

# Promoting Transfer through Case-Based Reasoning: Rituals and Practices in the Learning by Design Classroom and Evidence of Transfer

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Our goal in education is to help students learn content and skills in ways that allow them to use what they are learning in new and novel situations. We want them to learn for transfer. The cognitive literature focuses on the cognition, or individual reasoning, needed to learn for transfer (see, e.g., Bransford et al., 1999). The socio-cultural literature focuses on the social interactions that are important for learning skills and practices in such a way that they can be performed in new and different contexts (e.g., Lave & Wenger, 1991). Both agree the building blocks for engaging in skills and participating in practices in an expert way are developed over time and in stages and require a variety of experiences and reflection on them. The computational models of cognition that come out of case-based reasoning (CBR; Kolodner, 1993) allows us to redefine transfer as spontaneous reminding and use of previous experience in reasoning about a new situation (Kolodner et al., 2002). This interpretation of transfer suggests practices for the classroom that can promote transfer (Kolodner, 1997).

We've designed a project-based inquiry approach to science learning for middle school called "Learning by Design" (LBD; Hmelo et al., 2000; Kolodner et al., 1998, 2002), based on these principles. We've identified many of the affordances and potential affordances for transfer that project and problem-solving activities provide, and we've designed classroom rituals and practices that help teachers and students identify those affordances and act on them. In science education, there is a need for students to learn not only content but also the skills and practices of scientists — from measuring and observing to interpretation of data to justifying with evidence and explaining causally to communicating with others, planning investigative activities, and applying what's been learned. LBD focuses on helping students learn this full set of objectives.

CBR tells us that productive learning from experience requires timely feedback on one's experiences, interpreting that feedback and explaining what happened in light of one's goals and intentions, making connections between one's goals, plans, and explanations, and having the chance to try again. It emphasizes the iterative nature of learning and the centrality of explanation. LBD's activity structures and sequencing provide both affordances and scaffolding for such reasoning. Students learn within the context of design challenges that require iterative trial and refinement for achievement. It is also highly collaborative. They engage in a variety of public presentations (poster sessions, pin-up sessions, and gallery walks) where they present their ideas, interpretations, and experiences to their peers in an interactive forum. Preparing for a session requires making

connections between one's goals, plans, and explanations. The public venue allows students to get help from their peers at explaining their results. It also provides students with a variety of examples that are then discussed with lessons that might be learned from the full set extracted. As they iteratively move toward better design solutions, they iteratively enhance their understandings of concepts and their abilities to engage in skills and practices.

Students spontaneously make reference to previous experiences over the course of several months of engaging in LBD activities, especially with respect to carrying out skills and practices. Our performance assessments show spontaneous reminding and use of both knowledge and skills, and LBD students are more capable than comparison students of engaging as scientists and collaborators (Kolodner et al., 2002). We propose that studying learning environments that encourage the natural use of case-based reasoning will increase our understanding of transfer.

## Acknowledgments

This work has been supported by the National Science Foundation, the McDonnell Foundation, and the Woodruff Foundation. Many others are involved in this research, including Paul Camp, David Crismond, Barbara Fasse, Jackie Gray, Jennifer Holbrook, Lisa Prince, Mike Ryan, and many teachers. Thanks to them all.

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