Emergent Roles, Collaboration, and Conceptual Outcomes for Two Eighth-Grade Groups in CSCL Science Classes

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Abstract: When collaborating in groups, students may assume emergent roles as they interact over time. Emergent leadership can improve group functioning, but this depends on how leadership is supported by group members. We studied how roles emerged in two groups of eighth-graders participating in CSCL activities over a 12-week science unit. A leader emerged in each group, but through different processes. Group A showed greater distribution of contributions to decision-making and science talk than Group B, as well as greater conceptual gains on a content test. In contrast, Group B focused more on off-task talk than Group A. While our sample is too small to make causal claims, better distribution of contributions to talk and on-task participation seemed to positively impact collaboration and learning.

Introduction

Collaborative activities help students to share perspectives, negotiate meaning-making, and deepen their understanding (Stahl, 2006). However, assigning students to groups does not mean that they will collaborate in productive ways (Dillenbourg, 2002). To support collaboration, scaffolds, such as scripts, can help students set groups norms and interact in productive ways (Mercer & Dawes, 2008; Wang, Kollar, & Stegmann, 2017). Some scripts include roles that are intended to foster collaborative meaning-making (De Wever, Van Keer, Schellens, & Valcke, 2010; Strijbos & De Laat, 2010). Scripted roles assign responsibilities to group members, which can improve students' accountability, interdependence, equity in contributions, collaboration, and learning (De Wever et al., 2010; Strijbos & De Laat, 2010). However, scripted roles have some limitations. Rigid roles constrain students' self-regulation (Wang et al., 2017), and students may deviate from scripts (Hoadley, 2010). This latter issue points to a need to understand how roles emerge with and without scripts.

To understand emergent roles, we can examine how students working in groups take on responsibilities over time, and, in turn, how these responsibilities constrain students' interactions (Mercier, Higgins, & da Costa, 2014; Sarmiento & Shumar, 2010). For example, students taking on leadership roles may direct the group's intellectual or organizational progress (Mercier et al., 2014), with or without support from others (Strijbos & De Laat, 2010). Leaders may also attempt to control others' participation or use of shared resources (Jones & Issroff, 2005). Yet, other students may seem to abdicate their responsibilities (e.g., free-riders; Strijbos & De Laat, 2010). How students take on roles, whether scripted or emergent, has implications for the efficiency and structure of group collaboration and can shape how learning processes unfold (Spada, 2010; Strijbos & De Laat, 2010). Further, emergent intellectual leaders can help groups to successfully complete tasks (Mercier et al., 2014). In our study, we aimed to understand how roles emerged in two groups as they participated in a CSCL science unit. Our research questions were: *how did roles emerge via group discourse over the 12-week unit, and what effects did roles have on students' conceptual outcomes*? These questions have implications for supporting learning processes in CSCL contexts that encourage student to set their own group norms.

Methods

This study investigated how two groups of eighth-grade students (4 students per group, $N = 8$) collaborated during a 12-week, design-based CSCL science unit. Both groups had the same teacher, but in different classrooms of an urban middle school in the U.S. Midwest. During the unit, students designed compost bioreactors that decomposed quickly and odorlessly while promoting microbial activity. Two CSCL activities informed students' designs. Students collaboratively brainstormed questions and conducted research using an e-textbook over four sessions. Students also used a simulation to explore decomposition in compost over four sessions. While the teacher determined the groups, no scripts or other scaffolds for collaboration were provided.

We collected video data from the first and last sessions with the e-textbook and the simulation for each group (558 min). Our goal was to analyze how students' discourse and control of resources shaped role formation over time. To analyze groups' discourse, we developed a coding scheme for students' decision-making and science talk (Lemke, 1990) after viewing videos of group work. Our first category, *Decision-Making Talk*, included the following codes: (i) asking for decisions; (ii) making conceptually-directed decisions; (iii) making task-related decisions; (iv) accepting a decision; (v) repeating a decision; (vi) questioning a decision; (vii) offering an alternative; and (viii) controlling resources. Our second category, *Science Talk*, included the following codes: (i) reporting observations or results; (ii) conceptual discussions; and (iii) metacognitive reflection on group knowledge. We also included a category for *Off-Task Talk*.

The first two authors established inter-rater reliability with 10% of the full data set (717 turns of talk, Cohen's kappa = .843). The first author coded the remaining data (except teacher-student talk and inaudible talk) for a total of 5,504 turns of talk. We next calculated frequencies of students' coded discourse and divided each student's total by the group's total for each code. We used these proportions to compare students' talk over time and identify roles in groups. We also compared the two groups' talk using *z*-score tests of homogeneity.

Finally, we compared student's pre- and post-unit scores from a researcher-designed content test. Due to small group sizes, we compared relative percent gains within groups, rather than conducting statistical tests.

Findings

To understand roles, we analyzed how each group member contributed to group discourse, especially decision-making and science talk. Group A contributed 2,407 turns of talk. Mala contributed the most to (40.0%), followed by Sylvia (28.0%), Rose (27.3%), and Melinda (4.7%). Table 1 below shows each student's contributions to decision-making and science talk over the four activities, with darker shading indicating higher contributions.

Mala contributed the most to conceptual (70.7%) and task-based (55.1%) decision-making during three of four activities. She also offered alternatives (36.2%) and controlled resources (38.7%) more than her group members. Sylvia and Rose also contributed to decision-making, especially during Activity 3 (see Table 2). Sylvia contributed the most to asking (41.0%), accepting (35.6%), and questioning (37.5%). Rose repeated decisions as often as Mala (32.7%), but she also contributed the most to off-task talk (33.5%). Melinda contributed the least to each kind of talk. Regarding students' science talk, Mala contributed the most to conceptual discussion (44.2%), followed by Sylvia (26.1%), Rose (25.1%), and Melinda (4.7%). Mala also contributed the most to metacognitive reflection (51.8%), followed by Rose (27.1%), Sylvia (20.0%), and Melinda (1.2%). Thus, Mala contributed the most to conceptual and metacognitive talk in Group A.

As Mala contributed the most to decision-making and science talk overall, we identified her as the *conceptual and task leader* in Group A, with support from other members (see the excerpt below Table 1). However, Sylvia and Rose made considerable contributions to the group's discourse, especially during Activity 3. Sylvia acted as the *decision evaluator* by asking for, questioning, and accepting others' suggestions, with some support from Rose. In contrast, Melinda acted as a *quiet learner* in her group. Melinda contributed little to group discourse, but we observed she used the simulation on her own to conduct additional experiments as Mala, Sylvia, and Rose discussed earlier experiments. We also noted that students tended to focus their gaze on shared resources (e.g., the computer) or each other during discussions, which we interpreted as active participation.

Table 1: Group A's decision-making and science talk over four activities

	Decision-Making Talk				Science Talk			
Student	Activity 1	Activity 2	Activity 3	Activity 4	Activity 1	Activity 2	Activity 3	Activity 4
Mala	0.420	0.488	0.290	0.446	0.461	0.524	0.242	0.491
Sylvia	0.283	0.218	0.430	0.329	0.238	0.154	0.401	0.242
Rose	0.268	0.218	0.269	0.189	0.248	0.264	0.338	0.218
Melinda	0.029	0.077	0.011	0.036	0.053	0.058	0.019	0.048

Mala:	Who is your group leader? All right, me.
Rose:	Mala.
Sylvia:	Group leader – do we even have one?
Rose:	Yeah, Mala.
Sylvia:	Wouldn't that be [the teacher]?
Rose:	No, it would be one of us.
Mala:	I'm the leader today.

For comparison, Group B contributed 3,097 turns of talk. Christy contributed the most (34.3%), followed by Josh (27.3%), Lydia (21.2%), and Luis (17.2%). Table 2 below shows each student's contributions to decision-making and science talk over the four activities, with darker shading indicating higher contributions. Christy contributed the most to conceptual (80.0%) and task-based (60.3%) decision-making during the four activities. She also asked (50.0%), accepted (51.4%), repeated (43.8%), and offered more alternative (55.0%) decisions. Josh questioned decisions (46.7%) and controlled resources (38.7%) more than other group members. Lydia and

Luis contributed less to decision-making than Christy or Josh. Regarding students' science talk, Christy contributed the most to conceptual discussion (52.3%), followed by Josh (28.1%), Lydia (10.1%), and Luis (9.5%). Christy also contributed the most to metacognitive reflection (70.0%), followed by Lydia (20.0%), Josh (10.0%), and Luis (0.0%). Thus, Christy contributed the most to conceptual and metacognitive talk in Group B.

As Christy contributed the most to decision-making and science talk, we identified her as the *conceptual and task leader* in Group B. Group B, however, seemed to accept her leadership differently than in Group A. While other members of Group A actively supported and/or questioned Mala's ideas, the members of Group B accepted Christy's role as leader by abdicating responsibility. Group B seemed content to let Christy "do all the work" (see the excerpt below Table 2). Group B also demonstrated frequent off-task talk or activities, such as braiding hair. Josh provided limited support for Christy's decision-making by questioning others' decisions. However, Lydia and Luis mostly acted as *free-riders* in the group (Strijbos & De Laat, 2010).

Table 2: Group B's decision-making and science talk over the four activities

	Decision-Making Talk				Science Talk			
Student	Activity 1	Activity 2	Activity 3	Activity 4	Activity 1	Activity 2	Activity 3	Activity 4
Christy	0.508	0.546	0.612	0.569	0.487	0.491	0.561	0.444
Josh	0.161	0.303	0.259	0.235	0.223	0.362	0.311	0.270
Lydia	0.195	0.118	0.082	0.118	0.140	0.098	0.054	0.159
Luis	0.136	0.033	0.047	0.078	0.151	0.049	0.074	0.127

Christy:	What the heck?
Josh:	What the heck, nah nah. We haven't even got this done yet. We haven't even got this done yet. We're all working while you're just talking so…
Christy:	What the…?
Luis:	And *you're* stressing out.
Lydia:	Josh, she's doing all the work.

Thus, one student in each group emerged as a conceptual and task leader. However, the dynamics in which leadership emerged differed between groups. In Group A, Sylvia and Rose actively negotiated Mala's ideas. However, in Group B, Christy was the primary decision-maker and contributed the most science talk. To illustrate differences, we compared groups' talk using *z*-score tests of homogeneity. We found that Group A contributed significantly more decision-making talk than Group B (37.6% vs. 12.1%, $z = 22.2$, $p < .001$). Also, Group A contributed significantly more science talk than Group B (38.9% vs. 20.2%, $z = 15.3$, $p < .001$). However, Group B contributed significantly more off-task talk than Group A (69.5% vs. 30.6%, $z = 28.7$, $p < .001$). Thus, Group A seemed to demonstrate more productive collaboration than Group B.

We also compared students' learning outcomes as assessed on a content test. We calculated percent gains by subtracting pre-test scores from post-test scores. In Group A, all four students showed conceptual gains on the post-test (ranging from 15.4% to 37.5%, with an average gain of 25.7%). Sylvia improved by 37.5% on her post-test (41.9% to 79.4%). Rose improved by 25% (50.0% to 75.0%), as did Melinda (66.2% to 91.2%). Mala improved by 15.4% (66.9% to 82.4%). Yet, in Group B, only two students showed conceptual gains on the post-test (ranging from -2.9% to 25.0%, with an average gain of 7.2%). Josh improved by 25.0% on his post-test (59.6% to 84.6%) and Lydia improved by 6.6% (58.1% to 64.7%). However, Luis had a 2.9% decrease on his post-test (66.9% to 64.0%). Christy had scored 100% on her pre-test, and she again scored 100% on the post-test (0.0%). Thus, Group B demonstrated lower conceptual gains on the post-test than Group A.

Discussion and conclusion

Our goal was to understand how roles emerged during CSCL activities in a 12-week science unit, and how these roles may have shaped students' conceptual outcomes. From our analysis of group members' contributions to decision-making and science talk over time, we found that one student in each group assumed a leadership role. Mala (Group A) and Christy (Group B) contributed the majority of conceptual and task-based decision-making, as well as conceptual discussion and metacognitive reflection. Thus, Mala and Christy acted as intellectual and organizational leaders in their respective groups (Mercier et al., 2014). However, we observed differences in how other group members accepted this leadership. Mala's group members seemed to accept her leadership while still engaging in constructive critique of her ideas (Mercer & Dawes, 2008). However, Christy's group members accepted her leadership because it meant they could contribute less. Consequently, Group A seemed to collaborate more effectively than Group B, as members of Group A engaged in more decision-making and science talk, and significantly less off-task talk, than Group B.

Although members of Group A did not contribute equally to conceptual discussions or metacognitive reflection, they all showed conceptual gains on their post-tests. Even the quiet student, Melinda, appeared to benefit from her group's conceptual and metacognitive talk, as shown by her higher post-test score (the second highest score of students in both groups, with the exception of Christy). However, in Group B, only Josh and Lydia showed conceptual gains on their post-tests. This is partially explained by Christy's maximum score on both pre- and post-tests. However, Luis appeared to do *worse* on the post-test. Luis did not show the same benefit as Melinda, likely explained by his tendency to engage in off-task talk.

While acknowledging that our sample is too small to determine causality, our findings indicated that distributed, active participation in CSCL activities (in discourse or attention) may be more important than emergence of a leader in supporting collaboration and conceptual gains in each group. Each group included an emergent leader (Mala, Christy), along with one student who contributed little to group decision-making (Melinda, Luis). However, the less-verbal students showed marked differences in their participation and outcomes. Melinda seemed to pay attention to her group's activities; conducted experiments as other students discussed concepts; and demonstrated conceptual gains on her post-test. Luis, however, participated in off-task talk and activities, and actually did worse on the post-test than pre-test. His lack of participation reflected a larger trend in Group B to engage in "free-riding" (Strijbos & De Laat, 2010), as members of Group B seemed content to let Christy complete their work. Correspondingly, Group B demonstrated overall lower conceptual gains compared to Group A.

This study's implications relate to how the assumption of roles, as evidenced in group discourse, shapes collaboration and learning within groups. Intellectual leaders can help groups to successfully complete tasks (Mercier et al., 2014), but how leaders are accepted may also affect the group's conceptual outcomes. While a student in each group assumed leadership, this leadership did not always promote productive collaboration (Dillenbourg, 2002). Thus, some scripting of roles may support student's participation in shared meaning-making (De Wever et al., 2010; Spada, 2010). However, since students do not always enact roles as intended (Hoadley, 2010), we must understand how groups establish roles and norms for collaboration over time (Mercer & Dawes, 2008; Sarmiento & Shumar, 2010) to inform the ways in which we integrate scaffolds for setting group norms (Wang et al., 2017) and intervene at key points to redistribute roles and reshape collaboration.

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