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The Diffusion and Appropriation of Ideas: An Investigation of Events Occurring *Between* Groups of Learners in Science Classrooms

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Abstract: Researchers have conducted numerous studies on the interactions of individuals *within* groups, however, there has been little research on phenomena occurring *between* groups of learners in classrooms. This exploratory study identifies and categorizes different events occurring between members of different learning groups in three ninth-grade physical science classrooms. Distributed cognition is used as a framework for describing how inter-group interactions serve to diffuse ideas throughout the collective, how these interactions influence the processes and products of students' work, and how characteristics of learning tasks themselves afford or constrain different kinds of inter-group interactions.

Keywords: Science education, social cognition, high school

Context of Study

By investigating how different types of knowledge (e.g. simple facts, tool-related practices, and problem-solving strategies) diffuse between groups of learners in science classrooms and come to be recognized as shared by the students, one can provide empirical evidence for the distributed nature of knowing and learning in school settings. Unfortunately, only a few classrooms that have been successfully studied in this way (Roth & Bowen, 1995). The current study took place in three ninth-grade introductory physical science classrooms in a public suburban high school in the Northwest. There were 32 students in each class; these classes met twice a week for 110 minutes and once a week for an additional 50 minutes. Students worked in groups of four, on problem-based activities. They could move about the room at any time to get materials, visit other groups, or talk with the teacher. Teacher interactions with students were generally restricted to telling students where certain materials could be found or clarifying requirements of the task. Activities observed in this study were:

1) Traffic Jam: students design, build functional two-way traffic light that was operable using a single switch.
2) Apollo: students design, use a set of tools that could retrieve an object from a challenging enclosure.
3) Calorimeter: students build functional calorimeter and use it to test the energy value of different samples of food.
4) Survey: students use hand-made tools to survey plot of land, construct topographic map from the survey readings.
5) Catapult: students design, build catapult from limited range of materials.

Methodology

The activities were observed over a period of approximately six months. Data collection procedures captured events occurring between assigned groups of students. Two groups of four students in each class, who sat at adjacent tables, were targeted for observation. Significant observations were followed up with informal interviews during class time (Patton, 1987). Inductive analysis was used to search for patterns rather than imposing pre-determined patterns on the data (Patton, 1990). Debriefings were held immediately after classes to check the researcher's interpretations of the classtime experiences against those of teachers (Guba & Lincoln, 1989).

Findings

During the first project, Traffic Jam, three recurring situations consistently stimulated productive exchanges between members of different groups. *"Situations"* were defined as a set of relationships between student, teacher, peer, and place that represented the setting for the diffusion and/or appropriation of ideas. *"Events"* were defined as specific interpersonal phenomena that afforded the diffusion and/or appropriation of ideas by learners. All events in this classification occurred between students assigned to different groups. *Situation I* involved students *witnessing phenomena occurring outside the group*. This category included events such as (Ia) overhearing dialogue between the teacher and members of other groups, (Ib) witnessing how materials were being used by other groups or witnessing

special practices being developed by other groups, and, (Ic) witnessing the successes and failures of "trial runs" by other groups. In *Situation II*, students *physically migrated to other groups*. This situation produced nine different types of events including instances of "visiting" students (IIa) bringing their design drawings to another group for comment, (IIb) transforming the designs plans of the host group, (IIc) borrowing tools and materials from other groups, (IId) testing another group's tool or model, (IIe) listening to deliberations of entire groups that have come to a host table to ask questions, (IIf) asking for explanations of host groups' artifacts, (IIg) sharing specific problems they encountered with a host group, (IIh) introducing essential conceptual language to host group, and, (IIi) assessing host groups activities in relation to the goals of the activity. In *Situation III*, learners *interacted when congregating in public spaces*. This was exemplified by the students who met over the materials table in the center of the room or around fixed equipment stations. This general situation was the setting for three kinds of events-- (IIIa) students meeting in a materials area to exchange ideas about how different materials might be used, (IIIb) students meeting in areas where projects would be tested and discussing the criteria for a successful test, and, (IIIc) students gathering in areas where essential tools were stationed and discussing the affordances of these tools. In addition to the classification, three assertions were developed during the study and substantiated by evidence collected from all five activities. *Assertion #1: Inter-group dynamics were qualitatively different from intra-group dynamics.* At the outset of each activity, the separate student groups began courses of dialogue and design efforts that initiated unique trajectories of action. Each group used slightly different vocabulary, discussed different ways to use materials and tools, and, developed particular conceptual frameworks for the design/problem solution. The diversity of approaches adopted by different groups was the key condition for interactions between groups that were not possible as intra-group phenomena. For example, because groups were working at their own pace some were ready to test their designs early and these tests were often public events that drew the attention of classmates. *Assertion #2: The products of student work and the constructive processes leading to such products were significantly influenced by inter-group dynamics*. Throughout the observations of five different projects, there was not a single case where a group worked as an intellectual isolate from the other students in the room, and, the intergroup phenomena that regularly occurred produced a far greater volume of ideas for diffusion than could have been the case within a single group. However, not all group interactions were positive influences on student work in class. *Assertion #3: Different types of tasks afforded different types of interactions*. Opportunities to learn from the ideas, successes or failures of other groups was an emergent property of the learning tasks. In the Apollo activity, for example, students tested their extraction tools in the center of the classroom. During these kinds of public events, ideas quickly diffused to other groups for adoption, adaptation, or rejection. Conversely, the surveying activity provided the least opportunity for the public display of ideas-in-action. There were no opportunities for members of the groups to visit other groups because three members of each group had to coordinate their use of different surveying instruments and the fourth member of the group acted as a recorder. This effectively canceled out any possibility for student migration between groups, and, inter-group interaction was restricted to observing the developing practices of other groups, which could not be ascertained as fruitful by observation-- there were no unambiguous indicators of successful practice to emulate. Many of the events described in this classification are known to foster learning (Barnes & Todd, 1977; Cobb, 1991); among these are: tutoring others, receiving just-in-time help from other students who were willing to tutor, being asked to explain a model to someone else, comparing one's own model with another, and transferring one's own design experience to the design practice of another group. Such a wide variety of opportunities to learn from other students emerges only in the context of personal mobility and communication, and, even within this context, different types of tasks afford different kinds of interactions among learners.

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