

## **Creating a Classroom Culture and Promoting Transfer with “Launcher Units”**

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In other papers in this symposium, we have described LBD™ curriculum units and the various forms of scaffolding that are embedded within the unit materials themselves. In prototyping early versions of design-problem-centered curricula, we discovered several important issues that must be addressed for middle-school students to learn science within a problem-based environment.

*Science skills and principles:* The curricula provide for students to learn science concepts through authentic science practice. That is, students develop and run their own experiments to test their own hypotheses for the purpose of selecting among several alternatives. Middle school students, though, are not skilled scientists. In fact, middle school is usually the time when students first put into practice any formal scientific methodology, and it is usually the time when students first learn to think about how specific data may typify a more general pattern. Without exposure to the principles underlying scientific inquiry, students will obviously not put these principles into practice spontaneously, and so any experiments that they will develop will most likely be too poorly designed and run to provide interpretable data. At the same time, we must be aware of how little time is available in a school year to devote to training students as scientists, for the requirements of virtually all state and school curricula focus on learning specific scientific content (such as understanding principles of force and motion, chemistry, genetics, etc.) How then can we teach students enough of the important principles and skills of scientific inquiry that they have enough competence to develop and run valid experiments that illuminate the science content that is targeted in the curriculum?

Furthermore, different fields of science are explicated through different methods and principles. At the middle-school level, doing hands-on science in physical science and chemistry are perhaps best undertaken within the framework of a traditional science experiment. However, hands-on middle-school life science is arguably best undertaken through naturalistic observation, and earth science, through modeling. The practices of experimentation, modeling, and observation do share some fundamental characteristics,

but it is probably less important that students understand science practice at such an abstract level and more important that they understand specifically what an experiment is, or what a model is, or how to observe; what the nature of the data is that must be gathered; and how to interpret data in light of the practices employed in gathering it.

*Design skills and principles:* The curricula each center around design problems. Students have even less experience with design methodology than they do with scientific methodology—most students at least enter the class with a fairly well developed concept of what science is about, but few understand what design is and what it means to design. (This is hardly surprising, as design as a broad concept has only recently begun to be articulated and disseminated.) If there is little time in a science class to spend on science principles, there is even less available for understanding principles and practices of design. Fortunately, science and design practice share many common or near-common elements.

*Group work:* Design-problem-centered curricula traditionally are set up to have students work in small groups, for several reasons. First, the set of potential solutions is usually too large for a single student to explore on his/her own. Second, multiple perspectives allow more aspects of a complex problem to be discovered and discussed. Conversely, Third, perhaps conversely to the second point, it is easier for teachers to manage class progress when there are a few groups than when there are a large number of individuals. However, schools are responsible for teaching individuals, not groups. Teaching colleges do not focus on developing skills to facilitate group work of this nature; students do not learn about how to collaborate well with their group members, nor about how to work across group boundaries and jigsaw solutions.

*Iteration toward success:* Part of the standard mission of any school is to cut large learning issues into manageable chunks. In practice, this often means that any given part of an issue is explored only once or twice; it is therefore understandable that curricula yield to the temptation to provide carefully orchestrated classroom experiences that are guaranteed to explicate a specific learning message. In science classrooms, these experiences take the form of laboratory activities that are designed to have very little variation possible either in practice or in outcome. Middle school students who have had such typical laboratory experience of contemporary schools are conditioned to expect that the outcome of a given activity is pre-ordained. They think of activities as being one-shot experiences that succeed only if they match the specified expectation, so they do not spontaneously revisit issues or re-try tests.

*Developing curriculum-specific rituals:* Many of the needs we have explicated are addressed by the rituals developed for or adapted to Learning by Design™ curricula. For example, gallery walks and pin-up sessions are presentation sessions that center on bringing groups together to offer peer review of methodology and conclusions, and to disseminate ideas and results throughout the class. They are used at different stages of the research cycle, and so focus on different artifacts (stage conclusions for gallery walks, brainstorm and synthesis for pin-ups). The ritual of explicating rules of thumb is another example; this ritual is designed to facilitate making connections between:

- (a) data from specific set of tests conducted in service of a specific aspect of a design challenge; and
- (b) the science principle that underlies not just the specific design issue, but the nature of how the world works.

When LBD™ rituals are enacted well by the class and teacher, then, they provide the right sorts of cues and checks that science will be conducted well and that science will be addressed in the midst of design. It only remains for this very important set of activities to become ritual—that is, valued by the class, and practiced comfortably yet expertly.

### ***Launcher Units***

What ties these issues together is that they are the needs that must be addressed *before* a class can tackle a design problem to explicate science concepts. Each of the issues raised above is difficult to manage; as a set, they may seem quite daunting, especially when one eye is on the time constraints of the contemporary classroom.

Our solution to addressing these issues was to create specific units that precede so-called content units. During the first 3-4 weeks of the school year, which are traditionally reserved for an introductory unit on the nature and practices of science, LBD™ classes do a similar unit, called a launcher unit (derived from an early LBD™ physical science unit that focused on space travel). One such launcher unit is examined in detail elsewhere (Holbrook & Kolodner, 2000; Kolodner et al., submitted).

In brief, a launcher unit is a series of experiences of 1 day to 1 week. Each launcher experience cuts across the issues raised above, so that a given experience may: introduce design terminology and scientific practice, give students experience and feedback on group work and cross-class collaboration, and be centered around the practice of a particular classroom ritual. Some of the launcher unit experiences are thematically connected to one another; for example, in one launcher unit, the class's first design activity precedes a short documentary on IDEO, a design company. In another launcher unit, students watch and discuss the 1995 movie *Apollo 13* over the course of several

days. Some subsequent activities in the unit tie directly to aspects of space travel, while others draw connections between those problem-solving approaches depicted in the movie and those carried out by the class.

The experiences are selected and designed so that each serves as a vivid experience for the students. Such an experience can serve as a memory case (e.g., Kolodner, 1993); the homework and class discussions and artifacts that go along with the experience are developed to scaffold a specific set of science/design principles and the skills and practices associated with it. For example, learning about methodological variance and how to identify and control it serves as the basis of one activity. The activity itself is very memorable; weeks later in the content unit, as students prepare to design their first experiment, the teacher will say, “why is it important to write down all these details of exactly how you’re going to do your test?”, and the students will say, “when we did Oreo™, we couldn’t tell what the right answer was until all the tests were done the same way.”

The launcher unit experiences are designed around group work, just as projects in the content units are. But for launcher unit experiences, learning the value and the method of group and class collaboration is part of the lesson. Discussions and negotiations about collaborative issues are built in to the unit materials. For example, in one of the earliest activities, groups show each other and compare their first version of a designed artifact, then return to their groups to revise the artifact, then show it again. Inevitably, aspects of more successful designs show up in other groups’ second versions, and students accuse one another of copying. The teacher has the students read a section of the book that addresses this issue and leads a discussion of collaboration, learning from one another, and giving one another credit for ideas. Later, in the content unit, though groups may engage in informal competitions to make the “best” artifact, the groups ask each other’s advice, offer one another ideas and materials, and aid one another in construction.

LBD’s rituals were developed to facilitate two aspects of problem-centered learning. The first is moving among individual, group, and class-level work; the second is running through a sensible sequence of the problem, including necessary iterations (the LBD cycle). The rituals themselves are not common in middle school classes, so their introduction and repetition is essential. In the launcher unit, the activities were designed to include the use of the rituals. A ritual is introduced by the teacher; s/he gives a brief description of what the class will do and the expectations of the task. S/he may simply model the expectations, or even formally specify the expectations and then grade students on how well they meet them. For example, during the first gallery walk, the teacher may

ask each group a similar set of questions. Some groups will not be able to answer the questions the first time through. By the second gallery walk, the same questions are asked by the teacher, and this time, all groups are expecting them and have answers ready. Alternatively, the teacher may write a set of questions on the board and give the class time to prepare presentations before the gallery walk; as the groups present, the teacher has the gradebook in hand. Later, during the content unit, the students will may ask the teacher to “call a gallery walk” when they need to share ideas with other groups. During these later gallery walks, the students themselves ask questions that the teacher modeled earlier; the students themselves comment (or complain) about missing information. Rituals do not need to be explained or deconstructed at length; they just become the way the class does things

Examples such as this show that the launcher unit helps to enculturate the students, so that the necessary practices and values of science and design are automatically invoked as the students work through the project. The students know enough to design and run their own experiments, and how to check one another’s methodology before accepting one another’s conclusions. The students know enough to operationalize design test questions, keeping the criteria of the task in mind. When students get good data about the project artifact, it serves as the basis for generalizing conclusions from the artifact to the underlying science concepts that are the true goal of the project.

It is also interesting to note that the students invoke the culture of LBD in non-LBD situations. We have observed that LBD™ students who participate in traditional science fairs use the language and skills taught in the class—discussing confounding variables, running 10-30 trials, detailing pilot experiments and subsequent modifications, organizing the outline around terminology such as “criteria and constraints”. Such projects contrast with those from other classes, where the organizing principle is usually based on the “scientific method” process listed in a class textbook. We would claim that this difference is evidence of different enculturation experiences.

We also have informal reports from teachers in other disciplines that support our belief that the students invoke aspects of the LBD™ culture broadly. Social Studies and Math teachers have reported that LBD™ students have suggested “gallery walk” presentation styles and “whiteboard” discussions. The students themselves show a difference in their approach to group work; in interviews conducted at the beginning of the school year, they view group work as at best, a social opportunity, and at worst, an unfair division of labor. By the end of the units, they claim a deeper appreciation for group work and invoke terms such as “collaboration,” “sharing ideas,” etc.

These anecdotes are backed up with evidence from our formal assessment effort. On performance assessment tasks, LBD™ students show greater ability to collaborate within groups, to conceive a real-world challenge in terms of a model or experiment, to discuss important elements of good experimental design (such as number of trials, method of measurement, awareness of potential confounding variables), and to perform self-checks of procedure as they perform a lab activity (Gray, Camp, Holbrook, & Fasse, 2001).

### ***Conclusion: Generalizing the Concept to Other Project-Based Curricula***

While LBD™ launcher units were designed to support specific science content units, the framework is widely applicable. We developed the activities in the unit to help students and teachers to develop design and science practices, but also to develop collaborative skills and to value collaboration, to learn a cycle of doing, reflecting, and re-interpreting, and re-doing that is necessary for any in-depth project. We see this approach as widely applicable in any sort of project-based curricula, and look forward to seeing similar efforts developed for use with other curricula.

### ***References***

Gray, Jackie, Camp, Paul, Holbrook, Jennifer K. & Fasse, Barbara (2001). Science talk as away to assess student transfer and learning: Implications for formative assessment. Presentation in AERA symposium, From cognitive theory to science classroom: the Learning by Design™ case study. AERA meeting, Seattle, WA, April 2001.

Holbrook, Jennifer K. and Kolodner, Janet L. (2000). Scaffolding the development of an inquiry-based (science) classroom. In B. Fishman & S'O'Conner-Divelbiss (Eds.), *Fourth International Conference of the Learning Sciences* (p. 221-227). Mahwah, NJ: Erlbaum, and <http://www.umich.edu/~icls/>.

Kolodner, Janet L., Crismond, David, Camp Paul, Fasse Barbara Burkes, Gray Jacqueline, Holbrook, Jennifer K., Puntambekar, Sadhana, and Ryan, Michael (submitted). Problem-Based Learning meets Case-Based Reasoning in the middle-school science classroom: Putting Learning by Design™ into practice.

Kolodner, Janet L. (1993) *Case Based Reasoning*. Morgan Kaufman Publishers.