Title: A multifaceted examination of deeper learning in PBL elementary schools: school culture, critical thinking, and access to opportunity

Word count excluding reference list, tables, and figures: 989

Abstract

Context

> Healthy reform would develop a cadre of well-trained teachers who are bolstered by access to ample learning tools and other resources. These teachers . . . would move forward with a deep understanding of students' diversity. . .these educators would work to ensure that all students have equal opportunities to learn. (Carter & Welner, 2013, p. 226).

At the nexus of pedagogy, school culture, and access to opportunity there is potential to build an educational system that will work for all students and address the "educational debt" (Gloria Ladson-Billings, 2006) accumulated from centuries of inequitable education. Increasing access to student-centered approaches, specifically project-based learning as a vehicle for deeper learning, is a pathway for creating more equitable schools. To facilitate the spread of student-centered approaches, schools need to be able to measure, monitor, document, and communicate the impact. This demand for evidence of efficacy not only comes from policy and regulation, but also from parents/guardians and community stakeholders (NEA, 2008; PACER, 2011; Schneider & Buckley, 2002).

Background

Project-based learning

Evidence has accumulated over the years attesting to the effectiveness of the PBL approach in a myriad of contexts (Mergendoller, Maxwell, & Bellisimo, 2006; Holm, 2011; Han, Capraro, & Capraro, 2014; Duke, Halvorsen, & Strachan, 2016). Continued interest in PBL is spurred from use to address the opportunity gap and enable all students to have access to an enriching education that will prepare them for a constantly changing world. New Tech Network (NTN) is a part of the deeper learning network (William and Flora Hewlett Foundation, 2019) and has been the subject of significant research examining facets of deeper learning and PBL, including two recent projects undertaken by American Institutes for Research (AIR) documenting better academic and nonacademic outcomes (Zeiser et al, 2016) and NTN teacher practices associated with student agency (Zeiser, Scholz, & Cirks, 2018).

Research Question

This research examines the tools used to document the impact of a deeper learning instructional model built around PBL in public elementary schools nationwide.

This research is guided by the following questions:

1. How have elementary schools provided opportunities for students to develop deeper learning competencies and what is the relationship to student outcomes?
2. What tools can be leveraged for examining deeper learning in elementary schools?

It was hypothesized that the PBL instructional model would enable students to acquire deeper learning competencies while positively impacting school culture, and that the interaction

between access to deeper learning and positive school culture would impact overall student outcomes.

Setting

The research was conducted in subsets of 17 elementary schools with each phase including 6-7 elementary schools representing a diverse student population from the Northwest, Southeast, and Midwest of the United States. Schools were urban, rural, and suburban.

The individual school demographics range is displayed in Table 1.

Table 1
Participating Schools Demographics

	Min	Max
American Indian/Alaska Native	0	<1%
Asian or Asian/Pacific Islander	<1%	24%
Hispanic	3%	66%
Black	0%	40%
White	2%	90%
Hawaiian Nat./Pacific Isl.	0	<1%
Two or More Races	5%	7%
Free and Reduced Lunch	64%	100%

The sample size at each school was between 54 and 366.

Intervention

The elementary schools are implementing the NTN PBL model centered around pillars aligned to deeper learning (interpersonal, intrapersonal, PBL, and culture).

Research Design

An explanatory quantitative case study research design (Zainal, 2007) was used with design and statistical controls to account for school background factors when applicable.

Data Collection and Analysis

Data was collected during the AY 2017-18. Data sources included:

A. Pre/post design with Fall and Spring data collection:
    1. The Insight Assessment Educate Series developed by Facione (1990) for 4th grade with testing for statistical significance in the change scores.
B. Post-only Spring data collection:
    1. Youth Truth Student Experience Survey (YTSES) (Youth Truth, 2018) for grades 3-5 with comparative analysis using ordinal regression.

Findings

Critical Thinking

Individual difference scores document the change in scores from pretest to posttest for each individual student. Table 2 reports descriptive statistics for the OVERALL score in all Elementary School students who took both the pretest and the posttest (N=193). Change over time was evaluated for statistical significance using the GLM function in SPSS for Repeated Measures comparing pre- and post-test scores. No covariates were included in these analyses. Alpha was set at P<.05. Only cases that had both pre and post scores were included in any given analysis. The observed average gain from pretest to posttest was statistically significant [F(1,192) = 27.865, p<.000].

Table 2
Descriptive Statistics - Matched Pairs Sample (Elementary Schools)

	N	Range	Min	Max	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
Overall Skills Pretest	193	29	60	89	71.93	.348	4.838	23.407
Overall Score Posttest	193	26	64	90	74.18	.396	5.508	30.333
Valid N	193							

A comparison of mean scores demonstrated statistically significant gains from pretest to posttest for all six CT metrics in this NTN Elementary cohort: Analysis [F(1,192) = 20.959, p<.000], Inference [F(1,192)= 10.444, p<.001], Evaluation [F(1,192)= 23.558, p<.000], Numeracy [F(1,192)= 16.654, p<.000], Induction [F(1,192)= 22.873, p<.000], and Deduction [F(1,192)= 7.950, p<.005] (Table 3).

Table 3
Descriptive Statistics - CT Skill Metrics (Matched Pairs Sample)

	N	Range	Min.	Max.	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
Analysis Score Pretest	193	30	60	90	70.06	.379	5.260	27.669

Analysis Score Posttest	193	30	63	93	72.27	.417	5.795	33.586
								[F(1,192) = 20.959, p<.000]
Inference Score Pretest	193	31	60	91	75.35	.468	6.499	42.240
Inference Posttest	193	35	60	95	77.45	.510	7.079	50.113
								Inference [F(1,192)= 10.444, p<.001]
Evaluation Pretest	193	31	60	91	70.63	.448	6.223	38.723
Evaluation Posttest	193	34	60	94	73.14	.513	7.122	50.725
								Evaluation [F(1,192)= 23.558, p<.000]
Induction Score Pretest	193	32	60	92	73.24	.496	6.888	47.446
Induction Score Posttest	193	36	60	96	76.00	.518	7.200	51.833
								Induction [F(1,192)= 22.873, p<.000]
Deduction Score Pretest	193	28	60	88	71.05	.400	5.561	30.920
Deduction Posttest	193	32	60	92	72.60	.422	5.864	34.387
								Deduction [F(1,192)= 7.950, p<.005]
Numeracy Score Pretest	193	36	60	96	68.15	.496	6.897	47.562

Numeracy Posttest	193	40	60	100	70.78	.542	7.533	56.747
							Numeracy [F(1,192)= 16.654, p<.000]	

Table 4 below reports the descriptive statistics for Percentile Rank for the average Overall Critical Thinking Skills score at pretest and at posttest. Individual difference scores for national percentile were calculated to provide a more complete analysis of gains made by this NTN annual cohort in relationship to the national sample of Elementary School students. The NTN sample improved on average 9.1 percentile points when compared to benchmark performance of other elementary students in the US. The mean percentile rank at pretest was 31.52 and it rose to 40.61 at posttest representing a statistically significantly and highly meaningful educational gain [F(1. 192) = 25.987, p<.000].

Table 4
Descriptive Statistics Percentile Rank Change - Matched Pairs Sample

	N	Range	Min	Max	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
Percentile Rank Pretest	193	94	1	95	31.52	1.434	19.923	396.907
Percentile Rank Posttest	193	92	4	96	40.61	1.692	23.508	552.603
Percentile Rank Change	193	136	-57	79	9.09	1.783	24.767	613.414
Valid N (listwise)	193							

Culture

A series of ordinal regressions were used to assess differences between students' perceptions at New Tech schools and those at non-New Tech schools on the YTSES. Overall, students at New Tech schools rated statistically significantly higher than did students at non-New Tech schools on 16 items and lower on four items (Table 5).

Table 5
Ordinal Regression Results Summary Table

Factors	Items	t statistic NewTech	p-value	Odds Ratio
Student Engagement				
	Does your teacher want you to do your best?	**1.727**	**0.084***	**1.279**
	Does your teacher let you explain your ideas?	**4.378**	**1.20E-05*****	**1.267**
	Do you like coming to your class?	-3.742	1.83E-04***	0.820
Personal Relationships				
	Is your teacher fair to you?	**2.073**	**0.038****	**1.136**
	Does your teacher give you extra help if you need it?	**2.667**	**0.008*****	**1.154**
	Does your teacher tell you that you can do well if you work hard?	**2.416**	**0.016****	**1.164**
	Does your teacher treat you with respect?	**3.784**	**1.55E-04*****	**1.340**
	Do you like the way your teacher treats you when you need help?	0.379	0.704	1.025
Relevance				
	Do you think your teacher cares about you?	**4.769**	**1.85E-06*****	**1.415**
	Does what you learn in class help you outside of school?	1.586	0.113	1.080
	Does your teacher ask you about your life at home?	**8.370**	**5.78E-17*****	**1.506**
	Do you learn interesting things in class?	-1.086	0.277	0.943
Classroom Culture				
	Can you find the things you need in your classroom?	0.277	0.782	1.016
	Does your class stay busy and not waste time?	-3.254	0.001***	0.839

	Do students behave well in your class?	-3.966	7.31E-05***	0.794
	Do students in your class treat the teacher with respect?	-5.231	1.68E-07***	0.765
Academic Rigor & Expectations				
	Does the work you do in this class make you really think?	0.339	0.735	1.018
	Does your teacher explain things in ways you can understand?	**2.453**	**0.014****	**1.150**
	Does your homework help you learn?	-0.931	0.352	0.952
	Do you learn a lot in your class?	**1.960**	**0.050****	**1.135**
Instructional Methods				
	Does your teacher ask you if you understand what you are learning?	1.435	0.151	1.083
	Does your teacher explain things in ways you can understand?	2.453	0.014**	1.150
	Does your teacher ask you to show your work?	**2.762**	**0.006***	**1.190**
	When you make a mistake, does your teacher help you correct it?	**4.302**	**1.69E-05*****	**1.258**
Student Motivation				
	Do you care about how much your classmates learn?	0.384	0.701	1.023
	Can you concentrate in class?	0.253	0.800	1.015
	Do you explain your work to other students?	**2.211**	**0.027****	**1.143**
	I know what it takes to get good grades in school.	**2.834**	**0.005***	**1.278**
	Do you help other kids in class when they don't know what to do?	**2.325**	**0.020****	**1.148**
	Do you do your schoolwork, even if no one tells you to?	**4.046**	**5.22E-05*****	**1.278**
	Can you remember things you learn in school?	-1.667	0.096*	0.906
	My teachers think I can succeed if I try.	-0.653	0.514	0.942

*Statistically Significant at a 90 percent confidence level.
**Statistically Significant at a 95 percent confidence level.
****Statistically Significant at a 99 percent confidence level.*

Conclusions:

The measures used indicate critical thinking gains were made while students experienced a positive school culture – two of the aims of a NTN education. To best use the evidence generated from this study and similar studies it is recommended that findings from large-scale studies such as this and the seminal work by Zeiser et al. (2014) be used to create a Deeper Learning Implementation Rubric/spectrum of development that schools can employ as needed to document deeper learning outcomes and implementation.

References

Bergeron, L., Bennie, B., Boesche-Taylor, B., & Gehrke, A. (2018, April). *Student Culture Survey Validation: Creating a Tool to Support Culture Transformation and Equitable Learning Experiences.* Presentation at the annual conference of the American Educational Research Association, New York, NY.

Carter, P. L., & Welner, K. G. (2013). Building Opportunities to Achieve. *In Closing the opportunity gap: What America must do to give all children an even chance*. Oxford: Oxford University Press.

Duke, N. K., Halvorsen, A. L., & Strachan, S. L. (2016). Project-based learning not just for STEM anymore. *Phi Delta Kappan*, *98*(1), 14-19.

Educate Insight. (2018). Educate Insight Reasoning Skills tests for Children Grades K-12. User Manual and Resource Guide. San Jose, CA: The California Academic Press.

Facione, P. (1990). The Delphi Report (ERIC Doc. No. ED 315 423). San Jose, CA: Insight Assessment.

Friedlaender, D., Burns, D., Lewis-Charp, H., Cook-Harvey, C., and Darling-Hammond, L. (2014). *Student-Centered Schools: Closing the Opportunity Gap.* Stanford, CA: Stanford Center for Opportunity Policy in Education.

Greene, J. (2007). *Mixed Methods in Social Inquiry*. San Francisco, California: John Wiley and Sons.

Han, S., Capraro, R., & Capraro, M. M. (2014). How Science, Technology, Engineering, and Mathematics (Stem) Project-Based Learning (PBL) Affects High, Middle, And Low Achievers Differently: The Impact of Student Factors on Achievement. *International Journal of Science and Mathematics Education*, 1-25.

Holm, M. (2011). Project-Based Instruction: A Review of the Literature on Effectiveness in Prekindergarten through 12th Grade Classrooms. *Rivier Academic Journal*, 7, (2), 22-37.

Ladson-Billings, G. (2006). From the Achievement Gap to the Education Debt: Understanding Achievement in US Schools. *Educational Researcher*, 35, (7), 3-12.

Mergendoller, J. R. , Maxwell, N. L. , & Bellisimo, Y. (2006). The Effectiveness of Problem-Based Instruction: A Comparative Study of Instructional Methods and Student Characteristics. *Interdisciplinary Journal of Problem-Based Learning*, 1(2). Available at: https://doi.org/10.7771/1541-5015.1026

National Education Association (NEA), NEA Education Policy and Practice Department, Center for Great Public Schools. (2008). NEA Policy Brief: Parent, Family, Community Involvement in Education. Accessed online January 14, 2019 at: http://www.nea.org/assets/docs/PB11_ParentInvolvement08.pdf

National Parent Technical Assistance Center (PACER). (2011). *Evidence-Based Practices at School: A Guide for Parents*. Minneapolis, MN: PACER Center.

National Research Council (NRC). (1999). How people learn: Brain, mind, experience, and school. J. D. Bransford, A. L. Brown and R. R. Cocking (Eds). Washington, DC: National Academy Press.

North Carolina Department of Public Instruction. (2013). NC STEM Attribute Implementation Rubric. *STEM Education Schools and Programs*. Retrieved 25, August 2018: http://www.ncpublicschools.org/docs/stem/schools/rubrics/elementary-school.pdf

Schneider, M. & Buckley, J. (2002). What Do Parents Want from Schools? Evidence from the Internet. *Educational Evaluation and Policy Analysis*, 24, (2), 133-144.

William and Flora Hewlett Foundation. (2019). Hewlett Foundation K-12 Teaching and Learning Strategy Paper. Accessed online January 14, 2019 at: https://hewlett.org/strategy/deeper-learning/#ideas-practice

Youth Truth, 2018. *Design & Methodology: Family and Staff Surveys*. San Francisco, California: Youth Truth.

Zeiser, K., Taylor, J., Rickles, J., Garet, M. S., & Segeritz, M. (2014). Report 3: Evidence of deeper learning outcomes. *Findings from the study of deeper learning: Opportunities and outcomes*. Washington, DC: American Institutes for Research.

Zeiser, K., Scholz, C., Cirks, V. (2018). *Maximizing Student Agency Implementing and Measuring Student-Centered Learning Practices*. Washington, DC: American Institutes for Research.

Zainal, Z. (2007). Case study as a research method. *Journal Kemanusiaan*, *9*. https://doi.org/10.1177/15222302004003007