The Best Made Plans of Mice and Curriculum Planners: Embracing Diversity in Teacher Needs and Planning for It

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Abstract: Curriculum designers, writers, and trainers should be aware that, for teachers, a diverse set of personal and classroom circumstances means a diverse set of classroom adaptations. In a world of infinite possibilities, it is impossible to predict what type of individual spin a teacher may put on the implementation of the curriculum when they adapt it to their specific needs. This paper, therefore, asserts the importance of identifying the key or pivotal elements of the curriculum in order to assure that they are, at the very least, included in the individualized enactments outside of our control. This planfulness may increase the likelihood of a closer-to-fidelity enactment insuring both student and teacher a richer experience that includes the primary principals the curriculum designers had in mind.

Introduction

With apologies to Robert Burns, we have learned that one thing curriculum planners have in common with his "mice and men" is that their plans "will surely go awry". Given the diversity of circumstances of teaching environments and circumstances, teachers can be counted on to deviate from the written or planned curriculum when implementing it in their classrooms (Barab & Leuhmann, 2003; Blumenfeld et al., 2000; Fasse, Holbrook, & Kolodner, 2002; Fishman & Krajcik, 2003; Fishman et al., 2003; Kolodner et al., 2003; Songer, Lee, & Kam, 2002; Songer, Lee, & McDonald, 2003.) Accordingly, we believe that those of us who develop lessons, modules, and/or curricula should acknowledge this as a reality, not be disappointed that or when it happens, and plan our materials so that what we define as the most important element(s) will be sure to be included.

The issue here is adaptability (fitting an innovation to the practice) and sustainability (keeping it there as part of everyday common practices) (Fishman & Krajcik, 2003; Fishman et al., 2003). If the curriculum is to be put into sustained practice, the developers must take into account teacher ownership. It is the teacher who is ultimately responsible for both the progress of the students and the daily functioning of the classroom so it will be the teacher who influences how and what will be done in the classroom (Barab & Leuhmann, 2003; Fishman & Krajcik, 2003). Teacher autonomy and access to support structures and materials influence, for better or worse, the level of the curriculum's real-world implementation (Songer, Lee, McDonald, 2003). Failing to acknowledge or accept this by creating an inflexible, "rubberstamp" curriculum is likely to result in its being modified to the point of being unrecognizable, losing its integrity by becoming incorporated into prevailing practices, or being abandoned entirely (Blumenfeld et al., 2000; Barab & Leuhmann, 2003).

In over five years of experience with various incarnations of Learning By Design™ enactments, we have yet to find a teacher who has implemented the curriculum from beginning to end specifically as written. What we have found, instead, are teachers whose diversity of real world circumstances dictate various types of individually determined customizations of LBD™ to meet the needs of their environments, their student populations, their teaching styles, and the limitations of their resources. We feel that what the teacher decides to leave in, take out, or do differently plays a major role in determining the student's and teacher's (and curriculum planner's) feelings of satisfaction with the effort. These random though contextually-situated customizations have resulted in the array of predictable outcomes—some LBD teachers who have implemented it as close to its intentions as we can hope, some who got in the ball-park with a reasonable effort, some who modified it beyond recognition, some who co-opted it into standard "lab" experiences, and some who abandoned it altogether. We are in agreement with Barab and Leuhmann (2003) who say that "the core challenge…is not to design some 'correct' version of curricula or assessment that will be implemented 'whole cloth' by willing teachers, but to

develop flexible support structures that facilitate local adaptation and ownership [of the curriculum]". We would extend this notion by also suggesting that by clearly determining what it is that makes the curriculum or reform uniquely what it is, we can aid each user in getting closer to an adaptation that is what we had in mind when we crafted it. It is, therefore, incumbent upon curriculum designers, writers, and trainers to identify *the* most pivotal or defining parts of the curriculum in order to focus on (via materials and training) the importance of including these elements at the very core of the experience. Thus allowing maneuvering room for each teacher's special needs while assuring fidelity to the ideals.

The purpose of this paper is to share what we have learned about adaptation during five-plus years of watching middle school physical science and earth science teachers use LBD in real-life classrooms. To understand how we came to this lesson, it is necessary to know a bit about what Learning By Design is and get a feel for the variety of implementations by meeting a few of the teachers. To this end, a brief explanation of LBD will be followed by some classroom descriptions and a discussion of how these teachers and their students showed us the importance of identifying *our* defining element.

What is Learning By Design?

Learning By Design "is a project-based inquiry approach to science learning with roots in case-based reasoning and problem-based learning…[The goal is for] the students to be successful thinkers, learners, and decision-makers throughout their lives, and especially to help them begin to learn the science they need to know" (Kolodner et al., 2003). The science content domains are physical science (specifically forces and motion and, to a lesser extent, simple machines) and earth science (specifically geology: land formations, erosion, rocks and minerals). Each curriculum is designed to cover half of the school year beginning with the three-week Launcher Unit, which establishes the cultures of collaboration and scientific experimentation (designing an experiment, data collection and analysis, evaluation of the data of self and others, etc.) "LBD students learn science in the context of achieving design-and-build challenges. Included…is a set of ritualized and sequenced activities that help teachers and students acclimate to the culture of a highly collaborative, learner-centered, inquiry-oriented, and design-based classroom" (Kolodner et al., 2003). The curriculum is iterative in nature proposing a design-and-build challenge that requires students to revisit what they have just built, observed, and proven through data as they tackle the next phase of the challenge. In the physical science units, students are asked to design and build a miniature car with various types of propulsion systems that must meet different sets of criteria (forces and motion) and a lifting device for someone with a disability (simple machines). The earth science units ask students to design and model a way of managing erosion for a proposed community project and to make recommendations for an underground transportation tunnel across the state of Georgia using their knowledge of geological formations as well as issues related to topographical features and ecology (Kolodner et al., 2003).

The public rituals in the form of gallery walks, pinups, poster sessions, rules of thumb, and whiteboarding (Kolodner et al., 2003) foster the public discourse that makes LBD what it is. During these activities, students share their own ideas and constructively critique the ideas of others using prior knowledge, knowledge gained through experience in the class (i.e., class discussions, teacher lecture, readings, design diary activities, designing, building), and/or knowledge created through rounds of experiments (data collection and analysis). These practices, or rituals, provide form for a science-based collaborative community of learners. Each activity has its own purpose and is a tool for encouraging discourse and analysis of experimentation and design. Depending on which ritual the class is employing, students learn that they are responsible for presenting ideas that can be justified with good data. They also learn how to look at the presentations of others with an eye for accuracy as well as asking for explanation and giving their own ideas or suggestions. They learn to use the information gained through the presentations of others to inform their own work. When the practices of scientists are then layered on top of this, we see students evaluating the experiments of others and basing their own work on whether they find the data of others to be trustworthy or not. In this environment, students learn to evaluate the work of others, and have their own evaluated, based on its merit. For it to work effectively, the teacher must value the purpose and understand the rituals as a means to the purpose. The teacher must foster a community in which respect is the ultimate value so that the rituals become a vehicle for communication among groups of students from within the class as well as between classes across the entire school day.

We have been working with classroom science teachers in a large metropolitan area in the southeastern United States since 1994, piloting the first iteration of the curriculum in its current form (beyond isolated lessons) in the spring of 1998. We have evaluated the work of over two-dozen teachers and more than 3,500

students (Kolodner et al., 2003). Multiple methods of data collection with both LBD and non-LBD comparison classes have been employed to get a full and reliable picture of student outcomes. We use a paper-pencil pre-test and post-test along with periodic curriculum quizzes to obtain statistical measures of content acquisition. Performance assessments administered at the end of each module use paper-pencil and video data to help us understand the development of students' collaborative and scientific methods skills as well as content knowledge as they work individually and in groups to solve a problem (Kolodner et al., 2003). Qualitative data in the form of both formal and informal interviews (with students and teachers) along with regular classroom observations with field notes and video tape serve to round out the picture of student content understanding, the development of the inquiry-based culture and collaborative community, and in answering the question "what is going on here?" with regard to day-to-day classroom activities (Fasse & Kolodner, 2000). The qualitative data sources have also served over the years to help us, internally, determine what works and what doesn't work as we crafted the design challenges and rituals. These sources of data are triangulated within-year and across-years to inform a rich understanding of middle school science teachers and the nature of adapting an innovation such as the LBD curriculum.

Years of quantitative statistical analysis combined with qualitative observations provide evidence that LBD students always do as well as or better than comparisons on both assessments of content understanding and assessments of their scientific reasoning performance (see Kolodner et all, 2003). However, results are not the same across all LBD classrooms. When teachers focus on building a community using the LBD public practices to encourage it, performance assessment outcomes show that the students are better at scientific reasoning and collaboration. When teachers focus on the content that can be learned from LBD units' activities, students learn the content very well and perform far better than comparison students. It is only when they focus on both that students achieved in all categories.

Learning By Design and Teacher Customization

The various enactments of Learning By Design over the years have shown us that, in the words of television's Seinfeld character George Costanza, when it comes to adaptations of curricula, teachers are, indeed, "the masters of their own domain". We have found that we cannot predict how a teacher will customize the curriculum. Even when given specific guidelines for what might be considered peripheral, they still find their own places to add or subtract or make it their own. Consistent with the reports of others (Barab & Leuhmann, 2003; Fishman et al., 2003; Fishman & Krajcik, 2003; Songer, Lee, McDonald, 2003), the general causes of customization are time issues, support systems (peer, school administration, parental noise, district-level administrators, etc.), materials, standardized testing initiatives, quality of students, class size, etc. But we agree that the most significant factor is what Leuhmann (in Barab & Leuhmann, 2003) calls "the role of the teacher (including her pedagogical perspective, learning goals, interests, content expertise, memberships, school roles, self-efficacy, and experiences)." Ultimately, it will be the teacher's values that will determine if and how she will utilize the curriculum to meet her purposes while living with the external factors (i.e., parents, class size, administrators, etc.).

What follows are descriptions of a few LBD teachers who stories can illustrate for us some of the diversity of teacher needs that influenced their adaptation of the curriculum. It is through the experiences of these teachers and their students as well as other LBDers that we have come to appreciate the value of identifying and supporting the key element that makes the LBD experience uniquely LBD. That is, the notion of community.

Mark

Mark expected his LBD students to be respectful of each other, respectful of their school/class environment, and respectful of the work to be done. He used the design challenge with an inquiry approach to create a community of student scientists ("Remember," he would often say, "you are not science students, you are *student scientists*") who worked collaboratively within groups, between groups, and across classes to co-construct knowledge. Mark was an interesting hybrid of a traditional and inquiry teacher. He understood the value of the public practices for creating this community, and he took full advantage of them, even adding a computer-based intranet to the classroom to allow students to share their experimental results, ideas, and design experiences with each other across classrooms (Kolodner & Nagel, 1999), but while he scaffolded students well as they were learning, he was also a more directed teacher than one might expect in an inquiry classroom, taking control of discussions and giving mini-lectures about content on a regular basis. This directedness worked very

beautifully when mixed with the LBD's public activities. Mark's students successfully learned the science content and mastered the skills of scientists, and they also learned to trust each other, to care about the quality of their work, and to value sharing and building knowledge with colleagues (i.e., their classmates and teacher). His students learned both content and scientific reasoning, as well as collaborative skills far better than their comparisons.

Lisa

Lisa, a long-time LBD teacher, is reflective about her teaching and the benefits that she believes it gives her students. She readily admits that the design-based, inquiry classroom is not a natural venue for her, especially after 13-plus years of using traditional pedagogy: "I like students in desks in rows, quiet, with their hands raised. I prefer order and lots of structure. This environment [where there students are moving around, talking among themselves, and asking questions of her that she must resist answering outright while guiding them to discover the answer] is not natural to me. But I have discovered that there is order here and that organization is necessary. It is not out-of-control like I [previously] believed inquiry classrooms to be. There's a lot of structure here." A year later, she repeated this same point, adding: "I can never go back to 'students in desks, desks in rows", I will never be able to teach any other way than this [LBD] because I've seen how [effectively] it works." She never seems to think that anything is beyond the capabilities of her students; she holds the bar of expectations for achievement, participation, and behavior high and, generally, her students prove themselves equal to her confidence in them.

Lisa delivers the LBD curriculum as close to written as we've seen. She uses the public structures to establish the collaborative community to their greatest advantage, but in her own way. For example, she refuses to do whiteboarding simply because she is not comfortable with it. Yet, she begins each round of experiments with a whole-class event on the overhead projector for identifying variables and defining the experiments that is nearly indistinguishable from whiteboarding. Lisa also has her own opinion of gallery walks. She values them and uses them effectively during the launcher unit to introduce the notion of collaboration—when is it collaboration, when is it "stealing my idea"? —and to establish a community of shared knowledge. She refuses to revisit the gallery walk after students spontaneously begin moving around the tables asking about and critiquing ideas. She says she does not have time to convene formal gallery walks and yet she unnecessarily spends three days lecturing and drilling students on related but unscripted trigonometry. As a former math teacher, this is a subject close to her heart and a teaching structure that feels natural to her. But, Lisa's classroom is one where science content and scientific method co-exist with inquiry and the design challenges that the students themselves come to almost automatically employ to propel their work from one stage of the experimentation and/or design to the other. Her students, like Mark's, perform well compared to comparisons on science content understanding, scientific reasoning, and collaboration.

Ellen

Ellen's implementation of the LBD earth science erosion materials is nearly perfect. She knows the content and is trained in inquiry methods. She leads efficient open-ended class discussions, creates a sound community of learners, successfully guides her students through the modeling challenge related to the erosion content, and then she stops. Ellen has a passion for teaching rocks and minerals her own way so she is not interested in using LBD tunneling materials to replace what she feels effectively teaches the material in a more time-conservative fashion. She values the public structures and uses them appropriately and with satisfaction. She gets the beginnings of a good community of learners going in her classroom, we just can't interest her in continuing LBD into rocks and minerals. Because she never completed the tunneling unit, we don't have hard data on her students' learning.

Tanya

Tanya's students dotted every "i" and crossed every "t" so thorough was her coverage of the LBD launcher unit. Her students did every written assignment, every reflective activity, and participated fully in every ritual and structure. But when they got to the content unit, Tanya ran out of motivation. Tanya teaches out of field; she is not trained in the content area and is uncomfortable with it. Her primary goal for her students is that they become good investigators; the content is secondary in her mind. In LBD the groundwork for scientific methods in the form of data collection and analysis is put firmly into play during the launcher unit. In the Vehicles in Motion unit, these skills continue to be used and developed but within the context of the content. Tanya gets most of what she wants for her students from the launcher unit. Once in the content-rich unit, she

loses her confidence and struggles to stay ahead of her students. She, as other teachers, cites time constraints as her reason for altering the curriculum. Tanya was an early LBD teacher who had abandoned it for several years while she taught in another content domain. Returning to physical science, she decided to again use the LBD curriculum. Because over the years, it had evolved from what she remembered, she was given a one-on-one tutorial that proved insufficient for helping her with both the added. Additionally, it is difficult in Tanya's school to establish much of a classroom community. The class time of each teacher is not held sacred by the faculty or administration, which means that there are differing subsets of students attending class each day. Students miss class to work on school-wide projects, prepare for assemblies, and finish work in other on-team classes, along with ordinary absences for illness and appointments. The students working in groups vary daily; the students in the class vary daily. The public structures suffer. As a result of this revolving door for student attendance and the resultant lack of continuity, it is difficult to maintain a community where knowledge is co-constructed. This combined with her lack of confidence in the content yield a less than satisfying experience for teacher and students. Tanya's adaptation is inquiry-based, design-challenge driven but without rigorous attention to science content and without community. Her students typically perform the same as comparisons on content understanding, better than comparisons on some scientific reasoning, but poorly on collaborative skills.

Cate and Mandy

Mandy truncates the curriculum because she feels a constant pressure from the other science teachers in her school to move at a certain pace in order to cover more content areas during the school year. She justifies the radical alterations by saying her students are not mature enough to handle many of the rituals and structures as designed. She does not understand the purpose of the public sessions and, thus, enacts them haphazardly. For example, when she does, she allows students to continue working or talking in groups during peer presentations. She goes through the motions of enacting some of the public structures but her students so poorly attend to them as she rushes through them that they are rendered meaningless. They turn out to be a waste of time. Cate also eliminates many of the public structures. She feels pushed for time by the number of content areas she must cover during the school year so, while she believes in the tenets of the curriculum, she must make choices based on outside pressures.

It is clear in their enactments that neither teacher values the role of the public structures or role of the community of learners at either the theoretical or the practice level. Both teachers blow past them in their adaptations on a quest to cover content and conserve time. The result is a less rich experience with a project-based inquiry unit during their school year. Students in classes of both teachers learn science content well compared to comparisons (remarkably well for Mandy's students), but they are no different than their comparisons in scientific reasoning capabilities or collaboration.

Sam

Sam, a first year LBD teacher with knowledge of the content area and experience using inquiry-based methods, became so excited by the possibilities that he added activities and field trips to the already time-constrained curriculum. We warned him that time would be a factor, but he was persistent in including these ancillary activities. We likened it to a hungry first-timer at a smorgasbord—overwhelmed by the possibilities, he was filling his plate with salads before he even got to the other courses. As predicted, Sam began to run out of time by the end of the launcher unit. In order to finish the next unit by the deadline he set for himself, he cut many of the content activities short and removed iterative opportunities and public knowledge-building and sharing rituals, which were crucial to the experience for his students. On his first go through the curriculum, he missed the opportunity to establish the collaborative community.

Sam's adaptation is inquiry, design-based but without iteration and related public structures (i.e., whiteboarding, pinups, posters, rules of thumb) that foster co-construction of knowledge. Also, missing is a value structure that encourages cohesiveness and mutual respect among the students prohibiting the community to exist as a place where students feel they own the learning. He believes that LBD's expectations for content understanding as well as collaborative learning are not attainable by his students although his students are capable, relatively high SES in a school that values student autonomy and intellectual curiosity. The limitations his beliefs put on his students' capabilities combined with his related classroom management practices to be ineffective for fostering the respectful, trustful community of learners (Campione et al., 1995) required for LBD to be satisfying to him, his students, or us (the designers and trainers). Like some other novice LBD teachers, Sam has been overwhelmed by having so many expectations to meet at one time that he was unable to make

meaning of them all on the first pass. Because Sam is a first time LBD teacher, we are still collecting data from his students, so the measurable learning outcomes are yet to be determined.

Discussion

Evaluation results over the years (see Kolodner et al., 2003) provide measurable evidence of LBD student success in content understanding, scientific reasoning, and collaboration. So the success we are referring to here might be more specifically called *satisfaction*. For the purpose of this discussion, let's define satisfaction as knowing or feeling that the effort required by the teacher to learn and implement the approach--and to keep using it--is worth it. And, also, that the students have the feeling or knowledge that their time has been well-spent as well. For us, the curriculum designers and trainers, satisfaction means the sense of knowing that what the innovation or curriculum should be is actually being experienced by the users.

We (i.e., the curriculum designers, writers, and evaluators) knew what we wanted the innovation to be, and we were fairly certain that our curriculum was the correct vehicle for our vision. But it was not until we began to see it enacted that we could determine the features that make it unique. It was not until we saw contrastive sets of LBD adaptations that we could confirm what it is that makes the LBD classroom unique. What was the essence of this thing we kept calling "LBDness"? We weren't always as clear on what the core of it was or how to explain it or the value of naming it. A bit like that common saying, "I don't know what it is, but I'll know it when I see it". We, on the other hand, knew what it was, we were fairly sure how to get to it, but we didn't know its true meaning until we saw it (or the absence of it). What Lisa, Mark, and Ellen show us by example, and what Sam, Cate, Mandy, and Tanya show us by contrast, is that at the very core of LBDness is the LBD collaborative community and the participant structures that support it. There is a palpable difference in the quality of the experience for both teachers and students (i.e., a difference in satisfaction as defined above) when these notions are central and when they are not. Success in creating this environment rests on the teacher's commitment to fostering a culture (a set of commonly held values, roles, mores, and norms) where respect and trust are valued so that students are comfortable sharing their ideas and constructing knowledge as a group (Campione et al., 1995).

There is a qualitatively different feel in Lisa, Mark, and Ellen's classrooms than in the classrooms of Sam, Mandy, Tanya, and Cate. LBD is going on in all seven places but it is going on differently. The experiences of the first three and their students are more satisfying and richer--to us and, more importantly, to them. These are classrooms, where students participate in the LBD public rituals appropriately and regularly, where the students feel comfortable sharing their ideas, evaluating ideas of others, and having their own ideas critiqued by their classmates. These are classrooms of people who treat each other and their environment with respect and where, therefore, there is mutual trust. These are classrooms where knowledge is shared and co-constructed, classrooms where students evaluate and use data (their own and others) to substantiate decisions. In these inquiry classrooms, students learn science and learn the skills of scientists within the context of a design challenge but they do so in a place where respect for others, respect for the ideas of other, and respect for the property of others is valued and where it then enhances their own self-respect and confidence. Here we witnessed what we believed (and continue to believe) LBDness and the LBD classroom ought to be in its idealized form. These are classrooms where our "teachers understand that collaborative learning is not simply a call to have students work in groups, but rather, it is a value that needs to permeate the classroom—through sharing across groups, more expert students helping less expert ones, the teacher admitting what he or she does not know and getting excited about learning from the students, the students together figuring out what they need to lean more about and helping each other with their investigations and experiment designs, and so on. We ask them to take the idea of communities of learners (e.g., Brown & Campione, 1994; Campione, Shapiro & Brown, 1995) very seriously" (Kolodner et al., 2003).

Lisa, Ellen, and Mark value the notion of fostering a community of LBD learners, they understand the public rituals that will give it structure and support co-construction of knowledge. Lisa taught us that when a teacher is uncomfortable with a particular way of doing something, if she understands its goals or purpose, she can find a way to get to the same place using a structure of her own design as she has done with white-boarding on her overhead projector. Lisa and Mark have also taught us that, if the teacher includes certain aspects of the curriculum regularly and with fidelity, we can forgive that others are let go. Lisa is religious about poster sessions, pinups, and rules of thumb (Ryan, 2003); with those public sessions firmly in place, the effect of the absence of gallery walks is reduced. While including gallery walks would offer yet another opportunity for the

students to learn from and inform each other, Lisa's fidelity to the other public structures assures that her students get what they need to be good scientists as well as plenty of other opportunities to be good members of LBD's community of learners. Mark also included most of the public structures and helped his students construct their own knowledge. He added mini-lectures given as time savers when he thought the students already knew enough basics to understand them, and he was generally correct. Ellen taught us that, if the teacher gets it (i.e., the key idea) an adaptation could be satisfying even when the teacher sets limitations for how many of the content units she will enact.

By contrast, Sam, Mandy, Tanya, and Cate's students successfully completed the design challenges in a customized version of LBD that does not include fostering a community of learners and the public practices that give it structure. Their students learned the science content and many of the skills of scientists within the context of a design challenge in an inquiry classroom. They achieved important goals. They had a successful LBD experience. These teachers adapted LBD to their own needs with varying degrees of success. But, what the other teachers show us by comparison, is that these teachers and their students could be getting even more out of LBD. Somehow, whether we failed to make it explicit or they just didn't get it, these teachers missed the opportunity to create collaborative communities of learners. The public rituals were short-changed, as were the iterative opportunities. It's the chicken-or-egg question of whether the public rituals were missing because they didn't iterate enough to warrant them or if the iterations were missing because the teacher did not know how to use the public rituals to support them. Either way, the answer from teachers who do this is that they just don't have the time. Yet for the amount of time invested, and LBD is time intensive, something more meaningful can be gained by including the public structures that support the community of learners. But, first the teacher must believe in the value of it, as do Mark, Lisa, and Ellen, and they must also believe their students can achieve it.

Sam and Tanya have taught us the importance of more clearly and/or overtly defining for the novice teacher *the* central tenets, the key ideas that we feel make LBD special. The novice teacher can be nearly blinded by the array of new skills. For example, understanding LBD rituals and structures, their purpose, and how and when to use each of them is a substantial task in itself. But when undertaken along with a new way of managing students, content embedded in a design activity, the management of the materials for the design activity, etc., those essentials can fall by the wayside. Holding all of the elements of such a complex innovation in one's head on the fly may be too much to ask. The answer may be to prioritize the principles and the structures that yield them so that they can be grappled with one-by-one until the full set is realized.

Both Cate and Mandy have some understanding of the purpose of the public rituals, but when having to make the tradeoff between covering all the content and covering the practices of scientists too, they choose to keep the content in and leave the other out. This suggests a need to write our materials with teacher instructions that help teachers know what to leave in and what they can safely take out.

It is possible that identifying these key factors may play a role in advancing adaptability of LBD in another way. As teachers complete the design challenges within our curriculum and move on to other content domains they can continue to employ the benefits of the community and the rituals for public discourse. Once this culture is established it does not need to dissolve after the LBD content unit is completed. Lisa does this with an electricity unit.

What we learned from all of these teachers and others is that individual adaptations are to be expected and anticipated. We learned that students and teachers can reach some type of success with most adaptations. But we also learned that, if we want the adaptations to retain the flavor of the innovation we have in mind, it would be best to define for others and ourselves the factors that are central to getting there.

Conclusion

With regard to adaptability (Fishman & Krajcik, 2003; Fishman et al., 2003), we have learned that teachers will do what they are going to do and they are going to have rational reasons that we may or may not see or agree with, for it. The problem then becomes controlling the adaptations so as to retain the integrity of the reform idea as teachers make it their own. When teachers customize LBD and continue the use of their customized version, we would hope that it would remain recognizable by retaining the qualities unique to LBD. We would want to make sure that the teacher's adaptation is essentially LBD or else it becomes any inquiry classroom, any design unit, any case-based reasoning curriculum. Because LBD has a set of rituals and structures unique to itself, it is important that we clearly identify the qualities that make LBD uniquely LBD. In identifying

the central tenet(s) for the teachers and ourselves, we assure that, if other things have to go or get altered or truncated, teachers will continue to focus attention on this factor. In the case of LBD, we know that teachers and students will have a richer experience when an adaptation employs the public practices establishing a community of learners, as we had hoped.

Curriculum planners and educational pundits are frequently criticized for their "ivory tower" disconnect from the real world of the teachers they advise. This point is one that is well taken by the LBD staff. After five-plus years of training teachers and then observing and interviewing teachers and students in a variety of school milieus, we still find ourselves blurting out in exasperation, "..but he/she is not doing it right" upon discovering a teacher's deviation from our carefully crafted plans. This is generally followed by a "let's add this…" knee-jerk reaction that we must reign in for its uselessness in the face of the teacher's real-life dilemmas. And, even while knowing that "right" is defined by the circumstances each teacher faces each day, we still have to be purposefully mindful to avoid this reaction. As we watch our LBD teachers each make it work in his/her own way, we struggle daily to remember that the classroom is not the perfect world that we wish it to be. By clearly and purposefully identifying for ourselves and for the teachers *the* most specific elements that make LBD unique and valuable, we can avoid disappointment in the diverse implementations and assure a more successful and satisfying experience for both teachers and students. In planning the curriculum, we must be equally as planful for the reality of adaptation, the ultimate usage, as well. From our own experience some of the ways we believe curriculum designers might do this is by identifying the essentials in early trials, teaching teachers those essentials well and making sure they understand them, understanding the effects of different adaptations from early trials and making those clear in teacher materials, and to specifically target these essentials as the foundation for the novice user.

References

Barab, S.A., & Leuhmann, A.L. (2003). Building sustainable science curriculum: Acknowledging and accommodating local adaptation. *Science Educator*, 87: 454-476.

Blumenfeld, P., Fishman, B.J., Krajcik, J., Marx, R.W., & Soloway, E. (2000). Creating usable innovations in systemic reform: Scaling up technology-embedded project-based science in urban schools. *Educational Psychologist*, 35 (3):149-164.

Campione, J.C., Shapiro, A.M., & Brown, A.L. (1995). Forms of transfer in a community of learners: Flexible learning and understanding. In A. McKeough, J.Lupart, & A.Marini (Eds.), *Teaching for transfer: Fostering generalization in learning* (pp35-68). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Fasse, B.B., Gray, J., Holbrook, J., Camp, P.J., and Ryan, M. (2001) *Scaffolding teacher's development through curriculum materials*. American Educational Research Association Seattle, WA, April 2001.

Fasse, B.B., Holbrook, J.K., and Kolodner, J.L. (2002) *Addressing Teacher Misconceptions in a Learner-centered Classroom.* Paper presented at International Conference of Learning Sciences, Seattle, WA, October 2002.

Fasse, B. B. & Kolodner, J. L. (2000). *Evaluating classroom practices using qualitative methods: Defining and refining the process*. In proceedings International Conference of Learning Sciences 2000 (ICLS), pp. 193-198.

Fishman, B.J., & Krajcik, J. (2003). What does it mean to create sustainable science curriculum innovations? A commentary. *Science Educator*, 87: 564-573.

Fishman, B.J., Marx, R.W., Blumenfeld, P., & Krajcik, J. (2004). Creating a framework for research on systemic technology innovations. *The Journal of Learning Sciences* (in press).

Holbrook, J,. Fasse, B.B., and Gray, J. (2001) *Creating a classroom culture and promoting transfer with "launcher units"*. Paper presented at American Educational Research Association, Seattle, WA, April 2001.

Kolodner, J.L., Camp, P.J., Crismond, D., Fasse, B., Gray, J., Holbrook, J., Puntambekar, S., & Ryan, M. (2003) Problem-based learning meets case-based reasoning in the middle school classroom: Putting Learning By Design into practice. *The Journal of Learning Sciences*, 12(4): 495-547.

Kolodner, J.L. & Nagel, K. (1999) *The design discussion area: A collaborative learning tool in support of learning from problem-solving and design activities.* In proceedings of CSCL '99, Palo Alto, CA, pp. 300-307.

Ryan, M.T. (2003). *Enhancing conceptual understanding, scientific reasoning, and transfer through design rules and science talk*. MS Thesis. University of Kansas, School of Education.

Songer, N.B., Lee, H-S, & Kam, R. (2002). Technology-rich inquiry science in urban classrooms: What are the barriers to inquiry pedagogy? *Journal of Research in Science Teaching*, 39 (2): 128-150.

Songer, N.B., Lee, H-S, & McDonald (2003). Research towards an expanded understanding of inquiry science beyond idealized standard. *Science Education*, 87: 490-516.

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