Working Together with XO Laptops

A study of the XO laptop
in collaborative work at the Cambridge Friends School

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One for All
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I. Introduction

Even though the vast majority of American elementary and middle schools give students access to computers in computer labs and classrooms, most schools do not have a one student to one computer ratio. According to data released by the U.S. Census Bureau, there was an average of 3.9 students per computer in American public and private schools during the 2005-2006 school year (3). Although students have access to computing resources at school, many are still not able to take ownership of computers by having their own laptops that they can use at school and at home.

One Laptop per Child is a nonprofit organization based in Cambridge, MA that created a market for low-cost computing by designing the first inexpensive laptop for children. The $200 XO laptop was first distributed in 2007 as a means of bridging the digital divide. Today, over 1.3 million children in more than 30 countries use the XO laptop (7). Specifically designed for the developing world, the XO is an energy efficient computer that can withstand high temperatures and exposure to water. It also boasts a rotating screen that allows configurations for e-book reading and gaming as well as standard laptop use. In addition, the XO is the only laptop with wireless mesh network technology that allows offline peer-to-peer communication.

Although the XO was designed for the developing world, we believe that it also has potential as a learning tool in the United States. The mesh network and open source software allow students to share information and activities. Considering the unique features of the XO, we chose to explore how students work together while using XO laptops. Previous research has shown that collaboration is part of the foundation of learning:

> "Similar to notions of 'situated learning' and 'cognitive apprenticeship' that posit learning as located in contexts and relationships rather than merely in the minds of individuals, sociocultural and historical theories argue that learning derives from participation in joint activities, is inextricably tied to social practices, and mediated by artifacts" (4).

Other studies have shown that "[c]ollaboration can occur within a whole class, among groups in a class, and with people and groups outside the classroom" (1). Compared to individual work, there is often less division of tasks, such that each group member contributes to several aspects of the work. "[G]roups are not highly structured nor are specialized roles assigned. Collaborative tasks tend to be open ended and answers are not predetermined" (1). We hypothesized that less division of tasks might lead to more equal contribution from each group member and more active participation. The introduction of laptops with such developed tools for group work might also inspire a better understanding of teamwork and successful collaboration.

In order for teachers to feel comfortable transitioning from more traditional computer brands to a one-to-one computing model using the XO, it will be necessary to study how the XO influences classroom dynamics and student achievement. We designed a research plan in order to explore how students use the XO laptop for collaborative work. For our first XO pilot program, we choose the Cambridge Friends School (CFS) in Cambridge, MA because of its open-minded approach to education and technology.

Specifically, we worked with sixth grade students and teachers to learn how students work on group assignments at CFS.

After observing group work without laptops, we introduced XO laptops into the classroom and hosted several XO training sessions so that students felt more comfortable with the Sugar operating system. One of the key findings of the 2001 CEO Forum on Education and Technology is that "technology can have the greatest impact when integrated into the curriculum to achieve clear, measurable educational objectives" (6). We anticipated that the most crucial means of achieving this integration would be through student and teacher training workshops and lesson plan development.

Our results suggest that XOs may have made it easier for students to find and to share information. Class-wide use of laptops also seemed to encourage participation since all students were able to conduct research on their own laptop. Because students had not yet used the mesh network and because of differences in the collaborative tasks examined, it was difficult to understand the effects of the XO on division of tasks. Use of XO laptops did not seem to affect student willingness to help peers or conceptions of team dynamics.

II. Hypothesis

Introduction of the XO laptop into the classroom will increase the level of collaboration amongst students. This will be seen through less division of tasks, use of the mesh network to share information, equal contribution by group members, more helpful behavior, and a better understanding of team dynamics.

III. Design

We piloted the XO laptop in the sixth grade at the Cambridge Friends School. All 28 sixth grade students and three sixth grade teachers participated in the pilot. Community members donated XO laptops during the fall and winter so that every sixth grade student and teacher received a laptop, achieving the desired one-to-one ratio. Teachers attended two fall training sessions and received laptops in January, when we collaborated with high school students at the Illinois Math and Science Academy to host a pre-pilot week of training sessions and activities. During this pre-pilot week, we worked with teachers to develop a customized bundle of software specific to their syllabi. The bundle includes:

- Firefox
- WikiBrowse: an encyclopedia that students can use offline
- Record: image, video, and sound recording capabilities
- Memorize: a program that allows students to create and play matching games
- GeoQuiz: a geography quiz activity

Previous research has shown that it is often difficult to untangle the effects of technology and student behavior because of many outside factors that can influence

learning. For example, a study on community in a Knowledge Forum classroom suggested that teacher facilitation of certain behaviors was closely related to the effects of technology on those behaviors:

> "…[T]rust is a key part of teamwork, yet trust is difficult to establish through electronic communication. In the grade 5-6 Knowledge Forum classroom, students were willing to publicly post their (often erroneous) theories because the teacher had fostered an atmosphere of mutual trust and tolerance for tentative understandings. It is highly unlikely that this level of trust could have developed through online interaction alone" (5).

In order to account for outside effects on collaborative behavior, we observed group work without laptops during March before introducing laptops and hosting training sessions for students in April. Students were interviewed after collaborative work without and with the XO in order to control for effects that teachers and school customs might have on collaborative behavior.

The interview protocol (Appendix A) was developed using the indicators for collaborative behavior that we outlined in our hypothesis. We also used the constituent elements of activity theory as a framework for understanding the group work that was completed. The interviews aim to help us understand the object (motive), subject (human activity), tools, rules (constraints), community, and division of labor within the context of each collaborative activity (4).

IV. Results

Two mid-achieving students, Sarah[1] (female) and Thomas[2] (male), were interviewed about their involvement in a collaborative biology activity completed without laptops. These interviews were each approximately 15 minutes in duration.

The same two students were interviewed again about a collaborative biology activity that was similar in scope but that allowed students to use XO laptops. The interview with Sarah was 25 minutes long, while the interview with Thomas was 15 minutes long. This collaborative activity took place four weeks after XOs had been introduced to students. During these four weeks, students used XOs for three to five hours per week.

Interview narratives (Appendix B: Without laptops, Appendix C: With XOs) were compiled from transcripts.

Student responses indicate that sixth graders were able to find and to share information more easily. XOs also seem to have allowed more active participation, as all students were able to simultaneously research on their own laptops. However, using XOs did not seem to affect students' willingness to help team members or their understanding of team dynamics. At the time of data collection, teachers and students did not feel comfortable using the mesh network. In order to better understand the full effects that the XOs could have on collaborative behavior, it will be necessary to collect data after the

[1] Name changed for reasons of confidentiality.
[2] Name changed for reasons of confidentiality.

mesh network has been integrated as a learning tool. It will also be necessary to assign the same project without and with XOs. Although the two group activities examined were similar in subject matter and scope, they required different resources and imposed different limitations.

V. Analysis and Reflection

A reoccurring theme in the interviews was that XOs allowed students to find information more easily, causing them to move more quickly through the assignment. Sarah said that "using the XOs is faster and easier and it would get things done better." Even though she did not mention ideas of efficiency in her definition of a good team, Sarah stated, "[My team was a good team because] we were getting a lot of stuff done and so I'm proud of my team." This suggests that although she did not feel that XOs were a direct cause of her group's positive team dynamics, she may have viewed the increased efficiency caused by XOs as part of the reason her group was a good team.

Similarly, Thomas felt that XOs made students work more efficiently, allowing more time to talk to peers at school instead of having to continue the assignment at home. He said, "I think having XOs made us get a lot more work done because there are only two computers in the class so we would have had to wait a lot or had more to take home. But I think since we did it at school we were a lot more efficient and had more time to talk over with our group mates." This also indicates that XOs encouraged more active participation in the activity since students were able to conduct and discuss online research on laptops instead of waiting for computing resources.

Interview results also suggested that XOs played a role in sharing information, especially through movement around the classroom and collaborative online research. Although Sarah felt that XOs did not affect student communication, she noted that XOs were very portable and allowed students to move around the classroom. "We mainly used [the XOs] for internet and they are small and easy and portable so that helped. We moved around the classroom a lot with them." In order to better understand how XOs affect body language and physical interactions between students, it would be helpful to analyze gestures using video footage.

Thomas felt that XOs improved communication amongst students. "[XOs affected the way we communicated] because you can't really turn [a computer screen] and show your group mates, but with the XO, you can turn it and still be writing to show them. I think that helps a lot. You don't have to move. You just have to turn the computer and you could still be writing down your information that you recorded…. It made it a lot more easier to communicate rather than if we were working on desktops because desktops are much bigger and you have much less space to write and we got to work at desktops a lot." This response suggests that the rotating screen on XOs, which was initially designed for e-book reading and gaming, might also play a role in sharing information.

The way that students shared information and used XOs seems to have created inclusiveness within the classroom. Sarah felt that the entire class—not just individual groups—was able to collaborate on the online research component of the project. "If people found a certain website they thought would be helpful to anyone, they would write

it up on the board and it would be helpful to anyone in the group or the whole classroom." Additionally, Thomas felt that XO use indicated that everyone on his team contributed equally to the group work. "I think everybody used the XOs and worked really well." This might suggest that the one-to-one ratio encouraged more active participation by improving access to resources and by establishing common tools and tasks.

One notable difference between Thomas' first and second responses to what he learned was that he felt that he learned about teamwork during the activity with XOs. During the initial group project without laptops, Thomas stated, "I learned where most of the major bones of your body go and I learned more on work and problem solving." However, in the activity with XOs, he stated, "I learned about specific regions of the body so far and how to work really well with group members." We originally expected to see an increased understanding of teamwork as a concept. However, XOs might have an influence on behavioral aspects of collaboration that was difficult for students to articulate. In future interviews, it might be more helpful to discuss the skills that students use when working with others instead of their general conception of collaboration.

Due to the absence of mesh network use and differences between the two group assignments, it was difficult to understand the effects of the XO on division of tasks. For both activities, students report that tasks were divided but that everyone could contribute to each task. Additionally, there were no significant changes in student willingness to help peers or conceptions of team dynamics.

One of the main challenges with the CFS pilot was that XO laptops were stored on a cart and kept at the school, much like the existing laptop cart system that allows classrooms to rent Macintosh iBooks. Teachers did not feel that students were responsible enough to bring their laptops to school everyday, but indicated that students might be allowed to take laptops home later in the school year. In addition, it was extremely challenging to integrate the XOs into existing curriculum in an authentic way. Since the sixth grade curriculum was re-written this year, we were not able to get detailed syllabi for the classes at the beginning of the term. Thus, lesson plans were developed on a weekly basis, leaving little time for development and editing.

For our next pilot program, we will be targeting a lower income school. In order to facilitate teacher integration of XOs, we will be compiling and distributing an XO introduction manual for teachers using material from training workshops that we hosted at CFS. We will also give teachers a lesson plan handbook with ideas about how software can be used for each class subject and example lessons from the CFS pilot. Lastly, students will be able to take XOs home from the start of the pilot. Although teachers at CFS did not feel that students would be able to handle the responsibility of owning a laptop, we feel that students treated the XOs very differently from textbooks and other school materials. During lessons, XOs were sometimes distracting because students wanted to explore other software. Taking the laptops home would have allowed students to take more ownership of this technology by allowing them to more naturally integrate it into schoolwork and free time.

VI. Sources

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VII. Appendices

Appendix A: Interview Protocol

After group work (without laptops):

Explanation:

Hello. My name is (MacKenzie Sigalos/Katelyn Foley), and I'm a student at Harvard. I am from the student organization, One for All, which is interested in how students your age work together. I want you to know that your participation in this interview is completely voluntary and that you may stop the interview at any time. I'm going to ask you a few questions about how you work on group assignments in class. Is that okay with you?

Thanks so much for agreeing to meet with me. Your answers will help me better understand how students work together.

If asked:

One for All is a Harvard student group that was founded this fall to promote 1-to-1 computing here and around the world. We work with One Laptop per Child, the organization that makes computers for people your age.

1. Tell me about the group work that you did in class.
    a. What was the first thing that you did?
2. Did you enjoy doing the group project?
3. What did you use to complete the assignment? I'm interested to know whether you used a handout from your teacher, books, computers, or class notes.
4. Were there any resources that you did not use that you wish you had used?
    a. How would these resources have helped you complete the assignment?
5. Who did you work with on the group project?
6. How did you work together? I'm interested to hear how you communicated with each other, such as talking to each other or writing on paper.
7. How did you guys split up tasks?
8. What parts of the project did you work on?
9. Did you feel that everyone gave the same amount of effort?
10. Did you help other people on your team with their tasks? Why / why not?
11. What makes a good team?[3]
12. Did you feel that your team was a good team?[4]
13. What about your project shows me that a team worked on this project?
14. Did your teacher edit the material produced by your team?
    a. If so, did you find this helpful?
15. Did your teacher provide feedback to the group as a whole or did you have the opportunity to meet with him/her individually?
16. What did you do if you didn't know how to complete a part of the assignment?
17. What did you learn during the team activity?
18. When you were preparing for the test, did you feel like you remembered the material better after the group activity?

After group work using the XO laptops:

Explanation:

Hello. My name is (MacKenzie Sigalos/Katelyn Foley), and I'm a student at Harvard. I am from the student organization, One For All, and have been helping to bring the XO laptops to your class this spring. I want you to know that your participation in this interview is completely voluntary and that you may stop the interview at any time. I'm going to ask you a few questions about how you use the XO laptops. Is that okay with you?

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[3] Question derived from Katerine Bielaczyc's interviews.
[4] Question derived from Katerine Bielaczyc's interviews.

Thanks so much for agreeing to meet with me. Your answers will help me better understand how XO laptops are being used in your classroom.

If asked:

One for All is a Harvard student group that was founded this fall to promote 1-to-1 computing here and around the world. We work with One Laptop per Child, the organization that makes the XO laptop.

Interviews after group work with XO laptops:

1. Tell me about the group work that you did in class.
    a. What was the first thing that you did?
2. Did you enjoy doing the group project?
3. Did you use XO laptops to complete the assignment? If so, when did you use them?
4. What other resources did you use to complete the assignment? I'm interested to know whether you used a handout from your teacher, books, classroom computers, or class notes.
5. Tell me about the mesh network.
6. Did you use the mesh network? If so, how?
7. What programs did you use on the mesh network?
8. Did you use any programs without connecting peer-to-peer? If so, which ones?
9. Who did you work with on the group project?
10. How did you work together? I'm interested to hear how you communicated with each other, such as talking to each other, chatting on the XO, or writing on paper.
11. How did you guys split up tasks?
12. What parts of the project did you work on?
13. Did you feel that everyone gave the same amount of effort?
14. Did you help other people on your team with their tasks? Why / why not?
15. What makes a good team?[5]
16. Did you feel that your team was a good team?[6]
17. What about your project shows me that a team worked on this project?
18. What did you do if you didn't know how to complete a part of the assignment?
19. What did you learn during the team activity?
20. Did you feel like you remembered the material better after the group activity?
21. Tell me about your experiences with the XO laptop compared to working in groups without laptops.

[5] Question derived from Katerine Bielaczyc's interviews.
[6] Question derived from Katerine Bielaczyc's interviews.

Appendix B: Interview narratives for activity without laptops

Interview 1: Sarah

[The teacher] had different questions up around the room, she posted up, and she also had us label the bones on the skeleton [with our notecards]. And that was a little frustrating at some point because everything was falling off…. We put tape on the back and took [the notecards] up there [to the skeleton]…. As a group, we would decide which ones we would use to put on the skeleton. We communicated on like this goes there and no that goes there…. [The teacher] had us plan ahead so we used the smallest [notecards] and that would be the best so it wouldn't be crowded.

[I helped other people] because some people forgot about the bones and what they did. So I helped some people in my group figure it out…. Most people had a full set of notecards, but some people forgot one or two of the bones…. We would partner up and look over our notecards, both our notecards, and see if we had the same notecards…. If we disagreed, we would usually talk about it and then if we couldn't figure it out, we would ask [the teacher]…. [A good team is made up of] people who can get along well and don't fight often and are cooperative with each other.

[The activity] was actually pretty interesting. We learned a lot more … because we really didn't care as much or know about the skeleton as we do now. Because now that she taught us about it and we'll probably have more questions about it and we'll know more about it and it's much more interesting…. It's probably easier to understand [material] when you're doing a group activity because if you look at your class notes after you might not understand what they are talking about. You will be like "What does that mean? I don't get it!"… [During a group activity,] you would know what you were doing at that moment and you would probably understand it. They would explain it better…. And that part [about bones] was on the tests, and we all got that right. And we all have favorite bones now. It's funny.

Interview 2: Thomas

We were in four groups and we were trying to see who could put up all the different major bones in the body and we were trying to see which group could put them up fastest…. [We used] index cards that said the name of the bone like flanges or tibia and it gave a little definition…. We just divided up one person's set of cards and we all put them on there…. And then if they didn't have any of the ones we needed, we just used somebody else's cards…. I did a lot of taping and stuff and putting [the notecards] on the bones…. We would stick one on and then we would check with each other to see if it was right or not and then if we all agreed or not.

We all used good teamwork, I thought…. Everybody tried their hardest…. [A good team is being] willing to disagree almost but willing to be flexible instead of being stubborn cause if you're stubborn you won't get any work done. Cause if you're able to disagree

but then be flexible, then you'll work out…. We helped each other out. If we disagreed on where one would go and we would show them, and they would be like "oh yeah" and realized they had made a mistake by putting the wrong one there or something…. [When you disagree with somebody,] you say it nicely. You don't say like "oh, you're wrong!" or something like that. You say "I think this goes here rather than there because this one goes here and that one goes there" rather than yelling at them or saying it unrespectfully…. We would check our notes and stuff to prove a point if somebody disagreed or not.

[If you don't know how to do part of the assignment,] you just check with one of your classmates because you always have somebody you can rely on to help you…. I think a group in class helps more [than a lecture] because you repeat the material more and you have other people to help you to have a better understanding where a bone is and what kind of bone it is…. [Other people can help you understand something] by quizzing and by helping you understand what you got wrong. I think that helps a lot…. I think that when you're in class you almost don't want to be wrong, but when you're with a friend, it's easier to make a mistake and be corrected.

[In the activity,] I learned where most of the major bones of your body go and I learned more on work and problem solving.

Appendix C: Interview narratives for activity with XOs

Interview 1: Sarah

In science class, [the teacher] has us studying the job of a physical therapist and a personal trainer…. We had to research stretches, exercises for the muscles, and we get case studies. [The teacher] comes up with these people who have a certain problem with a part of their body, like they got in an accident or they just want to build that muscle or they just want to lose weight. [The case study] says the name of the person, how old they are, why they came, what's wrong, what they want us to do. And then we have to give recommendations and we find out some way to help them.

We used XOs in the classroom and then for homework, we used our own computers…. We used Firefox on the XOs. [The teacher] just told us to use Firefox and nothing else…. We mainly used [the XOs] for internet and they are small and easy and portable so that helped. We moved around the classroom a lot with them…. I don't really know if they helped with the communication. I know in general using the XOs is faster and easier and it would get things done better…. If people found a certain website they thought would be helpful to anyone, they would write it up on the board and it would be helpful to anyone in the group or the whole classroom.

We could also work on a case study together if it included another person's section or if it [related to another person's role as a physical therapist or personal trainer]. If the case study included one of your sections, you would have to work on that together. Ben and I

both wanted to do arms so we had to do rock/paper/scissors so we had to decide it randomly. It was kind of individual, but if we had to work on [the case studies] together, we would.

[The XOs affected the way I worked with other people] because I had to research one of the case studies, but it was my section, but it had one of my friend's muscles that she was doing, so we would just research stuff until we found the right thing and we would come sit next to each other and work on it, together…. We were allowed to talk so we would talk to each other. We would look at each other's screens. We would say, "Oh, you should go to this website."

It was much easier to work with the XOs alone because you wouldn't have to keep asking questions of everybody. You could just research it or it was much easier working alone. It was easy to work in a group…. We would sometimes work together as a whole group because we might have found something that another person needed or help research something that another person couldn't get at…. If we had a disagreement on something, we could hopefully research it on the internet and that might help us with research on the disagreement we were disagreeing about.

[We all gave the same amount of effort because] we all researched a lot and we were really focused so we could get things done fast…. What I think makes a good team is some people who can cooperate with each other, who listen to each other. When someone in your group is talking, they really listen and not get sidetracked. People who can work together easily and not fight all the time…. Kind of like a bunch of friends at a sleepover…. [My team was a good team because] we were getting a lot of stuff done and so I'm proud of my team.

Interview 2: Thomas

We were gathering research on Firefox with the XOs because we have case studies this week. Like such-and-such is a 45-year-old person who just had a hip replacement or something. And then they aren't really mobile yet, and they are trying to get healthy for a dance coming up in October or something. And so we needed to research on the XOs exercise and stretches for our group to complete the case study and to help the person rehab so he or she will be completely healthy by that set date.

We used Firefox to research exercises and stretches and to find out other activities and stretches they should do for rehab and for how long…. I think using Firefox and using the fun little icons is fairly easy and enjoyable…. We used WikiBrowse a little bit. Information that you can't get on the internet, you can get on WikiBrowse.

There were four people in our group and we each picked two regions of the body that were assigned under the eight. And we each did our own regions cause there are ten to 14 questions…. Sometimes we shared XOs and sometimes talked or wrote down information to show the person to check over or whatnot…. I think everybody used the

XOs and worked really well. Especially my group because I know we're doing really well. Everybody is working really hard.

I think having XOs made us get a lot more work done because there are only two computers in the class so we would have had to wait a lot or had more to take home. But I think since we did it at school we were a lot more efficient and had more time to talk over with our group mates…. [XOs affected the way we communicated] because you can't really turn [a computer screen] and show your group mates, but with the XO, you can turn it and still be writing to show them. I think that helps a lot. You don't have to move. You just have to turn the computer and you could still be writing down your information that you recorded…. It made it a lot more easier to communicate rather than if we were working on desktops because desktops are much bigger and you have much less space to write and we got to work at desktops a lot.

Everybody contributed to each part because we checked over each other's and we did research on each other's part as well just to make sure the information was right. I think that really helped…. [If I didn't know how to complete part of the assignment,] I would check in with one of my group members because they are there for me…. [When we disagreed on something,] we showed each other our sources and we double-checked.

I learned about specific regions of the body so far and how to work really well with group members. [I remembered the material better after the group activity] because you hear it multiple times and you talk about it multiple times with your group mates and it really sticks in your mind.