Weaving Together Parts to Achieve a Whole: Gestural Activity for the Coordination of Information in the Teaching and Learning of Chemistry

Stephanie Scopelitis, University of Washington, 1019 Harms Ave, Libertyville, IL 60048, scope@u.washington.edu
Mike Stieff, University of Illinois-Chicago, 845 W. Taylor St. (M/C 111) Chicago, IL 60607, mstieff@uic.edu

Abstract: In this study we examine the effects of how instructors and students use gestures to coordinate concept information for science learning. The findings reveal that as gesture use can be an effective instructional method, gestures as teaching and learning resources are only as valuable as they are visible. We conclude our study by encouraging new instructional designs that make use of the affordances of gestures in coordinating representations and orienting visual perspectives.

Introduction
We see learning as a dynamic process constructed through actions and interwoven relations among resources (Hutchins, 1995; Stevens & Hall, 1998). These resources include participants, settings, objects, sequences of activities, and multiple communicative modalities that go beyond talk. In our analysis we employ the idea that it is not only essential to cross resources, but it is also necessary that resources be coordinated, ordered, and highlighted with gestural activity (Goodwin, 2000; Stevens & Hall, 1998). We take the focus that gestural activity can assist in the construction and communication of scientific insights and add to this that gestural activity used to coordinate science knowledge is a fundamental practice of teaching and learning in STEM disciplines.

Recently, researchers have focused on the role of gestural activity in teaching and learning across STEM disciplines (e.g., Becvar, et al., 2005; Roth & Bowen, 1999; Scopelitis, Mehus, & Stevens, 2010) to suggest that gestural activity supports concept explanation and understanding. We expand on this by examining in detail how gestures are used in chemistry teaching. Prior studies of student and expert problem solving in chemistry (e.g., Stieff, 2011) suggest that gesture plays an important role in scaffolding spatial reasoning in the domain for the individual, but little is known about how higher education chemistry instructors and students use gestures interactively in this domain. Through our study we first show how an instructor employs gestural activity in university small group tutoring sessions to coordinate and sequence layers of disciplinary information and how students use gestures for achieving understanding interactionally. We further examine how and when critical gestures are attended to by all participants.

Methods
We employ microanalysis of videotaped interactions, which involves fine-grained, qualitative analysis of sequences of talk, gesture, and action. (cf., Erikson, 1995). The recorded interactions were logged and transcribed, and the verbal and gestural techniques used to communicate concepts were identified and analyzed. Using a constant comparative approach, we engaged in repeated cycles of analysis to produce emergent themes that characterize the functional and pedagogical role of gestures in chemistry.

Results & Discussion
Our results show three distinct uses of gesture by the instructor for coordinating representations and discipline information. Our analysis of the instructor revealed how gestures are employed with the intent (1) to connect present information, (2) to bridge previously acquired information with present information, and (3) to orient a learner’s spatial perspective to external representations. Importantly, these uses of gesture offer critical actions that weave together layers of information and link and sequence ideas to achieve the communication of concepts. Our data further show that students also use gestures (1) to coordinate discipline information to communicate understanding, (2) to make requests for clarification, and (3) to negotiate transitioning knowledge to achieve understanding.

Finally, the data demonstrate that while in some instances students are able to make use of gestural activity to coordinate and communicate critical content information, in other instances they are not. Students are challenged as their attention is pulled in multiple directions. Students simultaneously need to attend to information communicated in both instructor diagrams and gesture and information in their notebooks. This alternation of attentional orientation renders it difficult to capture all the necessary coordinating gestures performed in the process of teaching and learning.
Scholarly Significance & Implications

Gesturing for the coordination of information is especially critical in the teaching and learning of chemistry. The discipline is populated with diverse and multiple representations that individually fail to communicate an idea completely. Students need to learn how representations are related to one another and how a single representation links to others to make a whole. As a result, gesturing for chemistry understanding is not only to animate talk or enrich information. Rather, gesture can often be the crux of the information itself. Examples from the data show that an instructor’s gesturing is means for coordinating present information, invoking passed knowledge, and demonstrating a perceptual stance. We also show how gesturing to coordinate information is used by the students in interaction with the instructor and peers to extend understanding and think through problems together.

The data show that the diverse gestural activity as means for coordinating information can be part of a teacher’s repertoire of intentional pedagogical practices necessary to orchestrate the myriad representations and multiple layers of information that flood the chemistry classroom. The data, however, further reflect that the critical information these coordinating gestures provide is only as valuable as it is visible. This suggests new designs for chemistry teaching and learning environments that not only make use of an instructor’s gesturing to coordinate information, but also gives opportunity for instructors’ gestural demonstrations for delivering information to be continuously accessible to learners. Certainly, by the very nature of the lecture-format classroom arrangement prominent for chemistry teaching, the available uses and functions of gestures are different compared to those present in these small group arrangements. However, answers for new designs might be found through further investigation into how teaching and learning unfolds in other arrangements such as small group sessions that provide different opportunities to engage material resources such as gestures.

References


Acknowledgments

The research reported here was supported by National Science Foundation (REESE #0723312). The opinions expressed are those of the authors and do not represent the views of these agencies.