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Spatial Manipulative Note-Taking Tool for Small Group Face-to-Face Collaboration in Science Class

Litong Zeng, University of Illinois at Urbana Champaign, litongz2@illinois.edu
Xuesong Cang, University of Wisconsin Madison, xcang@wisc.edu
Afroza Sultana, Toronto Metropolitan University, afroza.sultana@torontomu.ca
Stacy Cernova, Toronto Metropolitan University, acernova@torontomu.ca
Megan Wang, Toronto Metropolitan University, megan1.wang@torontomu.ca
Dana L Gnesdilow, University of Wisconsin Madison, gnesdilow@wisc.edu
Sadhana Puntambekar, University of Wisconsin Madison, puntambekar@education.wisc.edu
Ali Mazalek, Toronto Metropolitan University, mazalek@torontomu.ca
Mike Tissenbaum, University of Illinois at Urbana Champaign, miketiss@illinois.edu

Abstract: This study explored the Idea Wall, a collaborative knowledge-building tool to support students' collaboration in small groups during a plant biology science curriculum. We examined the affordances and challenges of the Idea Wall and found the effective use of the tool's spatial organization capabilities by students, particularly the Yup Zone and the intermediary neutral spaces, for collaboratively organizing notes. But there's also a need for improvements in some features of the tool's design and instructional guidance.

Introduction

Collaborative learning, emphasizing collective knowledge building through the exchange, negotiation, and expansion of ideas among participants, establishes a foundation for communal learning within the classroom (Tissenbaum & Slotta, 2019). This approach has been shown to foster deeper understanding and the development of shared expertise (Ong et al., 2020). Within technology-rich learning spaces, previous research has indicated the value of collaborative learning in encompassing a variety of modalities to enhance understanding and engagement (Dennen & Hoadley, 2013). However, it is important to carefully design and take into consideration the affordances of the features of the tool (Jeong & Hmelo-Silver, 2016). Understanding the relationship between modalities and affordances will help us create better collaborative learning environments that align with the learners' needs. To this end, this work builds on multiple prior research on the Idea Wall (described below), to answer the following research questions: 1) How does the current design of the Idea Wall enable students' small group face-to-face collaboration and collaborative knowledge building within a plant biology curriculum? 2) What improvements can be made to the Idea Wall to optimize collaborative interactions?

Methods

The SimSnap learning environment was developed around three central technologies: Idea Wall, a digital plant simulation, and a digital notebook. For this study, our analysis only examines the small-group collaboration during Idea Wall activities. The Idea Wall is a collaborative spatial manipulative note tool that aims to facilitate collaborative knowledge co-construction, by allowing students to add ideas (in the form of notes) to a shared canvas, where they could spatially move them around to support the organization, negotiation, and build on of ideas. The canvas has distinct color-coded zones to enable collaborative negotiation: agreement (Yup - green), disagreement (No - red), and synthesis (Combine Zone - brown).

Participants were forty-three grade 8 students from two classes (n1 = 24; n2 = 19) and a teacher from a STEAM magnet school. After the study, 17 students who consented participated in a focus group interview.

There were five collaborative Idea Wall activities over 6 days, focused on the growing healthy plants. Each Idea Wall activity had 3-4 students per group. We screen-recorded the interactions of 4 groups (2 in each class) for 4 Idea Wall activities (IW2-IW4, 16 Idea Wall sessions total). Post-intervention, we conducted focus group interviews with three groups of students (n = 17). Two researchers watched all recordings and interviews and collectively took notes, coded, and co-analyzed the data. We also examined all 4 groups final Idea Walls screenshots, and examined the collaborative activities of one group (1A-*main-sunflower*) and it's jigsaw variation for IW4 (1a-*jigsaw-sunflower*). Coding Scheme: For the *sunflower* groups, we coded all their interactions within the Idea Wall, as well as their verbal interactions using a coding scheme adapted from Tissenbaum et al. (2017), resulting in the following five codes: 1) Making suggestions verbally about science content; 2) Making suggestions verbally about tool use; 3) Clarification; 4) Narration; 5) Maintaining joint attention.

Findings

Across all activities each group submitted at least 2 notes in the Yup zone, with one group submitting 11 notes for IW2. An examination of the notes that did not make it to the Yup Zone revealed that two groups during IW2 placed notes in the No zone, and in each case, it was because they were off topic. When groups used the Combine Zone, these activities were classified as two distinct types: *Organizing* (tidying and re-organizing their notes); and *Rise Above*, which are ones where "students generate a deeper formulation of their understanding of the topic such as synthesizing key ideas together" (Ong et. al, 2020). Most of the students used the Combine Zone for *Organizing*, with many of those (7 of 16 groups) consisting of students cleaning up identical notes by combining them together.

In the interviews, one student stated that the Combine Zone helped them remove duplicate notes rather than cluttering up the Idea Wall. Students also used the Combine Zone to edit mistakes/mistyped ideas. Most students stated that they did not use the No zone, instead, just not putting the notes in the Yep zone.

1a-jigsaw-sunflower Idea Wall 4: There were 3 notes on the screen (one a combined note), and all got submitted to the Yup zone, and were all coded as relevant to the question. The No zone was not used by the group. In the Idea Wall, students seldom talked, and the talking that did occur was not about the collaborative notes.

1A-main-sunflower Idea Wall 5: In IW5, students wrote 7 notes in total but only submitted 2. They had 3 notes in the neutral zone and 2 notes in the Combined zone unsubmitted. No student interacted with or placed another student's notes into a zone. Despite limited interactions with other's notes, there were multiple discourse events that related to the notes. We did not find any instances in which students wrote about the content related to other students' discourse, which would have indicated a deeper level of synthesis. The students tended to focus only on writing down their findings from the previous group instead of talking about the differences.

Discussion

The Idea Wall helped with the students' group coordination, enabling them to look at the prompt questions and the notes other members had written. In purely verbal collaboration, losing track of the conversation can make it difficult to reengage. In terms of spatially organizing notes, students understood and used the Yup Zone with no issues; however, some groups left valuable notes in the neutral zone and the Combine Zone. We were not sure if students understood that they could only submit the notes in the Yup Zone, in part, because in the current version, the submission button was placed at the bottom Idea Wall, which may have implied to the students that they were submitting the whole Idea Wall. Student engagement with the Idea Wall's No Zone was minimal and often off-topic. Focus groups revealed groups bypassed the No Zone, opting not to place notes in the Yup Zone instead. Some students repurposed the No Zone for deletion due to a lack of an actual delete feature. To this end, we anticipate future designs of the Idea Wall Yup Zone and No Zone to change in one of two ways: 1) require students to arrange all notes into either Yup or No Zone before they can submit, to induce more collaboration; or 2) remove the No Zone while adjusting the placement of the submission into the Yup Zone to make the neutral zone the de facto no zone. For the Combine Zone, students mainly used it to organize their notes as we did not provide deletion or editing functions. There is potential to improve students' ability to synthesize and create Rise Above notes. From our analysis, we believe more direct scaffolding on how to use the Combine Zone could support this.

Our analysis also showed that the Idea Wall could improve, facilitate, and support students' science knowledge building. Of particular interest were times when students submitted notes from previous Idea Wall discussions and tried to modify and discuss them. This points to the ability of the Idea Wall to support synthesizing ideas across successive activities. Students' verbal interactions were different for each group, with task-related joint attention verbal communications tending to lead to valuable insight and suggestions about science content, leading to important collaborative notes. However, there is a need to provide better scaffolding on how to effectively synthesize each other's ideas and engage in collaborative knowledge building.

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