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Examining Nonverbal Interactions to Better Understand Collaborative Learning

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Abstract: Verbal and nonverbal communication are complementary facets of social interactions. CSCL studies typically analyze discourse; few investigate nonverbal interactions and fewer examine both. In this paper, we present a coding scheme that helps highlight the nonverbal interactions during group work. We examined two groups and found that although they had similar verbal participation levels, they varied in the content of their verbal interactions and substantially in their nonverbal interactions as they engaged in learning activities. Our study highlights the importance of examining nonverbal communication patterns in groups in addition to the discourse, to obtain a richer understanding of how collaboration occurs.

Introduction

Collaborative learning (CL) and computer-supported collaborative learning (CSCL) are known to positively impact student learning. Collaboration necessitates working and learning together as a group; however, simply assigning students to work in groups does not always result in productive collaboration (Barron, 2003). While CSCL studies usually focus on analyzing discourse, i.e., verbal interactions, among group members (Barron, 2003; Roschelle & Teasley, 1995, Suthers et al., 2010), nonverbal communication is also an integral part of social interactions in the classroom. This may include facial expressions, eye gaze, gestures, or posture (Miller, 2005). Consider a student who talks but does not work versus a student who speaks minimally, yet maintains eye contact, nods along, and participates in group activities. Examining only the discourse makes it challenging to account for these differences in participation and may under-represent or exclude less vocal students (Komorowska, 2018).

Studies on nonverbal cues in collaborative work typically focus on a single dimension, such as gaze (Schneider & Pea, 2015) or posture (Radu et al., 2020), though few examine more (Cukurova et al., 2018). While examining individual categories may provide a more fine-grained lens, they do not adequately reflect the complexity of group interactions. To better understand how groups collaborate in CSCL classrooms, we need to examine the nuances of social interactions in real classrooms and ask what are other group members doing when one of them is talking. Examining indicators of verbal and nonverbal communication can provide a more holistic understanding of collaboration, from which we can derive scaffolding strategies to support students to work more collaboratively. In this paper, we present our preliminary study on the coding schemes that we developed to examine the verbal and nonverbal interactions between group members in a CSCL activity. We applied these coding schemes to two groups to understand how examining nonverbal interactions in addition to verbal can provide a more complete picture of a group's collaboration. Thus, the goals of this study are:

1. What differences do we see in the verbal and nonverbal interactions between groups?
2. How can examining nonverbal communication help us understand collaborative interactions in a group?

Methods

We examined two videos of two groups (Group A and Group B) of four middle school students from the same science class in a US Midwestern public school. The students were grouped based on their prior knowledge, determined from pre-test scores; Group A had four boys, while Group B had four girls. The design-based biology unit focused on helping students build a scientific understanding of ecosystems. For a uniform comparison, we selected two activities, where Group A and Group B engaged in the same activity. In the first activity (week 1), students built a "bioreactor" for their compost experiment. In the second activity (week 9), both groups explored VidyaMap (a digital, interactive concept map) on their laptops to explore concepts and answer questions. The videos were transcribed and parsed by turns of talk. We focused on both verbal and nonverbal aspects of an individual's interaction with others and their activity; thus, one unit of analysis was the group. We also compared the nonverbal behaviors of the two least vocal students; thus, our other unit of analysis was the individual.

We inductively generated two coding schemes based on a series of interaction analysis sessions (Jordan & Henderson, 1995), where six lab members watched sections of the videos and discussed how to code verbal and nonverbal aspects of collaborative learning. We initially had 17 coding categories for verbal and 22 for nonverbal. After further analysis and literature review, the coding schemes were refined to reflect codes indicative of collaboration, to 13 categories for verbal and 12 categories for nonverbal interactions.

Coding categories: Verbal interactions

From watching the videos, we noticed that the students' verbal interactions included asking and answering questions (may or may not be content-related) and discussing ideas, either by generating ideas themselves or from prompts from the materials. We then reviewed the literature to understand which could be considered as indicators of collaboration. The verbal codes of *seeking involvement*, *initiating new ideas*, and *uptake of ideas* are related to established collaborative indicators (Roschelle & Teasley, 1995; Suthers et al., 2010). Asking and answering questions are indicative of collaborative knowledge building (Hmelo-Silver, 2003). The question category were split into *Question - Conceptual (QC), i.e.,* what or why of their experiment or activity*; Question - Experiment (QE), i.e.,* how to do something; and *Seeking help*. Similarly, the question-answering categories were *Response - Explanation (RE) / Observation (RO) / General (RG)* and *Providing help*. We also added the codes *Agreeing*, where a student agrees with the view of their group member (Hmelo-Silver, 2003), and conversely, *Disagreeing*. The other verbal codes were: *Affirmation / positive reinforcement* (complimenting group members or affirmation), *Negative emotion* (expressing being upset or frustrated) and *Social talk* (talk not related to the lesson or activity).

Coding categories: Nonverbal interactions

Our initial 22 codes were based on the observed behaviors in the group videos, such as where the students were looking or what they were doing. The coding scheme was then refined by grounding it in literature, to ascribe meaning to the nonverbal actions. For instance, the direction of eye gaze is an important indicator of where a student's attention is focused (Barron, 2003; Tomasello, 1995), and other synchronized nonverbal actions such as head position or leaning together to view a common reference point can suggest collaboration and engagement in the activity (Barron, 2003). To capture the multi-faceted nature of gaze and attention, we categorized our codes into *Joint Visual Attention* (looking at the same tool, artifact, or person, at the same time), *Looking at individual tools*, *Looking at others*, *Look away (outside group)*, and *Head nods/shake*. We included body-based indicators of attention, such as *Leaning towards* (Barron, 2003) and conversely, *Leaning away*. We also included codes indicative of individual work that could detract from group collaboration, such as *Fiddling* and *Writing*. Lastly, we included codes for observable emotions - Positive emotion (e.g., smile), Negative emotion (e.g., frown), and Bored (e.g., yawn) - that could indicate how the student is feeling, which may indicate their engagement level. Our nonverbal coding scheme is complementary to, but independent of the verbal codes.

Coding procedure

We first coded the transcripts using the verbal coding scheme to analyze the discourse, taking context into consideration, e.g., a "yeah" response could be considered agreeing with another student or answering a question, depending on the context. We then used the nonverbal coding scheme to code the videos for nonverbal cues, with each code subdivided into four columns representing each group member. As all students in the group can simultaneously display (multiple) nonverbal cues, we coded the nonverbal cues of each individual in the group for each turn of talk, using the transcript as an anchor. Each turn of talk could be assigned multiple codes. Two researchers coded 25% of the transcripts for verbal interactions, with interrater reliability of 99.39%. For nonverbal interactions, the first author established 99.60% and 99.47% interrater reliability with two other researchers for 25% of the transcripts. The remaining transcripts were coded by the four researchers.

Results

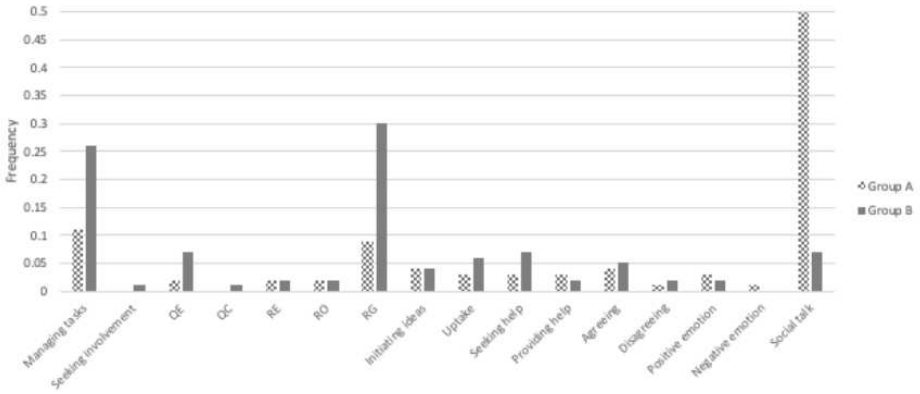
We used two videos of each group in our analysis: Group A members were Bruno, Joel, Ben, and Trey; Group B members were Hanna, Sally, Sruti, and Juliana. Verbal participation levels were determined by using percentage of talk for the two videos (Percentage of talk $=\frac{\text{The turns of talk for each student}}{\text{Total turns of talk}}$). The nonverbal participation level was calculated by using the frequencies for the *joint visual attention*, *looking at tools*, *looking at others*, *head nods*, *leaning towards*, and *positive emotion* codes and calculating the relative frequency for each group member.

The verbal participation patterns were similar for Group A and B: one member had the highest participation (Bruno-37.8% in Group A, Hanna-35.5% in Group B), one member had extremely low participation (Trey-5.7% in Group A, Juliana-4.4% in Group B), and the other two members were in between. Group A's nonverbal participation patterns remained similar to their verbal pattern (Bruno-29.2%, Joel-29.8%, Ben-28.6%, Trey-12.3%); however, Group B's nonverbal participation pattern changed from their verbal, with almost equally shared participation among group members (Hanna-23.7%, Sally-25.1%, Sruti-22.7%, Juliana-28.5%).

Group B showed higher occurrences of verbal-based collaborative behaviors than Group A (see Figure 1). Group B had higher frequencies for the talk-related codes ($\bar{x}_B$*=0.07*) than Group A ($\bar{x}_A$*=0.03*). Group A (0.498) had almost seven times as much *social talk* as Group B (0.074), indicating that they went off-task more often. While both groups had the same frequencies for *initiating new ideas*, Group B (0.06) showed double the *uptake* of Group A (0.03), which may be indicative of their collaboration quality (Suthers et al., 2010).

Figure 1

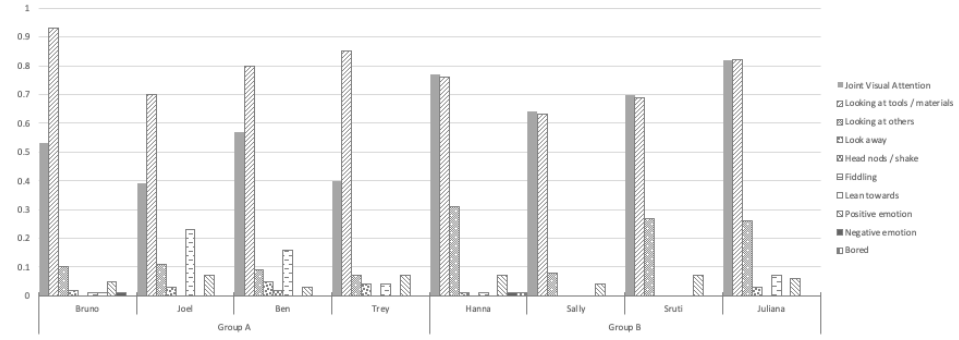
Frequencies of the verbal codes for Groups A and B



We then looked at individuals' frequencies for their nonverbal codes (see Figure 2). Group B's *joint visual attention* was higher than Group A ($\bar{x}_A$*=0.47,* $\bar{x}_B$ *=0.73*). Although Trey (Group A) and Juliana (Group B) were the least vocal members of their groups, Juliana (and Hanna) had the highest *joint visual attention* in her group (0.79) whereas Trey had the lowest (0.25). Group B members looked at each other more often than Group A ($\bar{x}_A$*=0.37,* $\bar{x}_B$ *=0.92*). Juliana (0.26) looked at her group nearly four times as often as Trey (0.07) in his group. Group A showed higher instances of *looking away* ($\bar{x}_A$*=0.04,* $\bar{x}_B$ *=0.01*) and *fiddling* compared to Group B ($\bar{x}_A$*=0.11,* $\bar{x}_B$ *=0.02*), which may indicate that they were not as engaged. Group A and Group B showed similar frequencies of *positive emotion* ($\bar{x}_A$*=0.06,* $\bar{x}_B$*=0.06*). The frequencies of the remaining codes were less than 0.001.

Figure 2

Frequencies of the nonverbal codes for Groups A and B



Although both groups completed their work, they showed different participatory structures. Group A mostly worked asynchronously, sometimes resorting to copying each other's work when falling behind, indicating a lack of deep understanding of the concepts, which was also reflected in their discussions. They rarely looked at each other while speaking, mostly focusing on their tools and the group's common resources (e.g., the laptop) were often monopolized and tasks were not equally shared, with at least one group member frequently not actively participating in the activity. In contrast, Group B displayed a more collaborative approach, sharing resources and distributing tasks more evenly. While one member frequently took charge, she did not monopolize resources. Group B asked each other questions that prompted them to think further, and they co-constructed their understanding through discussion. Juliana, the quietest member, demonstrated engagement by often looking at her group members or activity, and sometimes contributed key ideas, indicating her understanding of the concepts.

Discussion

In this study, we developed two coding schemes to examine verbal and nonverbal interactions in groups during collaborative learning and applied them to two groups. Our findings suggest that examining nonverbal behaviors in addition to verbal interactions can help us better comprehend collaborative interactions in CSCL classrooms.

Our first research question asked: *What differences do we see in the verbal and nonverbal interactions between groups?* While both groups completed their work, they showed different participatory patterns in their verbal and nonverbal interactions. Although Trey (Group A) and Juliana (Group B) were the least vocal in their groups, Trey's nonverbal participation was the lowest in his group, while Juliana's nonverbal participation was

the highest in her group and more than double Trey's. Group B showed a more equally shared nonverbal participation among group members compared to Group A. Group B also had higher frequencies for talk-related codes (e.g., involving others, asking and answering questions, etc.) and double Group A's *uptake*, suggesting that Group B was more collaborative. Behaviors such as *initiating new ideas*, *uptake*, and prompting collaboration and deeper thinking of ideas by asking questions and giving explanations are considered to be indicative of collaboration (Barron, 2003; Hmelo-Silver, 2003; Suthers et al., 2010). Group A had nearly seven times the *social talk* of Group B, suggesting that they went off-task more frequently. Juliana and Hanna (Group B) had the highest *joint visual attention* (0.79), whereas Trey (Group A) showed the lowest *joint visual attention* in his group (0.25). This suggests that Juliana was more attentive to the activities and discussions of her group members than Trey. Group A members also *looked away* from their group more often and showed higher instances of *fiddling* compared to Group B, which may indicate they were not as engaged. Capturing nonverbal behaviors also provided insights into other group trends, e.g., Group B kept common resources more accessible to all group members and shared resources more frequently than Group A, where certain members tended to monopolize common tools. Thus, observing nonverbal behaviors in conjunction with verbal interactions indicate that Group B demonstrated more instances of collaborative behaviors than Group A, addressing our second research question: *How can examining nonverbal communication help us understand collaborative interactions in a group?* Examining the nonverbal participation of Groups A and B provided a more nuanced understanding of their different collaboration patterns as they worked together in a CSCL classroom. Although Group A completed their tasks, they were more disengaged, often working by themselves instead of as a group. In contrast, Group B worked collaboratively as a group, displaying high joint attention, often looking at the activity together and at each other during discussions.

Our preliminary study highlights the importance of examining both verbal and nonverbal interactions to better understand group collaboration, and that transcripts alone do not adequately reflect different participation behaviors. Our coding schemes provided complementary insights into the different participation patterns and engagement levels of group members, indicating that considering both verbal and nonverbal participation patterns can offer a more complete understanding of group collaboration. Potential confounds such as gender and activity type may affect the degree of collaboration. Future studies will extend our analysis to other groups and activities. This could help facilitate CSCL in classrooms and help identify strategies to support student collaboration.

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