UltraLite Collaboration: A Low-Cost Toolkit to Promote Collaborative Learning in the Classroom

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Abstract: The UltraLite Collaboration toolkit is a low-cost, collaborative electronic quiz book that encourages students to work together and share their reasoning when answering teacher-authored questions. Group dialog occurs in teams of three students within a school classroom. Students do not receive feedback about their individual answers, but rather about the group’s level of agreement, and thus must discuss their answers. Previous work suggests significant growth in content-related dialogue using similar, but much costlier tools.

Introduction
Primary school students typically work either individually or contribute to class-wide sharing of answers (Hiebert & Grouws, 2007). Students seldom have the opportunity to explain their thought processes or listen to peer reasoning (Stigler & Hiebert, 1997). More extroverted or content knowledgeable learners often dominate unscaffoleded group discussions. UltraLite Collaboration Toolkit’s aim is to facilitate small group discussions where students share ideas and receive content feedback, structuring dialogue such that all students participate.

Foundational Work
This work is grounded in both learning sciences theory and the contextual classroom user testing of TechPALS handheld collaborative toolkits (Roschelle et al., 2009).

The UltraLite Collaboration toolkit leverages Resnick’s (1998) Digital Manipulatives concept by equipping students with physical, computationally–augmented “answer tokens” that elicit feedback from the game board, and ultimately, from their peers. The nature of group interaction facilitated by UltraLite incorporates Adams & Hamm’s (1996) findings that consensus building discussion is only achievable in small student groups, not in large classrooms. As peers build small group connections and view each other as knowledge sources rather than competitors, students construct a climate more likely to emphasize understanding over memorization (Zurita & Nussbaum, 2004).

This project drew upon previous TechPALS prototypes, which were handheld Computer Supported Collaborative Learning (CSCL) devices with a custom-designed Eduinnova platform (Roschelle et al., 2009). These platforms underwent two cycles of research, in which TechPALS was introduced into three fourth-grade California classrooms. Positive results were shown compared to the control group, with the treatment group testing significantly higher on post-test assessments (Roschelle et al., 2010). Additionally, the TechPALS toolkit group exhibited greater student collaboration along several metrics. However, major implications from these studies suggested that the overall cost of ownership should be significantly lower, the academic content needed to be more customizable for each classroom’s needs, technical issues needed to be streamlined, and initial training time for students and teachers needed reduction (Roschelle et al., 2010).

Current Design
The UltraLite Collaboration prototype addresses design insights revealed by earlier work while also facilitating the same goal of collaborative classroom learning. The overall content creation and interaction platform in the UltraLite prototype differs from previous work. First, the teacher uses open source custom software to author quiz books (Figure 1, a) with tailored academic content for the needs of the classroom. Groups of three students receive an UltraLite game board (Figure 1, b) and each student gets an answer totem (Figure 1, c). Then, as a group, the students check out one of the several teacher-authored paper quiz books. After the students toggle the booklet ID (corresponding to a particular answer key) into the game board (Figure 1, e), they progress through the book’s content. When the group approaches a new question, each student individually submits their answer with their personal answer tag (Figure 1, c). After all students have submitted answers, the game board gives feedback in the form of colored lights (Figure 1, d). In the current interaction mode, the group as a whole receives feedback if all the submitted answers are correct (green light) or if at least one student (not identified) submitted a different answer (red light). Specific correct or incorrect answers are purposely left unidentified by the toolkit, thus encouraging group discussion before answer resubmission. This feature was seen in previous work of TechPALS and contributed to greater levels of student collaboration through higher frequencies of giving an answer, giving an explanation, reading a question aloud, making a collaborative move, directing a peer, disagreeing with another student, and asking an on-topic academic question. (Roschelle et al., 2009).
The physical UltraLite Collaboration toolkit is comprised of three main components. Students use the game board (Figure 1, b) and tangible answer tags (Figure 1, c), while the teacher leverages the content generating software. The game board contains all of the programmed computational components of UltraLite Collaboration: a low-cost microcontroller and circuitry, three colored LEDs to signal feedback, a book ID selector, a page number selector, and three docking spots for students to submit their answers with an answer tag. These answer tags contain embedded resistors of three different values that correspond to one of three answer choices. For a student to submit an answer, he or she lines up the respective answer portion of his or her answer tag to the dock of the game board. This completes a simple resistor circuit that the game board logic circuit interprets as a particular submitted answer choice. Each kit runs on a 9V battery with a bill of materials around $5 – $7 (USD).

One of the flexibilities of the UltraLite Collaboration Toolkit is that teachers may author their own content. An open-source formatting platform enables teachers to print their own booklets of questions and answers for student interaction scaffolding. In addition to using the software to create unique quiz books, teachers may also use a set of pre-existing booklets as well. The software collates the questions in several patterns, each with a color-coded book ID code. This technique assures students do not receive the questions in the same order during every interaction, and minimizes the risk of students simply memorizing a string of answers as a workaround.

Conclusion and Further Work

The design of UltraLite Collaboration was guided by the need for ultra-low cost kits that are not only deployable in classrooms, but could also be used in museums, on field trips, and other informal settings – hence the choice for a simple but functional feature set and elementary electronics. This design eliminates the complexities of deploying laptops and tablets into classrooms while offering a technological platform that could enhance teaching and collaboration is real settings, in a scalable way. The vision is that the combination of teacher authorability, low cost, ease of deployment, and visible gains in collaborative work will lower the threshold for adoption among the formal and informal educational communities.

References


