and commenting on an online video on the same topic, to completing a problem set at home using a digital environment. Given these diverse contexts, Dillenbourg, Järvelä, & Fischer (2009) articulate a growing need for researchers to explore how CSCL fits into broader pedagogical scenarios rather than designing a single CSCL experience for learners.

Integrating multiple CSCL technologies in a classroom creates unique opportunities for understanding and facilitating learner development of collaboration skills. Through interaction via multiple technological platforms (e.g., discussion forums, wikis, online Q&A), learners leverage their skills in different contexts; their collaborative interactions facilitate the development of literacies related to collaboration, problem-solving, and the subject domain. However, while the use of a single CSCL technology in formal education can lead to improvement in learning performance, integrating multiple technologies within a single classroom practice comes with behavioral, pedagogical, and logistical challenges (Dillenbourg & Jermann, 2010). The same learner might behave differently when interacting online rather than face-to-face, and may struggle to transfer knowledge and skills across platforms. Our research vision is to explore how we can design multiple technological platforms within a learner-centered classroom to facilitate collaborative skills, with a focus on mutual help-giving. Mutual help-giving involves a collection of behaviors including sharing resources, explaining concepts, giving feedback, and challenging each other's reasoning (Johnson and Johnson, 2009). Learners have many opportunities to engage in these behaviors as part of their schooling, ranging from brief informal interactions while working on an assignment to discussing ideas on an extended group project.

We have created a novel learning environment, called UbiCoS (Ubiquitous Collaboration Support), that includes three platforms where learners engage in help-giving surrounding ratios and proportions concepts. The first technology platform is Modelbook, an interactive digital textbook integrated with a discussion forum which is intended to be used synchronously and collaboratively with one's peers (see Figure 1, left). In the environment, learners can see questions relevant to each page of text (posted by their classmates or teacher) and have a single discussion in response to each question. The interactions in the textbook are intended to be similar to face-to-face discussion in the classroom but lower the barrier for participation since all learners are expected to make contributions, compared to a whole-class discussion where only a subset of learners might participate. The next technology platform is Khan Academy, which we use for asynchronous collaboration with a geographically distributed learning community (see Figure 1, right). While Khan Academy is well-known for its instructional videos, it also has a collaborative learning space where people participate in knowledge construction by commenting on videos to ask and answer questions about the content (www.khanacademy.org; Taton, 2011). We expect learners to see similar benefits in

answering questions on Khan Academy as on Modelbook, although because interactions are asynchronous, learners can take time to phrase their answer to produce more explicit and thoughtful explanations (Wu & Hiltz, 2004). However, learners may feel less connected to this platform due to its asynchronous nature and anonymous peers (Hiltz, 1998) and limit their help giving behavior. The third technology is a speech-based teachable agent, Cobi. Learners interact with Cobi using spoken language and a web application. The web application displays a problem description and partial worked-out solution steps in table form to guide the learners in their teaching of Cobi. There is a microphone image that learners use to press and talk to Cobi. Learners walk Cobi through the worked-out problems using spoken language, explaining each step. Cobi listens and responds with questions, self-explanations, and encouragement (Lubold, Pon-Barry, & Walker, 2015). During these interactions, we expect learners to benefit by articulating their reasoning and responding to agent questions. Learners may also feel as though they can make more mistakes when interacting with an agent rather than a peer (Chase, Chin, Oppezzo & Schwartz, 2009). On the other hand, they may be frustrated by the relative limitations of the agent (e.g., imperfect speech recognition, limited ability to explain its reasoning).

The goals for UbiCoS are twofold: Provide a platform for improved understanding of how collaborative skills transfer across activities, and support the development of these productive collaborative interactions by scaffolding learner and teacher practices. These goals are difficult to achieve, as there are several designs and logistical challenges related to building such a complex system. In this paper, we take a first step towards the design and development of UbiCoS by investigating the following research question: What are learners' motivations and strategies for help-giving? To shed light on this question, we engaged in five co-design sessions with middle school learners surrounding this theme. Using the results of these sessions, we can begin to design a curriculum and related technological support that facilitates learner help-giving across multiple platforms.

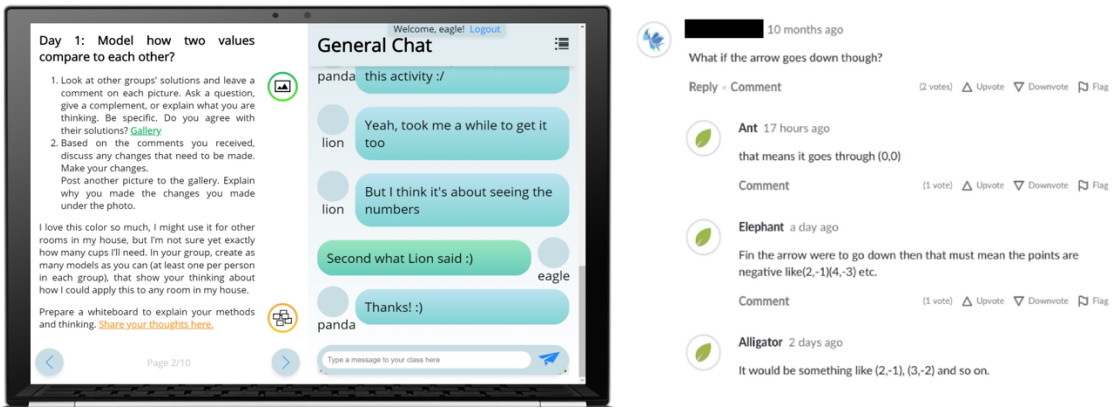

Figure: 1: (left) discussion on the right-hand side of the interactive digital textbook; (right) Khan Academy discussion

Student Input: Co-Design Sessions

With the above platforms as our starting point, we conducted a series of co-design workshop sessions with 8th graders to understand learner perceptions of help-giving and how they could inform our approaches for technology and curriculum design. Over seven months, we conducted five after-school two-hour workshops. We followed Sanders' (2003) approach to participatory design, where users' participation reveals their underlying goals and needs. Participants came from different schools within a single school district located in the Southwestern United States, and were part of a district leadership program that met regularly after school throughout the year. 87% of learners in the district qualify for free or reduced priced meals. In total, 16 learners participated in the sessions (9 female, 7 male).

To build rapport between learners and researchers, all workshops started with 15 minutes of unstructured social time over food. The goals for the first workshop were to familiarize learners with the project context and goals. Learners interacted with two of the digital contexts (the interactive digital textbook and the teachable agent), and designed achievement badges based on their previous collaboration experiences outside of these sessions, as well as the two technologies they used in the session. The goal for the second and third workshops was to understand how learners conceptualized aspects of technology-based support. In the second workshop, learners participated in a group design activity to brainstorm and create their own intelligent agent within the Khan Academy context, including its appearance, characteristics, and behavior. They were then asked to draw and describe their agents, as well as to develop a skit depicting interaction with their agents. In the third workshop, we took the Speed Dating approach (Davidoff, Lee, Dey, & Zimmerman, 2007) and presented learners with several scenarios of various help-giving dialogues,

enacted by Anki's Cozmo robot (www.anki.com/en-us/cozmo). We then had learners write and enact their own dialogues. In the fourth workshop, we further investigated help-giving motivations. Learners played a game where there were opportunities to informally help each other, filled out a self-report questionnaire related to their motivation more generally, and discussed their responses. The goal for the fifth and final workshop was to leverage learners' expertise as users and get their feedback on three preliminary findings and three design ideas. Learners first individually wrote down their thoughts on each item we presented, and then we discussed them as a group.

These sessions resulted in videos, discussion recordings, and paper artifacts. Rather than analyzing each workshop individually, we analyze their results in conjunction to better understand our research questions. Our analysis follows the general inductive method (Thomas, 2006). Several members of the research team initially generated codes for the data. All data was then coded by one of the authors in two distinct passes. To validate the clarity of the coding, another author was handed a set of thirty data points (18.9% of all data) as well as the list of codes, and was asked to assign codes to the data. Agreement between both raters was acceptable, Kappa=0.692. As additional validation, findings were discussed with the learners themselves in Workshop 5 (W5).

Throughout the workshops, learners discussed and demonstrated **motivations for helping others**. Perhaps the most salient reason for helping was **reciprocity.** One should help others because they have helped you before or could help you in the future. For example, when learners developed a script in which an agent tries to convince a learner to help someone else (W3), other learners had the agent appealing to reciprocity: "*They helped you before, so the best thing to do is help them.*" Another learner commented on his motivations: "*They always helped you before (...) you're always gonna need help sometime (...) if you help them they might help you.*" Along similar lines, learners also expressed the notion of **helping their friends in need.** In W3, when asked for feedback on whether the prompt "*It is a great practice to learn too*" would motivate a learner to answer a question, learners quickly and emphatically replied that it would not. Asked how they would prompt help instead, they proposed "*your friends need help.*" Learners also exposed their reasoning for not helping someone as they should **already know the content**. For example, a learner told us about a time when he was aggressive to a request for help in his class: (W3) "*Because we had learned it the year before that, everybody already knew it.*" Similarly, learners may also be unwilling to help when they have **already helped several times**. Both groups acknowledged this into their W3 scripts: "*but I already answered it 4 times.*" Learners also expressed their lack of time or bad mood as other reasons for not helping.

A second major theme brought up by learners was their **strategy for giving help**. The most striking feature of their strategy was a focus on **empathy and feelings** before actual content. For example, the badges learners developed in W1 highly focused on the social components of help-giving rather than on cognitive ones. Themes such as fighting to bully, being welcoming, and showing etiquette were prevalent across learners' badges. Furthermore, in W2 one of the agents was described as having feelings, and its skit began with the agent automatically detecting that the learner was sad ("*What's wrong?*") before proceeding with the content explanation. One learner explained the reasoning: "*if you're a strict person giving directions the person you're telling will lose track of you and doze off while you explain it. But if you're friendly, if you are friends with them, you can keep asking if they get it and since they know you they're gonna listen to you better*" (W5). Learners also repeatedly expressed their concern with the **clarity and conciseness of information.** For example, a learner wanted the support to "g*ive enough information to the point they [learner seeking help] understand*" (W5). Similarly, other learner commented their approach for helping: "*Give them [other student] the key ideas so it helps them better*" (W5) and that we should make sure that "*the information that the system gives is comprehensible and not confusing*" (W5). Finally, there were diverging opinions on **persistence while helping.** When prompted whether they would persist in trying to help someone who needed help, the majority of learners said that they would persist (W5). Learners also expressed **strong reliance on knowledgeable** help (i.e., teachers) especially when they could not help any further. For example, in W5 a learner suggested adding to the textbook app a chatroom with the teacher in case nobody could help you. Another learner suggested that instead of the "Activity recommendation" feature we proposed in W5, we added a "Teacher help" feature. He justified it in this way: "*Every time I ask some of my friends they usually don't understand, so they just ask the teacher."*

Conclusion

In this paper, we presented results from five co-design sessions that contribute to an understanding of learners' perceptions of and strategies for help-giving by emphasizing learners' focus on helping their peers, their prioritization of feelings in addition to content, and the need for authoritative sources to confirm the help they are giving. One contribution of our approach is that we present the learners' reports of their perceptions of help-giving behavior and motivations to engage in these behaviors in the classroom. Based on the results from the co-design, we have new insight into how to design curriculum for help-giving across the different contexts. For the interactive digital textbook, it is essential to build on the foundation of a positive classroom community (where learners have bonds of friendship and a mutual history) such that these bonds transfer to the digital setting. Many learners cited previous experiences as

their reasons for giving help: Have they helped the person before? Could they in the future? Is the person a friend? They often focused on providing social or emotional support before cognitive. Making both who the learners are helping and their previous relationships salient in the interactive digital textbook may motivate more productive interactions between the learners. Notably, there are different implications for Khan Academy, where the help-seeker may be unknown to the learners. It may be important here to focus on increasing awareness of the help-seeker's performance or existing knowledge, so that learners feel more motivated (e.g., because they can see that the help-seeker has helped others in the past or is genuinely trying to learn the material). Given learners' reliance on more knowledgeable (i.e., teachers) help and connections to their classroom community, bringing learners' peers and teacher into their interactions with other learners on Khan Academy may also be motivating for them. Lastly, we conceptualized the teachable agent as a safe place for learners to practice their help-giving skills. Based on the participatory design results, this may be a good setting for learners to: 1) focus on becoming more confident in their ability to explain in this particular domain, and 2) practice persisting with help in the face of the agent "not understanding." Our findings further suggest that learners may not see the value of the teachable agent, since it is not part of the classroom community, and thus potential benefits should be reinforced by the teacher.

To conclude, we conducted 5 co-design sessions to investigate learners' help-giving motivation and strategies. The results from the sessions will enable the design a CSCL curriculum and technology to support collaborative learning across multiple platforms by facilitating communication and interaction between learners. This paper represents one step towards the ultimate goal of supporting learners in developing their help-giving skills as they move between physical and digital contexts.

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