Using project based learning to teach 21st century skills: Findings from a statewide initiative

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ABSTRACT

This sought to determine the effect of project based learning (PBL) professional development and implementation on teachers' perceived ability to teach and assess 21st century skills. At the end of the 2010-2011 school year, data on teaching practices and perceptions were systematically gathered and compared from two groups of teachers matched by demographics, grade and subject: teachers expected to have utilized PBL after extended professional development (44) and teachers who had not received the professional development or were not expected to have used PBL (42). Teachers who used PBL and received extensive professional development reported more teaching and assessment of 21st century skills overall, with similar patterns seen within subjects and for nearly all of the measured skills.

OBJECTIVE & PURPOSES

This study focused on the impact of a weeklong summer professional development institute to help teachers develop effective PBL lessons emphasizing student development of 21st century skills. Teaching of 21st century skills was also emphasized in other state initiatives, meaning that teachers in general (not only PBL teachers) were expected to teach these skills.

The research questions addressed in this paper are as follows:

1. Do teachers who have used PBL with extensive professional development teach and assess 21st century skills to a greater extent than teachers who have not had similar professional development or do not use PBL?

2. How is PBL use and teaching of 21st century skills influenced by other variables -- such as subject and grade, class achievement level, block scheduling, etc.?

The researchers hypothesized that teachers who used PBL with extensive professional development would be more likely to effectively teach and assess 21st century skills. In addition

we sought to describe how teaching practices and perceptions vary and to identify empirically and conceptually distinct self-report measures for use in future research.

PERSPECTIVES/THEORETICAL FRAMEWORK

This study is important because it tracks an ambitious initiative to transform a relatively poor rural state into a state of 21st century teachers and learners. The largely rural state in which this study was conducted is one of the early Partnership for 21st Century Skills states and provides a test case for what other states are trying to do. For example, in a nearby state there is a similar initiative, with similar aspirations. "If northeast Indiana can engage thousands of its students in the higher-order thinking fostered by the approach, it will be well positioned not only to fill the jobs needed, but also to attract new ones" (Francisco, 2011).

This work is of interest because it attempted to scale up teaching reforms at a statewide level. It is an important theoretical question how widespread specific reform practices can become. The effort we studied sought to change teaching and learning not just in leading edge schools, for example as highlighted by the Alliance for Excellent Education (2011, p. 4), but also in "in high-poverty schools…with persistent achievement gaps" (The William and Flora Hewlett Foundation, 2010, p. 7). Our findings help address whether, despite some findings to the contrary (Camburn & Won Han, 2008), reform practices can be effectively used with all students, not just the advantaged (Boaler, 2002). This contribution ties theoretical concerns directly to practice and will inform the work of others.

Project based learning

Project-Based Learning (PBL) provides opportunities for students to learn deep content knowledge and 21st century skills. While PBL practices vary depending on grade level and subject area, projects should allow for some degree of student voice and choice, and should be carefully planned, managed, and assessed to connect rigorous academic content to 21st Century Skills (such as collaboration, communication & critical thinking) through student development of high-quality, authentic products and presentations (e.g., Mergendoller, Markham, Ravitz & Larmer, 2006).

Framework of 21st Century Skills

Our concept of 21st century teaching practices and skills is similar to the William and Flora Hewlett Foundation (2010) concept of "deeper learning" and "student-centered pedagogies" that include

> Models of teaching and learning that are project-based, collaborative, foster knowledge building, require self-regulation and assessment, and are both personalized (allowing for student choice and relevance to the individual student) and individualized (allowing students to work at their own pace and according to their particular learning needs). Each of these elements has a strong base of prior research linking it to positive outcomes for students in terms of development of 21st-century skills; see, for example, Bransford, Brown, & Cocking, 1999; Darling-Hammond et al., 2008.)" (In Shear, Novais, Means, Gallagher & Langworthy, 2010, p. 3)

These sources and several others provided the basis for conceptualizing and measuring the following skills, as shown here in Figure 1.

Figure 1. Definitions of 21st Century Skills

(CT) CRITICAL THINKING SKILLS refer to students being able to analyze complex problems, investigate questions for which there are no clear-cut answers, evaluate different points of view or sources of information, and draw appropriate conclusions based on evidence and reasoning (9 items, alpha = .90)

(CO) COLLABORATION SKILLS refer to students being able to work together to solve problems or answer questions, to work effectively and respectfully in teams to accomplish a common goal and to assume shared responsibility for completing a task (9 items, alpha =. 94)

(CM) COMMUNICATION SKILLS refer to students being able to organize their thoughts, data and findings and share these effectively through a variety of media, as well as orally and in writing (8 items, alpha = .93)

(CR) CREATIVITY AND INNOVATION SKILLS refer to students being able to generate and refine solutions to complex problems or tasks based on synthesis, analysis and then combining or presenting what they have learned in new and original ways (8 items, alpha = .94)

(S) SELF-DIRECTION SKILLS refer to students being able to take responsibility for their learning by identifying topics to pursue and processes for their own learning, and being able to review their own work and respond to feedback (10 items, alpha = .95)

(G) GLOBAL CONNECTIONS refers to students being able to understand global, geo-political issues including awareness of geography, culture, language, history, and literature from other countries (9 items, alpha = .96)

(L) LOCAL CONNECTIONS refers to students being able to apply what they have learned to local contexts and community issues (8 items, alpha = .95)

(U) USING TECHNOLOGY AS A TOOL FOR LEARNING refers to students being able to manage their learning and produce products using appropriate information and communication technologies (11 items, alpha = .95)

See Appendix A for full list of items with descriptive data.

METHODS

This study was undertaken with support from the Office of Research (OR), and in collaboration with the Office of Instruction (OI) at a state department of education. It uses a quasi-experimental design with systematic selection and verification of PBL users with extended professional development, and the comparison group.

The survey methods selected were believed to be the least obtrusive way of collecting the required data. An online survey was sent by the OR, followed by personal emails and faxes to schools. Communications with study participants followed Dillman (2000), including multiple contacts and a "social" incentive of a $15 gift certificate to be awarded randomly to one out of every three respondents.

DATA SOURCES/ EVIDENCE

Researchers worked with the OI to identify potentially strong PBL-using teachers, based on surveys at the end of extended professional development offered in weeklong summer institutes during two consecutive summers. After considering data from 600+ teacher attendees, 60 were identified who had successfully published a project in the state's peer-reviewed project

library, whose surveys indicated they had used PBL for at least a year, and who seemed likely to continue using PBL as a substantial part of their academic teaching. Selected teachers taught math, social studies, science or English in grades 4-11. The list of PBL teachers was provided to the OR, who identified a comparison group of teachers matched based on demographics, grade and subject taught.

We received completed responses from 38 out of 44 PBL teachers (86%) and 24 out of 42 Matched teachers (57%), for an overall response rate of 72%.

Before analyzing data we validated whether teachers should be in PBL group or not. We recoded PBL teachers who said they did not use PBL or receive extended professional development. We also recoded Comparison teachers who said they did use PBL, sometimes with limited professional development (a few days). This produced three categories for analysis: No PBL, PBL with limited PD, and PBL with extended PD.

The conceptualization of the skills and many of the survey items came from the international Innovative Teaching and Learning study (Shear, Novais, Means, Gallagher & Langworthy, 2010). We wrote new items and re-used items based on the reliability reported by Novais & Gallagher (2010) and in personal communications with Gabriel Novalis (April 27, 2011). We also looked at the drafts of instruments from The William and Flora Hewlett Foundation (2010) as well as older studies including a survey from Chicago Public Schools.

Before answering questions about their teaching practices, teachers provided background information and verified their eligibility. They also selected a target course, and a target class in which they felt their practices, including PBL use, if applicable, was most effective. Teachers answered the survey with this "target class" in mind.

The survey asked about the frequency of 5 to 8 practices specifically pertaining to each 21st Century skill, e.g., having students work in groups to support collaboration. Response choices were 1 'Almost never'; 2 'A few times a semester'; 3 '1-3 times per month'; 4 '1-3 times per week'; 5 'Almost daily'.

In addition to the frequency of different practices, we asked how much teachers perceive themselves as having taught and assessed each skill, for example:

a. I have tried to develop students' critical thinking skills

b. Most students have learned critical thinking skills while in my class

c. I have been able to effectively assess students' critical thinking skills

Response choices were 1 'Not really'; 2 'To a minor extent'; 3 'To a moderate extent'; 4 'To a great extent', 5 'To a very great extent'.

Practice and perception items were highly correlated within each skill, contributing to an overall index for each skill with strong reliability (standardized alpha = .90 or greater, with inter-item correlations all above .58. The items with the lowest communalities (corrected item total correlations) were the global connections skills, having students work in pairs or small groups and students using technology to keep track of their work.

Factor analysis tended to verify that the instrument was measuring different constructs. The last four skills -- global connections, local connections, self-direction and technology use skills -- emerged cleanly as four different factors. However, critical thinking, creativity, collaboration and communication items were less empirically distinct. Sometimes these conceptually grouped items loaded on their own factor, but there were exceptions. For example, having students convey ideas using media other than a written paper, while originally intended as communications skill sometimes loaded with technology skills. We can use this information to refine and shorten the indices in the future.

The current analyses use broad indices, but subsequent analyses will try to tease apart practices and perceptions. We hope that an outcome of this study will be a set of "distinct and

succinct" indicators for teaching of 21st century skills and identification of sub-dimensions (e.g., two types of critical thinking) if any are evident.

Finally, the survey asked teachers about their target class including, for example, indicators of academic press (e.g., hours of homework), the general level of student academic performance, and whether they had block scheduling. Only results for academic performance of the class have been analyzed so far and are reported here.

RESULTS

Teachers who used PBL and received extended professional development reported more teaching and assessment of 21st century skills overall (Table 1), with substantial and statistically significant effect size differences between the groups.

Table 1. Comparison of 21CS teaching by use of PBL, overall

PBL Category	N	Mean 21CS Index (Z score)	S.d.	ANOVA p <
No PBL emphasis or use	21	-.59	1.02	.001
Used PBL, with limited PD	17	-.05	.72	
Used PBL, with extended PD	24	.56	.86	
Totals	62	.00	1.00	

Similar patterns were seen for all four core academic subjects, with statistically significant differences in math (N=23, p < .01). In addition, this pattern was seen for all the indices of 21st century skills except for global connections (Table 2), which was predominantly reported by social studies teachers.

Table 2. Comparison of 21cs teaching by PBL use, indices

Skills Index	No PBL emphasis or use (N=21)	PBL limited PD (N=17)	PBL extended PD (N=24)	Total S.D.	Effect Size (Column 3 - Column 1)	ANOVA p <
Critical thinking	-.38	-.07	.38	.76	1.01	.002
Collaboration	-.48	-.16	.55	.83	1.24	.001
Communication	-.56	-.08	.55	.82	1.34	.001
Creativity	-.46	-.14	.50	.84	1.15	.001
Self-direction	-.43	.00	.38	.82	.98	.005
Global skills	-.16	.20	-.02	.87	.17	(NS)
Local connections	-.35	-.11	.39	.87	.85	.01
Using technology	-.47	-.01	.42	.82	1.08	.001
Totals	0.00	0.00	0.00	0.00	0.00	

Concerning the equitable distribution of reform practices, teaching of 21st century skills was evenly distributed regardless of teachers' ratings of student academic performance in their target class (Table 3). If anything, classes with students "at the expected level" had the fewest opportunities to learn these skills, with no difference between those who taught classes with students characterized as academically behind or ahead of most students.

Table 3. Comparison of 21CS teaching by class academic performance

Students whose academic performance is at…	Mean 21CS Index (Z-score)	N	S.d.	ANOVA p <
At the expected level	-.30	25	1.04	NS, (.15)
Behind most students	.23	13	1.02	
Ahead of most students	.20	22	.93	
Totals	.00	60	1.02	

Forthcoming analyses will address what other variables, for example block scheduling, help predict teaching practices and perceptions, as well as which skills teachers most frequently taught, and assessed and which practices teachers used.

DISCUSSION

Reforms in this state are intended to address the needs of some of the nations least-funded and lowest performing schools. It is important to see that teachers of students with a range of student academic performance can implement PBL as a way to teach and assess 21st century skills without sacrificing academic rigor. The findings suggest that PBL use with professional development can have an impact on 21st century teaching and learning.

The study identifies skills that teachers considered most teachable. These findings are useful in teasing apart these skills and how PBL use allows them to be taught more effectively.

Finally, all of the "PBL with extended professional development" teachers indicated that they had helped provide professional development to other teachers, compared to 33% of the PBL with limited professional development group. This finding about teachers in the most intensive PBL-using group offering professional development to others echoes findings from other studies suggesting that teacher professional engagement is a key predictor of teaching reforms (e.g., Riel & Becker, 2008). This is a concern because it suggests the PBL teachers may be already involved in reforms for reasons other than their PBL use. On the other hand, enthusiasm of early adopters and their providing support to others is important for scaling up any initiative. Future studies might use probability sampling to avoid the problem of having teachers with extremely strong "professional engagement" over-represented or include analyses that control for this variable. More careful attention to this issue will help provide an even better test of the effectiveness of PBL use for teaching 21st century skills.

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APPENDIX A. Practices for each skill with mean, standard deviation and min/max

In your teaching of your TARGET CLASS, how often have you asked students to do the following? (1 'Almost never'; 2 'A few times a semester'; 3 '1-3 times per month'; 4 '1-3 times per week'; 5 'Almost daily'. S)

		Mean	S.d.	MIN/ MAX
CT	Compare information from different sources before completing a task or assignment?	2.92	1.18	
CT	Draw their own conclusions based on analysis of numbers, facts, or relevant information?	3.97	0.96	2/5
CT	Summarize or create their own interpretation of what they have read or been taught?	4.03	0.89	2/5
CT	Analyze competing arguments, perspectives or solutions to a problem?	3.39	1.00	
CT	Develop a persuasive argument based on supporting evidence or reasoning?	2.97	1.12	
CT	Try to solve complex problems or answer questions that have no single correct solution or answer?	3.34	1.09	
CO	Work in pairs or small groups to complete a task together?	4.21	0.83	2/5
CO	Work with other students to set goals and create a plan for their team?	3.28	1.08	
CO	Create joint products using contributions from each student?	3.24	1.15	
CO	Present their group work to the class, teacher or others?	3.03	0.96	
CO	Work as a team to incorporate feedback on group tasks or products?	2.95	1.12	
CO	Give feedback to peers or assess other students' work?	2.87	1.11	
CM	Structure data for use in written products or oral presentations (e.g., creating charts, tables or graphs)?	2.82	1.11	
CM	Convey their ideas using media other than a written paper (e.g., posters, video, blogs, etc.)	2.66	1.07	
CM	Prepare and deliver an oral presentation to the teacher or others?	2.44	0.95	
CM	Answer questions in front of an audience?	3.03	1.34	
CM	Decide how they will present their work or demonstrate their learning?	2.71	1.00	
CR	Use idea creation techniques such as brainstorming or concept mapping?	2.97	1.12	
CR	Generate their own ideas about how to confront a problem or question?	3.35	1.09	
CR	Test out different ideas and work to improve them?	2.95	1.15	
CR	Invent a solution to a complex, open-ended question or problem?	2.61	1.01	
CR	Create an original product or performance to express their ideas?	2.57	1.09	

APPENDIX A. Continued…

		M	S.d.	Min/ Max
S	Take initiative when confronted with a difficult problem or question?	3.42	1.17	
S	Choose their own topics of learning or questions to pursue?	2.32	1.07	
S	Plan the steps they will take to accomplish a complex task?	2.95	1.21	
S	Choose for themselves what examples to study or resources to use?	2.65	1.17	
S	Monitor their own progress towards completion of a complex task and modify their work accordingly?	2.81	1.23	
S	Use specific criteria to assess the quality of their work before it is completed?	2.89	1.22	
S	Use peer, teacher or expert feedback to revise their work?	3.11	1.33	
G	Study information about other countries or cultures?	2.37	1.19	
G	Use information or ideas that come from people in other countries or cultures?	2.18	1.08	
G	Discuss issues related to global interdependency (for example, global environment trends, global market economy)?	2.35	1.24	
G	Understand the life experiences of people in cultures besides their own?	2.44	1.22	
G	Study the geography of distant countries?	1.88	1.18	
G	Reflect on how their own experiences and local issues are connected to global issues?	2.54	1.21	
L	Investigate topics or issues that are relevant to their family or community?	2.63	1.16	
L	Apply what they are learning to local situations, issues or problems?	2.74	1.19	
L	Talk to one or more members of the community about a class project or activity?	1.90	0.94	
L	Analyze how different stakeholder groups or community members view an issue?	1.87	1.00	
L	Respond to a question or task in a way that weighs the concerns of different community members or groups?	1.92	1.00	1/4
T	Use technology or the Internet for self-instruction (e.g., Kahn Academy or other videos, tutorials, self-instructional websites, etc.)?	2.94	1.32	
T	Select appropriate technology tools or resources for completing a task?	3.27	1.16	
T	Evaluate the credibility and relevance of online resources?	2.63	1.30	
T	Use technology to analyze information (e.g., databases, spreadsheets, graphic programs, etc.)?	2.92	1.22	
T	Use technology to help them share information (e.g., multi-media presentations using sound or video, presentation software, blogs, podcasts, etc.)?	2.82	1.26	
T	Use technology to support team work or collaboration (e.g., shared work spaces, email exchanges, giving and receiving feedback, etc.)?	2.48	1.29	
T	Use technology to interact directly with experts or members of local/global communities?	1.77	1.12	
T	Use technology to keep track of their work on extended tasks or assignments?	2.69	1.38	

Low N=60 out of 62. Min/Max = 1/5, unless noted