

Converting Problem-Based Learning to Standards-Based Assessment^{1,2}

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Introduction

The story of this research has a series of backdrops. One comes from long and somewhat painful experiences surrounding the rise, fall, and future of performance-based assessment, including multi-step constructed responses, portfolio documentation of accomplishment, and exhibitions. Because of technical shortfalls and costs of continued development, performance-based assessment was relegated to the classroom. The requirement for increased testing has elevated cost and efficiency as criteria despite policy commitments to raise academic challenge and measure results appropriately. With expanded accountability requirements, cost has become a major criterion in the development of many state examination systems. Moreover, meeting annual proficiency targets has resulted in attention to alignment for tests and their formats, more often than to the standards, domains, or constructs the tests are intended to sample. Thus, even the relegation of performance-based assessment to classrooms has been challenged by benchmark tests intended to predict state examination outcomes and focused curriculum that is to attend to state test requirements.

An additional context is after-school programs. At the National Center for Research on Evaluation, Standards, and Student Testing (CRESST), we have been evaluating the progress of LA's BEST, an after-school program focused on enrichment, adult mentoring, and the safety of children in schools located in unsafe Los Angeles neighborhoods. In recent times, after-school endeavors have been directed to focus more on improving student achievement.

Also, there is the belief that children's learning should be focused early on the acquisition of separate skills (i.e., sounds, graphemes, and the like). At UCLA's Corinne A. Seeds University Elementary School (UES), we have observed a program that has taken young children's interests and created integrated experiences that include particular domain-independent skills, such as metacognitive skills, planning, self-checking, problem solving, communication, and teamwork, as well as domain-specific skills. UES has actualized the CRESST model of cognitive demands in their programs (see Figure 1) through the use of problem-based and project-based learning.

This study intended first to investigate the degree to which problem-based and project-based learning as instructional methodologies could be transferred to an elementary school setting with far fewer instructional resources, students from diverse backgrounds, and an after-school program. Second, we intended to determine whether it was possible to infer systematically domain-independent performance in problem-based learning (PBL) situations.

¹ The work reported herein was supported by LA's BEST, Los Angeles, CA. The findings and opinions expressed in this report do not reflect the positions or policies of LA's BEST.

² We are thankful to the teacher at the LA's BEST school, her students, and LA's BEST leadership; and to the staff, principal, and children at Corinne A. Seeds University Elementary School (UES) at UCLA.

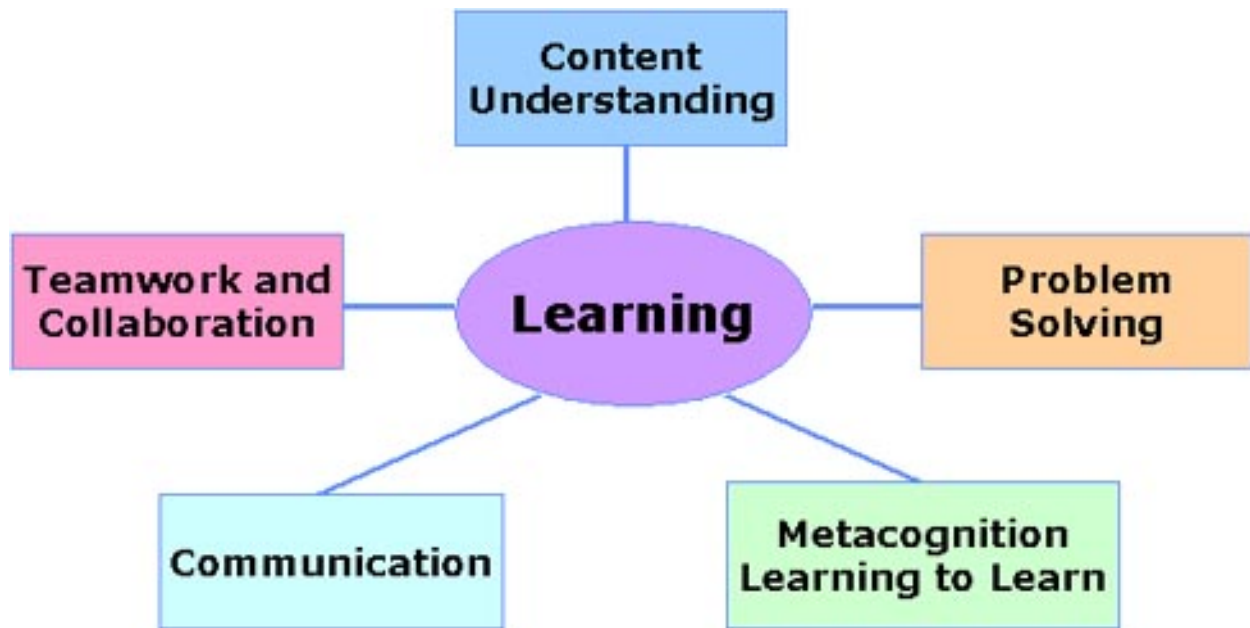


Figure 1. CRESST Model-based assessment.

Goals

Specifically, in a collaboration among the LA’s BEST After-School program, CRESST at UCLA, and the UCLA Corinne A. Seeds University Elementary School (UES), we decided to explore the following questions:

1. Could the complex, integrative learning program for young children used at UES be transferred into an after-school program populated by children from lower-income, lower-performing schools? Would their outcomes be comparable to those of UES students?
2. Could outcomes be inferred from problem-based and project-based learning with domain-dependent content?
3. Would domain-independent components be identified in student work, by the teacher, and by the researchers so that it could be argued that similar experiences were productive for after-school or other lower-performing students?
4. On a longer term basis, could quantification of such performance create more acceptance for integrated learning?

Impetus: How Did We Start? SO-SO SMOOTHIE, SO-SO GOOD!

Four-year-olds at UES in 2004 made smoothies in their classroom as part of their routine weekly cooking activities and as part of a science project looking at physical properties of matter (e.g., liquids, solids, etc.). After tasting the smoothie, one child said, “This is soooo good, we should take it out to the world and sell it!” This led to the children’s inspiration to make smoothies for the whole school, and the desire to charge for their product. Just how they would do this became a class problem to be solved. The children were taken to a campus food service center and given samples of smoothies to taste. The field trip served as part of the investigation process needed to solve their problem. The children developed the advertising slogan (SO-SO SMOOTHIE, SO-SO GOOD!), and after collaboratively preparing a script and practicing, they

visited all classrooms up through sixth grade, announcing the Smoothie day and explaining the time and price.

To get ready, the entrepreneurs developed a sign and a rotation of teams to make smoothies, serve smoothies, take money, make change, and collect used cups. Parents and friends provided ingredients and extra blenders. The children developed an architectural floor plan for the smoothie station and constructed it with blocks. Tie-dye skirts were created and tacked up around the service area, as were decorations. Safety and cleanliness were practiced, and on the Smoothie day, the children sold \$211 worth of smoothies (not counting what they had consumed). They counted the money on the floor at the end of the day, with one group assembling dimes into tens, nickels into twenties, etc. A heated discussion ensued about what to do with the money—more Smoothie days, more art supplies—but in the end, with no teacher prompting, they decided to give the money to children who needed it, to Para Los Niños, a well-known Los Angeles group serving low-income children. What do you think the children learned from this experience?

The Teacher's Description of the Project at UES

In some ways the smoothie project was something that naturally came from the children. They wanted to sell it to the world, this was the problem, so the children needed to figure out how to scale it down. They needed to work on this project together in order to solve it. At this point in our school year, the children had learned how to take on a project and work on it over time (learned, for example, through reading stories over and over, and through painting experiences that involved layering; and they had also learned how to work collaboratively). These were skills that were already in place. The children were involved in the discussion, brainstorming, planning, and implementation of the whole process. I raised questions such as:

- Who should we invite?
- Why are we doing the smoothie project? (Trying to figure out a purpose.)
- What will we be doing with the money?
- How much should we charge people?
- What will we need to let people know about our project?
- How can we let people know what ingredients we are using? (In case some people are allergic.)
- How and where can we set up our smoothie station?
- What will we call it?

Based on our discussions, we came up with different groups for children to get involved in. I introduced new vocabulary about how architects make a floor plan before they build something, and what advertisers do to let people know about their product, etc.

Before our brainstorming on how to organize our smoothie station, we had taken a field trip to UCLA's smoothie vendor to see how things operate in a real-life situation. The children got to taste a variety of smoothies, and decided on what ingredients they wanted to put in their own smoothies. After our return, we talked about what the children saw. They began to work collaboratively on the advertisement committee (using both written and computer advertisements), on the planning of the station (doing a floor plan of what the station would look like), on the ingredients committee, on the painting-our-

posters committee, and on the going-around-the-campus-to-post-the-flyers committee as well as to announce it to our customers.

What types of learning were the children involved in?

- The children were involved in art through the painting and the designing of the posters.
- They were involved in literacy through writing down the smoothie ingredients, and the text for the posters and flyers.
- They were involved in science through making the smoothie and seeing the various solids and liquids coming together and creating something new—different consistency, color, etc.
- They learned that their ideas are important and can be turned into reality.
- They learned how to collaborate and work with others.
- They were all part of the discussion and problem solving that went on throughout the process.
- They learned business skills of buying and selling, as well as customer service skills (which we discussed ahead of time).
- They were involved in math when they had to count all the money that they had gotten from their sales.

As a teacher, my job was to provide an experience that was interesting and intriguing, pose questions, provide materials to support the children's learning, and also provide real-life experiences that would deepen their understanding of the projects they undertook within the classroom.

At UES, these children also participated in a comparable long-term project involving science, art, and problem solving focused on plants, different designs and conditions for growth (actual experiments), and individual and collective art projects.

Procedures

LA's BEST identified a school where we could conduct the exploratory study. The UES teacher observed in the classroom and worked collaboratively with the LA's BEST After-School teacher to develop skills involving students' performance.

The UES teacher's observations of the LA's BEST work included the general areas of expertise, the specific skills developed, the modifications required for the setting, and her experience working with the LA's BEST teacher. The task was to create and perform a play.

Preparation for the study required several weeks, where building relationships with the after-school teacher and getting to know the children and setting, were the main elements. The project activity at the LA's BEST school continued for eight weeks.

Teacher's Comments on Her Work With the After-School Program

We again used children's ideas to fuel the project, which was to create and perform a play. The children wrote the story, they edited, revised and added to it. They learned their lines and divided into various groups to make the props, flyers, posters, tickets, etc. They collaborated, problem solved, and used their ideas, creativity, and imagination in the whole process.

We began by concentrating on oral narratives. I wanted the children to learn a structure for books and important aspects of a story—such as characters, setting, beginning/middle/end. I also wanted them to learn that stories have problems that usually get resolved in the end. We read a lot of different stories, as well as acted some out. I wanted them to hear great language, to hear different examples of books that had many of the features that I was talking about. Also, I wanted them to draw and visualize some of these aspects in their sketchbooks.

After our discussions, I wanted them to create stories with the variety of elements that we had investigated in the books (beginning/middle/end, problem that gets resolved). Each child created his or her own story by dictating it to an adult. I also took the children through the development process by taking one of the stories that a child had written, and developing it based on questions raised by the group (other things they wanted to learn more about in the story). They also had to take it to the next level: transform the story into a script, and develop all the steps to put on the play—decide who will be what character, rehearse their acting skills, make props and costumes, create banners and flyers, make and count tickets for the audience, etc.

In summary, specific skills were connected to the topic: drawing, writing narratives, listening to stories and dissecting structure, discussing characters and setting, and turning a narrative into a play.

Modification for LA's BEST Context

The LA's BEST setting, unlike UES, was an after-school environment and required sharing of space. The target age group was first graders (6-year-olds) compared with the 4- and 5-year-olds at UES.

Instead of a UES classroom, the setting was a standard LAUSD multipurpose room. As such, this physical environment provided little of the visual or auditory stimuli that would spark children's imagination (environment set up is a critical part of PBL). Their prior art experience consisted mostly of theme-based arts and crafts activities. During the time of our observations, they had not worked on activities over time, and the CRESST team didn't know what their abilities were in carrying through something over an extended period. We introduced some projects to develop some of these skills (e.g., paintings, which they would come back to repeatedly). We (the After-School teacher and I) planned some of the direction, and the children fueled the process. The children didn't come up with the idea of a play (since many of them were not familiar with this concept), but as we got involved in the process of turning books into a play, and later transforming their own writing into a play, they became more familiar and really interested in the idea of turning their big story into a play. We gave comparatively more direction than I would have normally done in a PBL at UES. The children were slow to warm up at first on sharing their ideas, but by the end of the project they felt very comfortable voicing them. So they learned through the process the importance of expressing their ideas and ways they can be the driving force of learning.

The best part about working with the teacher was that she was open and willing to learn. To facilitate the PBL process, we needed to develop a trusting relationship with her. So the beginning couple of weeks were really critical in building this bridge. Sharon (a pseudonym) initially did not practice a wide variety of instructional strategies. We worked together on gradually developing a more flexible structure, moving children around, using the space differently, and having the children in a group rather than in their separate, individual seats. We also worked together in planning the week—which assisted her in continuing the project

activities when the CRESST team was not there. Her input on what we could do in relation to the project was one of the most important parts of planning. For example, her ideas from a workshop she had taken on acting and role playing contributed significantly to the activities of the project. She really felt empowered and this was an important goal.

We developed strategies to help children layer work (start and add, continuing to refine and improve) and have them work on something over time. Having Sharon reading to the children every day was important. Also, we created a structure to the day that the children enjoyed and that benefited student learning (which made our job much easier). So we were working with someone who was smart and enthusiastic and got into the process. She was not initially aware of PBL, but she was open and willing to learn. The modeling and planning were the critical part of our work together.

Analysis

The research team at CRESST analyzed the tasks carried out by the children. First, it was clear that the student tasks fit within the CRESST Model-Based Assessment design. Illustrations of the analyses are reported below.

Domain-Independent and Domain-Dependent Illustrative Skills

The projects carried out by the children enabled them to learn skills that are domain independent (i.e., skills that transfer across domains), and domain dependent (i.e., skills that are specific to the particular project and that are more related to specific content). Below we offer a few examples of each:

- Domain independent
 - Collaborative work skills (e.g., teamwork, negotiation). For example, children learned to work in teams by editing their stories as a group; they collaborated in painting a big mural with the title of their play; they negotiated what roles they would each perform.
 - Metacognitive skills needed for a long-term project (e.g., planning, self-assessment, feedback). For example, children were involved in planning their play, from the initial story writing to the final performance; they thought about the steps along the way, and the phases they need to complete.
 - Communication skills to understand and express a wide variety of feelings and ideas. For example, the children were actively involved in asking questions in order to expand the original story line, in communicating with each other about their projects, and in expressing feelings verbally and non-verbally through their performance.
- Domain dependent
 - Language of theater (e.g., audience and actors, lines and script)
 - Dictating their own stories and enriching and editing these stories in order to derive a script that could be used to put on a play
 - Story structure (beginning, middle, and end; conflict, characters)
 - Painting with tempera and pastels, collage work (e.g., using beads, colored paper, pieces of foam, etc., to add texture to a painting)

California Content Standards Grade 1

A second analysis was done to map the skill-set of the project to the articulated (but only partially measured) skills that the California Content Standards expect children to develop in Grade 1 (California Department of Education, 1998, 1999, 2000, 2001). The project helped the children develop most of the skills outlined in the state content standards for theatre, visual arts, dance and movement, literacy and English language. The project also touched upon many important music, math and social science/collaborative work skills.

Literacy and English Language Skills

- Identify and describe the elements of plot, setting, and character(s) in a story, as well as the story's beginning, middle, and ending.
- Describe the roles of authors and illustrators and their contributions to print materials.
- Recollect, talk, and write about books read.
- Regarding a text that they have read or heard:
 - Respond to *who, what, when, where, why, and how* questions.
 - Use context to resolve ambiguities about word and sentence meanings.
 - Relate prior knowledge to textual information.
 - Retell the central ideas of simple expository or narrative passages.
 - Listen attentively.
 - Ask questions for clarification and understanding.
- Select a focus when writing.
- Use descriptive words when writing.
- Write brief narratives (e.g., fictional, autobiographical) describing an experience.
- Write brief expository descriptions of a real object, person, place, or event, using sensory details.
- Recite poems, rhymes, songs, and stories.
- Retell stories using basic story grammar and relating the sequence of story events by answering *who, what, when, where, why, and how* questions.
- Relate an important life event or personal experience in a simple sequence.
- Provide descriptions with careful attention to sensory detail.

Math Skills

- Count, read, and write whole numbers to over 300.
- Count and group objects in tens.

Social Sciences Skills and Skills for Collaborative Work

- Understand the elements of fair play and good sportsmanship, respect for the rights and opinions of others, and respect for rules by which we live.
- Collaborate with others in order to solve a problem or develop a project.

Dance/Movement Skills

- Demonstrate the ability to vary control and direct force/energy used in basic locomotor and axial movements (e.g., skip lightly, turn strongly, fall heavily).
- Name basic locomotor and axial movements (e.g., skip, slide, stretch, roll).
- Perform simple movements in response to oral instructions (e.g., walk, turn, reach).
- Use improvisation to discover movements in response to a specific movement problem (e.g., find a variety of ways to walk; create five types of circular movement).
- Respond in movement to a wide range of stimuli (e.g., music, books, pictures, rhymes, fabrics, props).
- Create a short movement sequence with a beginning, a middle, and an end.
- Create shapes and movements at low, middle, and high levels.
- Imitate simple movement patterns.
- Express basic emotional qualities (e.g., angry, sad, excited, happy) through movement.
- Perform improvised movement ideas for peers.
- Work with others in a group to solve a specific movement problem (e.g., design three shapes high, medium, and low; create slow and fast movements).

Music Skills

- Sing with accuracy in a developmentally appropriate range.
- Sing age-appropriate songs from memory.
- Improvise simple rhythmic accompaniments, using body percussion.

Theatre Skills

- Develop and use the vocabulary of the theatre, such as play, plot (beginning, middle, and end), improvisation, stage, character, and audience, to describe theatrical experiences.
- Observe and describe the traits of a character.
- Demonstrate skills in pantomime, tableau, and improvisation.
- Dramatize or improvise familiar simple stories from classroom literature or life experiences, incorporating plot (beginning, middle, and end) and using a tableau or a pantomime.
- Identify theatrical conventions, such as props, costumes, masks, and sets.
- Describe the roles and responsibilities of audience and actor.
- Describe what was liked about a theatrical work or a story.
- Identify and discuss emotional reactions to a theatrical experience.
- Demonstrate the ability to work cooperatively in presenting a play.

Visual Arts Skills

- Describe and replicate repeated patterns in nature, in the environment, and in works of art.

- Distinguish among various media when looking at works of art (e.g., clay, paints, drawing materials).
- Identify the elements of art in objects in nature, in the environment, and in works of art, emphasizing line, color, shape/form, and texture.
- Students apply artistic processes and skills, using a variety of media to communicate meaning and intent in original works of art.
- Use texture in two-dimensional and three-dimensional works of art.
- Mix secondary colors from primary colors and describe the process.
- Demonstrate beginning skill in the manipulation and use of sculptural materials (clay, paper, and papier-maché) to create form and texture in works of art.
- Plan and use variations in line, shape/form, color, and texture to communicate ideas or feelings in works of art.
- Draw or paint using secondary colors.
- Use visual and actual texture in original works of art.
- Create artwork based on observations of actual objects and everyday scenes.

Implications and Next Steps

Measurement Issues

The study, from a teacher and researcher perspective, provided documentation that PBL can focus on cognitive skills that are domain independent. Consistent with the CRESST model (Baker, 1997; Baker, Freeman, & Clayton, 1991; Baker & Niemi, 1996; Niemi, 1997), children's work can be assessed formatively during instruction and summatively to document their learning. We have previously been limiting the number of cognitive demands in tasks for young children to specific measures. The natural mapping of this work to our models (the teachers had no explicit training or preparation in our measurement work) suggests that (a) incorporation of skills in examples that build student competence should be a comfortable transition for teachers and needs to be verified by a credible sample; (b) our work in developing a computer-based system that includes cognitive demands and scenario development should be tried with young children (Niemi, 1996; Vendlinski & Stevens, 2000); and (c) the argument can be made and empirically verified that PBL and PBA can be used in the service of assessing standards. This argument was partially advanced in the analysis of contributions of cognition and technology to assessment design and its validity (National Research Council, 1991).

Next Steps

We intend to implement aspects of PBL/PBA in assessment development for middle school mathematics in the new CRESST multiyear experimental study. We will be assessing the degree of acquisition and performance of content-specific knowledge, measured on state examinations, as well as transfer skills to be measured on assessments of the same skills in different task and format contexts (e.g., the performance on assessments from the United Kingdom or PISA). We are also interested in pursuing the development of after-school professional experiences so that children will have integrated experiences of the sort we have described. Our prior analyses have documented the importance of regular attendance (at after-school programs and in regular school) to students' performance (Huang, Choi, Henderson, Howe, Kim, Vogel, Waite, & Yoo, 2004; Huang, Gribbons, Kim, Lee, & Baker, 2000). We will be seeking support for this research.

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