Federally funded study provides evidence of PBL effectiveness in high school economics: Could PBL be a hot topic in K-12, again?

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Note. This paper draws heavily from the final study report provided by Finkelstein, et al., (2010).

Abstract

Over the years, supporters of project- or problem-based learning (PBL) in K-12 have generally had to rely on limited research, weak research methods, and sometimes mixed results. Results from a federally funded, randomized controlled experiment in high school economics provide evidence for the efficacy of PBL and should fuel growing interest in this approach to instruction. The study examined the impact of a one-week summer professional development institute and use of five PBL curriculum modules on the economic knowledge of approximately 7,000 12th grade students, taught by 76 teachers in 66 schools. Student outcomes that were studied included scores on the standardized Test of Economic Literacy (TEL), and scores on performance assessments of student conceptual understanding. Teacher outcomes included confidence in teaching economics and satisfaction with teaching materials. The findings, prepared by the Regional Educational Laboratory West (REL West) at WestEd, indicates there were significant positive impact for students of teachers who received the curriculum compared to their peers and teachers scored higher in satisfaction with teaching materials and methods than those in the control group.

Purpose

This study was undertaken to provide strong experimental evidence concerning the effectiveness of PBL use in high school economics. The study was designed to assess student-level impacts of a problem-based instructional approach using a randomized controlled trial. It tested the effectiveness of a series of five curriculum units developed by the Buck Institute for Education (www.bie.org) on student learning of economics content and problem-solving skills. This study targeted high schools in urban, suburban and rural areas and engaged teachers who committed to teach economics for two semesters during the 2007/08 academic year.

Student achievement outcomes were the study's primary focus. Specifically, it examined whether the Buck Institute's curriculum improved grade 12 students' content knowledge as measured by the Test of Economic Literacy (TEL), a widely accepted, standards-aligned test used across the United States, along with students' problem-solving skills in economics as measured by a performance-task assessment. In addition to these student outcomes, the study examined changes in teachers' content knowledge in economics, their pedagogical practices, and satisfaction with the curriculum.

Why study economics instruction?

For decades, economists, prominent educators, and business and government leaders have advocated for developing economic literacy as an essential component in school curricula. Their arguments have ranged from the need for improving the ability to manage personal finances to the value of economic education for critical thinking and an informed citizenry. "The case for economic literacy is obvious. High school graduates will be making economic choices all their lives, as breadwinners and consumers, and as citizens and voters. A wide range of people will be bombarded with economic information and misinformation for their entire lives." (Tobin, 1986).

At the federal and state levels, economics has received increasing attention as a critical content area for K–12 education. Forty-eight states now include content standards in economics, with 40 requiring their implementation, and 17 requiring a course in the subject for graduation. (National Council on

Economic Education 2007). Economics is a required course for high school graduation in California and Arizona, the two states where the study takes place, and is usually taught to seniors for one semester.

While there is growing agreement on the need for some economics content in K–12 education, there is less consensus about where it fits into the curriculum, how to teach it effectively, and how much subject area background should be required of classroom instructors. Additionally, there is concern that many students do not understand economics and their teachers may lack content knowledge, access to relevant teaching materials and adequate professional development (Walstad, 2001, Watts, 2006).

Why study PBL use?

PBL is an approach to instructional design that can help organize the curriculum and deliver instruction. It provides a mechanism to gain student attention, to motivate and anchor learning. It provides opportunities for authentic assessment of content and skills, and use of new technologies. Research suggests that for the most important outcomes (other than short-term recall or recognition), such as long term retention and assessments involving elaboration of understandings, PBL has been as effective as traditional instructional approaches, and there are many studies that show PBL to be superior (Strobel & van Barneveld, 2008; Walker & Leary, 2008). Of these studies, relatively few have been well-designed K-12 experiments, however a few studies do suggest PBL can be effective in diverse K-12 settings (Barron & Darling-Hammond, 2008; Boaler; 1992; Edutopia, 2001; Marx, et al., 2004).

There has been an evolution of thinking about what PBL is. PBL can no longer be equated with "minimally-guided or "discovery learning" (Hmelo-Silver, Duncan & Chinn, 2007: Mayer, 2004; Kirschner, Sweller & Clark, 2006). Gradual consensus appears to be building that not all PBL is created equal. Considerable effort has to go into problem or project design, scaffolding and management of learning activities, and the requisite professional development for teachers in order for PBL to be effective. As Dewey noted, "The belief that all genuine education comes about through experience does not mean that all experiences are genuinely or equally educative." (1938, p. 25). Today's projects, such as those conceived at High Tech High School (http://www.hightechhigh.org/projects/), Envision Schools (http://www.envisionprojects.org), Expeditionary Learning schools (http://elschools.org/), or New Tech Network schools (http://www.newtechnetwork.org/) look nothing like the "child-centered" progressive education ideas of William H. Kilpatrick (1918), who popularized the 'Project Method" in the early part of the 20th century.

Contemporary PBL is standards-focused, and can incorporate a wide variety of instructional strategies –even more "traditional" lectures, skill-building activities, library and Internet research, and various forms of writing. Students can be assessed by both performance-based and traditional means. PBL differs from a traditional curriculum approach, however, by creating a reason to learn or "need to know" (besides getting a good grade on the test) prior to using any of these other techniques. PBL also provides opportunities for students to develop (and be assessed on) their ability to work together, manage complex work, explain themselves to an external audience, etc. Well-conceived projects or problems provide questions and challenges that can serve to organize the curriculum as a whole. These characteristics of PBL are reflected in the definition of PBL as "a systematic teaching method that engages students in learning essential knowledge and life-enhancing skills through an extended, student-influenced inquiry process that is structured around complex, authentic questions and carefully designed products and tasks" (Mergendoller, et al., p. 587).

Evaluations of small school initiatives have highlighted the prevalence of PBL:

> "Among the schools in this initiative that reported efforts to implement a common pedagogy across all classes, project-based learning (PBL) is the most commonly cited instructional strategy . . . .in practice, many educators will refer to the same activity interchangeably as 'project-based' or 'problem-based' learning, or simply 'PBL'." (Mitchell, et al., 2005, p. 40).

Additional evidence of growth of interest in PBL includes the number of schools and districts using PBL as a key component of school wide reform (Ravitz, 2010), state-wide initiatives (Williamson, 2008; Indiana University School of Education, 2010), web sites that emphasize PBL (e.g., Edutopia, 2001), and policy documents such as from the National Middle School Association (Yetkiner, Anderoglu, Capraro (2008) and the National High School Center (Harris, Cohen & Flaherty, 2008, p. 3).

A PBL approach to economics

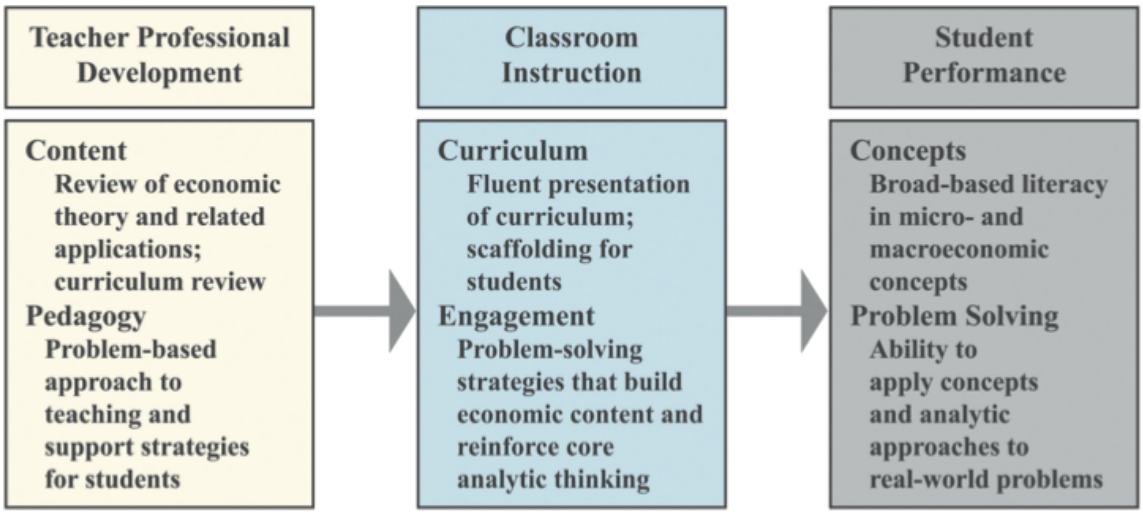
The approach to PBL in this study represents a modification of the problem-based approach originally developed for use in medical schools (Mergendoller, Maxwell, and Bellisimo 2000). The modifications were made for use in US high school settings, although the resulting curriculum has been found to be effective in college courses (Smith & Ravitz, 2008) and when translated for use overseas (Mo & Choi, 2003). In contrast with the more typical textbook and lecture- driven approach that is commonly seen, teachers initiate inquiry based on examination of real-world economic problems that require a set of disciplined, analytic steps. The intent is that students learn to contextualize, understand, reason, and solve problems using analytic skills that are taught as part of the curriculum.

Each of the five curriculum modules used in this study is set up around a fictitious (simulated) case study that is well suited to student-driven problem solving. Each unit is organized around four major phases:

1. Project launch
2. Framing the inquiry
3. Problem-solving and learning activities
4. Presentation, assessment and debrief

The step-by-step teaching guide that is provided is the cornerstone of each module. It lays out for teachers the problem statement, introduction, placement in curriculum, concepts taught, objectives, content standards, time required, lesson description, resource materials, sequence of the unit, procedures, and do's and don'ts. For the PBL group teachers, the curriculum is introduced during a five-day professional development workshop led by expert teachers who have used the materials extensively in classrooms.

The logic for the intervention and its intended effects are outlined in the below. Student achievement outcomes are of primary importance. These are hypothesized to be mediated by changes in teacher knowledge and pedagogical practice.



The intervention for this study included a combination of materials and professional development. The professional development consisted of a 40-hour economics course for teachers, held over five days in the summer of 2007. This workshop introduced five curriculum modules that contained fundamental components of the curriculum standards in economics in the states where the study was implemented (Arizona and California) and covered approximately 50–70 percent of the curriculum content of economics classrooms. Teachers left the session with an understanding of how to sequence the material for each curriculum unit into consistently applied teaching steps. During the course of the semester, periodic videoconferences were offered to support teachers during the implementation of the units, although these were sparsely attended.

Research Questions

The research questions for the study reflect the expected changes in teacher knowledge and practice, attitudes toward teaching economics and student outcomes. They were as follows:

1. Does PBE change students' content knowledge in economics?
2. Does PBE change students' problem-solving skills in economics?
3. Does PBE change teachers' content knowledge of economics?
4. Does use of PBE change economics teachers' instructional practices?
5. Does the use of PBE change teachers' satisfaction with teaching materials and methods use?

Methods

The study population and sample

Implemented from summer 2007 to spring 2008, the study targeted high schools in rural, suburban, and urban areas of both California and Arizona, two states where economics is a required course for graduation. Study participants included economics teachers who were randomly assigned to an intervention or control group.

Every school in Arizona and California with enrollment of more than 1,500 students (approximately 1,000 schools) was contacted to discuss the study. The recruiter had some discussion with administrative staff or teachers in nearly all of them. The resulting pool of schools in the study sample was 106. Only after a teacher was found willing and eligible to participate in the study were the school and district asked to permit study participation. Thus, the recruited sample was composed of teachers who volunteered to participate in a randomized controlled trial and who committed to participate in the professional development and to implement the curriculum if randomly assigned to the intervention group. The study team was not able to collect information about teachers who declined to participate in the study, and as a result, it is unable to make any inference about the differences between teachers who did and did not agree to participate.

After random assignment, and accounting for attrition and missing data, the intervention group for Spring 2008 included 35 teachers and their 2,502 students, while the control group included 29 teachers and their 1,848 students. There was attrition of 12 control teachers and 7 intervention teachers who did not return data for this study. In addition, two teachers in the treatment group did not provide outcome measures on the performance tasks. The number of missing students for each measure ranged from 11% to 15%, except for the performance tasks which were missing for 19% of the control group and 23% for the treatment group students. Students were excluded from the impact analyses if they were missing associated outcome measures.

Teachers in control schools participated in their regular annual professional development activities and continued their usual instructional practices in economics classrooms. (As an incentive for their participation they received the curriculum and professional development in the year following the study).

Measures

The experimental study was designed to test whether problem-based instruction in high school economics can result in gains in students' content knowledge. The primary outcome measure for this study is content knowledge gains for students in economics measured by the Council for Economic Education's Test of Economic Literacy (TEL), a 40-item closed-response economics exam (Walstad and Rebeck, 2001). This is a widely accepted, standards-aligned test used across the United States to measure economic literacy among high school students.

The research team augmented this outcome measure with an opportunity to test students' abilities to reason and solve problems with the concepts they had learned. Student problem-solving skills are measured with open-response performance assessments of applied economics concepts (performance task assessments) developed by the Center for Research on Evaluation, Standards, and Student Testing at the University of California, Los Angeles (UCLA CRESST). These written tasks gave students the ability to demonstrate problem-solving skills as they answered open-ended essay question, as outlined by Baker, Aschbacher, Niemi & Sato (1992) and Niemi (1996).

The assessment tasks were created and piloted by CRESST with more than 300 students in spring 2005, prior to this study. These feature paper-and-pen thinking and writing responses based on contextual prompts that focused on monetary policy/federal funds, monetary policy/employment, fiscal policy, consumer demand, and opportunity costs. These tasks were chosen because of their focus on fundamental economics concepts and their alignment with state standards in the course. These economics performance assessments do not explicitly reference the Buck Institute's curriculum and were piloted both with teachers who used the relevant curriculum units and with teachers who did not. The assessment tasks and their common rubric were revised based on several rounds of student responses. Based on this initial work, CRESST indicated that the tasks provide good evidence of the quality of student conceptual understanding in economics. The performance tasks were administered at the end of each semester as a measure of student learning. (These assessments did not have a pretest component.) Each task required 15–20 minutes to complete (75–100 minutes for all five tasks).

Pedagogical practices were measured using teacher self-reports on 9 items using items similar to those used by Ravitz, Becker & Wong (2000) to indicate the frequency different practices were used. "During the past semester, how often did you give assignments in economics that required students to do the following?" [1 = Never, 2 = A few times, 3 = Once or twice a month, 4 = Once or twice a week, 5 = Almost every day]: Work on projects that take a week or more; Work together in small groups; Use a rubric to help assess and guide their work; Organize and analyze information or data; Come up with solutions to economic problems, like those found in the real world; Consider alternative solutions to an economic problem; Orally present their work or ideas to others; Use the Internet to get information; and Use computers—besides word processing—to analyze or present data (such as Excel). The index measure based on these items was reliable, coefficient alpha=.85.

Teacher satisfaction with the curriculum was addressed by asking how satisfied on a scale from 1-5 (from "very unsatisfied" to "very satisfied") teachers were with the curriculum materials you have for teaching economics, and the methods you use to teach economics, with the mean on the two measures being reliable, coefficient alpha=.80.

Data Analysis

The analysis for this study compared the outcomes for students and teachers in the intervention group with their counterparts in the control group after the students' economics course had been completed in spring 2008. All outcome variables were treated as continuous variables in the impact analyses (estimated using multilevel or single-level linear regression models). To increase the precision of the estimates, a set of baseline characteristics of students and teachers was included in the models as covariates. These included student gender, race/ethnicity and pretest measures, as well as teacher background indicators (years teaching, number of college courses in economics and confidence teaching economic concepts) and aggregated student pretest measures. Additional information about dummy variables and randomization procedures are available in the full report, along with HLM models and treatment of fixed and random effects (Finkelstein, et al., 2010). Statistical power estimates for Type 1 error = .05 indicate a minimum detectable effect size of .18-.21 at the student level and .55 at the teacher level (based on 83 teachers and 40 students per teacher)

Findings

This REL West study was designed as an in-school, randomized controlled trial that tested the effectiveness of a Problem Based Economics (PBE) curriculum developed by the Buck Institute for Education on student learning and problem-solving skills. The study found that students benefited from the combination of the curriculum, the associated professional development program, and the support that was provided as part of the study's implementation. The students whose teachers used the problem based curriculum in their classrooms scored significantly higher on both content assessments (TEL and performance tasks) compared to students who were not exposed to the curriculum in their economics classes. In addition, teachers who used the curriculum were more satisfied with the materials than those who used standard teaching materials.

Student benefits

Results indicate that students whose teachers had received professional development and support for use of the PBL economics curriculum outscored their control group peers on the Test of Economic Literacy by 2.60 items (effect size = 0.32). Student academic performance was also assessed using open-ended performance tasks that tested problem-solving abilities in short essays. On a composite score of these tasks, students in the intervention group outperformed those in the control group (effect size = 0.27, $p < .05$).

One way to interpret the magnitude of these effects is to compare them with the overall progress that students make during an academic or calendar year. Hill et al. (2008) reported that 10th graders' scores on norm-referenced tests in reading increase by 0.19 standard deviation units and in math by 0.14 standard deviation units over a calendar year. Comparable growth information is not available for high school economics. One might imagine that not having taken any economics previously the growth of knowledge in economics would be greater than in these other subjects. However if growth in economics achievement is similar, the impact estimates are equivalent to at least one year of growth.

Benefit to Teachers

There were also statistically significant differences in favor of intervention group teachers on a measure of teacher satisfaction with the teaching methods and materials used to teach economics. The economics teachers who used the PBL approach were significantly more satisfied with the materials and methods than their peers who did not use the curriculum. The effect size was quite substantial (effect size=1.09, $p < .01$).

No statistically significant difference was found between the intervention and control groups on teachers' knowledge of economics, possibly due to a ceiling effect. Teachers averaged more than 90% correct on the pretest, which was the same as the student version of the test that was used.

Finally, no significant difference was found in teachers' pedagogical style with the survey measures used, based on a cut-off point using p value < .05. However, there was an effect size of .55, $p < .07$, even after multiple controls were in place, indicating a strong likelihood that PBE teachers were in fact more constructivist in their teaching practices as a result of using the curriculum.

Conclusion

The positive outcomes from this study are ground breaking in many ways. We are not aware of any other federally funded studies of this kind that examined PBL in a high school subject, or any K-12 for that matter. These findings add to the research base on use of PBL in economics, which had indicated promising impacts on student gains and teacher satisfaction. However, unlike previous studies, the design of this study allows for a causal interpretation of the students' gains and greater generalizability. Educators may be looking for ways to strengthen their economics education programs; this study may provide useful information to curriculum specialists and teachers interested in alternative approaches for providing instruction in a required component of the high school curriculum in their state.

However, in other respects this study only scratches the surface of our understanding of the impact of a PBL approach to teaching economics. A study like this only looks at "bottom line" differences attributable to the intervention. It does not address variations in the outcomes due to the quality of implementation or differences within teachers (e.g., who was more successful teaching economics than others using the curriculum and with which students, or how their practices in general and implementation of the curriculum differed).

Observations of classrooms indicate that implementation the PBE units varied enormously depending on the individual teacher. It was not clear that professional development session impacted teachers' use of the PBL materials compared to how they might have used the materials without professional development.

Observations of control group teachers also indicated a wide range of practices, including some very effective and clever use of methods that resembled PBL at times, use of Socratic discussions and other seemingly useful approaches. At the end of the day, it is very hard to get an impact in a study like this. There were a lot of teachers in both groups who were extremely engaging and had a certain "spark" for economics that was conveyed to students, while in both groups there were teachers who lacked this spark.

(Personal communication with Neal Finkelstein, September 24, 2010)

The differences in teaching practices were not statistically significant, suggesting the difficulty of capturing pedagogical differences. (Although self-reported practices almost showed a statistically significant difference (Effect size = .55. $p < .07$), there may be better ways to document differences in teaching quality both within treatment and control conditions. One such approach has been developed in large scales studies such as reported by the TeachScape project (Pea, et al., AERA 2010), which analyzes pedagogical practices using audio and video. It would be interesting to see a study of this curriculum that more carefully addressed pedagogical differences and how these impact learners.

A great deal can still be learned by understanding how the supports offered to teachers, which included online supports, were used and can be used in the future to scale use of PBL. The intervention included some technology supports via video conferences, but these were not studied and evaluated. A key question to be addressed is how to support more effective use of PBL and it is likely that new technologies can play an important role (e.g., see Ravitz, 2010b). Perhaps there are ways to offer online professional development for teachers who obtain the curriculum or even ways to put the curriculum itself into an online format for use by teachers and students. (Note. Social Studies School Services is now publishing this curriculum without a professional development offering under the name of Project Based Economics. http://www.socialstudies.com/c/product.html?record@TF43284).

While the PBE curriculum appeared to be beneficial as compared to the approaches used by teachers in the control group, according data in the TEL handbook (Walstad & Rebeck, 2001) , both the treatment and contrast group in our study below the norm scores for country. This means that although the PBE group appears to have benefitted, there is still a long way to go in delivering high quality economics instruction in the participating states. It is possible that the characteristics of schools where the study took place are different from the schools in which TEL was normed. For example, California and Arizona may have larger than average number of language minorities and low SES students. We still have a lot to learn about how PBL works with diverse students, including language learners. It is unclear how much the intensity of language required for PBL or the assessments that were used may have influenced the study results, and whether the curriculum may have measurably helped students with some backgrounds more than others. Future analyses of the data will examine which types of students did well with the PBL economics curriculum, and how implementation can best support different kinds of learners.

There is an inherent inability for this study, as it was designed, to untangle curriculum and pedagogy. The treatment group received not just a PBL approach to curriculum but a series of information session and materials designed to support their content knowledge and teaching during the curriculum. This makes drawing conclusions about the effectiveness of the PBL approach problematic; the difference in outcomes could be attributable to teacher learning and access to higher quality content, not just a new approach to teaching that content. We are not sure how you could separate these things, but perhaps the control group in future studies could receive resources designed at improving teacher content knowledge and ability to present that content, independent of the framing of this content by a PBL unit.

There are only so many economics teachers per school, so it is important to consider how the lessons from the economics study might apply to other grades and subjects. This curriculum was developed over the course of several years and involved experts in instructional design and content areas. This development effort is clearly more substantial than most teachers would be able to undertake However, in recent years, thousands of teachers have received professional development to design their own PBL units (tailored to their subjects and grade levels and students), and large libraries of projects have been developed using templates designed to scaffold planning, management and assessment of PBL (e.g., Buck Institute for Education, 2010; Williamson, 2008). The growth in the number of teachers who are trying to create well-designed PBL in an important development and there is very little research being conducted that might help people better understand how to effectively support their efforts.

One area of research to investigate in the future includes better understanding the conditions required for effective use of PBL. The intervention for this study was quite extensive. It will be important to figure out what is required if more people are to teach this way in economics and other subjects. People who have developed "small ID" reforms (lessons, curriculum) have often suffered from lack of "big ID" contexts (systemic change) for their work. The blossoming of large-scale PBL initiatives brings forth a plethora of opportunities for graduate students, researchers and developers (e.g., to study performance assessments, group work, student-as-researcher, specific technology scaffolds, etc.). Many challenges still face PBL users and researchers, but there has been progress in designing schools to support PBL (e.g., Author, 2010; Expeditionary Learning Outward Bound, 1999; Pearlman, 2002), creating online scaffolds

for PBL use (e.g., Hmelo-Silver, Duncan & Chinn, 2007), administering large scale performance assessments (e.g., Silva, 2008), measuring youth development outcomes (Newell & Van Ryzin, 2009). Now we have the first randomized controlled study to support PBL's effectiveness.

After answering the question "does it work" in this large study, it is still critical to learn how PBL can work better and be made more accessible across schools and subjects. There are unprecedented opportunities for research and it is important for the field to be aware of these. With the release of this new study, interest in using PBL to support effective teaching and learning should grow.

References

Baker, E. L., Aschbacher, P. R., Niemi, D., and Sato, E. (1992). *CRESST performance assessment models: assessing content area explanations*. Retrieved from http://www.cse.ucla.edu/products/guidebooks/cmodels.pdf

Barron, B. & Darling-Hammond, L. (2008). Teaching for meaningful learning: A review of research on inquiry-based and cooperative learning. In *Powerful Learning: What We Know About Teaching for Understanding*. San Francisco, CA: Jossey-Bass. Retrieved from http://www.edutopia.org/pdfs/edutopia-teaching-for-meaningful-learning.pdf

Boaler, J. (1997). *Experiencing school mathematics: Teaching styles, sex and settings*. Buckingham, UK: Open University Press.

Buck Institute for Education (2010). *Online project libraries*. [WWW document]. Retrieved from http://www.bie.org/tools/links/pbl_in_practice

Dewey, J. (1938). *Experience and education*. New York: Macmillan.

Edutopia (2001). *PBL Research summary: Studies validate project-based learning*. Novato, CA: Author. Retrieved from http://www.edutopia.org/project-based-learning-research.

Ely, D. (1995). *Technology is the answer! But what was the question?* The James P. Curtis Distinguished Lecture. University of Alabama, College of Education. ED 381 152. Retrieved from http://eric.ed.gov/ERICDocs/data/ericdocs2sql/ content_storage_01/0000019b/80/13/ca/58.pdf

Expeditionary Learning Outward Bound (1999). *A design for comprehensive school reform*. Cambridge, MA: Author.

Finkelstein, N., Hanson, T., Huang, C., Hirschman, B., and Huang, M. (2010). *Effects of Problem Based Economics on high school economics instruction*. (NCEE 2010-4002). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education.

Harris, J., Cohen, P., & Flaherty, T. (2008, July). *Eight elements of high school improvement: A mapping framework*. http://www.betterhighschools.org/docs/NHSCEightElements7-25-08.pdf

Hill, C.J., Bloom, H.S., Black, A.R., and Lipsey, M.W. (2008). Empirical benchmarks for interpreting effect sizes in research. *Child Development Perspectives, 2*(3), 172–77.

Hmelo-Silver, C., Duncan, R., and Chinn, C. (2007). Scaffolding and achievement in problem-based and inquiry learning: a response to Kirschner, Sweller, and Clark (2006). *Educational Psychologist, 42*(2), 99–107.

Indiana University School of Education-Indianapolis (2010). *Second annual PBL workshop attracts participants from across state, country*. Retrieved from http://education.iupui.edu/soe/news/news_projectbasedlearning2010.aspx

Institute of Education Sciences (2010). *Newsflash : Problem-based curriculum boosts high school students' knowledge of economics*. Retrieved from http://ies.ed.gov/ncee/edlabs/projects/project.asp?ProjectID=89

Kilpatrick, W. (1918). The project method. *Teachers College Record,19*, 319-335.

Kirschner, P., Sweller, J., & Clark, R. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist, 41*(20), 75–86.

Mayer, R. (2004). Should there be a three-strikes rule against pure discovery learning? *American Psychologist, 59*(1), 14–19.

Marx, R., Blumenfeld, P., Krajcik, J., Fishman, B., Soloway, E., Geier, R., & Tal, R, (2004). Inquiry- based science in the middle grades: Assessment of learning in urban systemic reform. *Journal of Research in Science Teaching, 41*, 1063-1080.

Mergendoller, J., Maxwell, N., and Bellisimo, Y. (2000). Comparing problem-based learning and traditional instruction in high school economics. *The Journal of Educational Research, 93*(6), 374–82.

Mergendoller, J., Markham, T., Ravitz, J., & Larmer, J. (2006). Pervasive management of project based learning: Teachers as guides and facilitators. In C. M. Evertson & C. S. Weinstein (Eds.), *Handbook of classroom management: Research, practice, and contemporary issues*. Mahwah, NJ: Erlbaum.

Mo, K., & Choi, Y. (2003). Comparing problem-based learning with traditional instruction: Focus on high school economics. *Theory and Research in Citizenship Education, 35*(1), 89-113. Published by the Association of Social Education in Korea (ISSN: 1598-7280).

Mitchell, K., Shkolnik, J., Song, M, Uekawa, K., Murphy, R., Garet, M., et al. (2005). *Rigor, relevance, and results: The quality of teacher assignments and student work in new and conventional high schools*. Washington, DC: SRI International. Retrieved from http://smallhs.sri.com/documents/Rigor Rpt 10 21 2005.pdf

National Council on Economic Education. (2007). *Economic, personal finance & entrepreneurship education in our nation's schools in 2007. A report card: survey of the states*. New York: National Council on Economic Education. Retrieved from http://www.councilforeconed.org/about/survey2007/NCEESurvey2007.pdf

Van Ryzin, M. & Newell, R. (2009). *Assessing what really matters in schools: Building hope for the future*. Lanham, MD: Rowman & Littlefield.

Niemi, D. (1996). Assessing conceptual understanding in mathematics: representation, problem solutions, justifications, and explanations. *Journal of Educational Research, 89*(6), 351–63.

Partnership for 21st Century Skills. (2007). *Partnership for 21st Century Skills Framework*. Retrieved from http://www.21stcenturyskills.org

Pearlman, B. (2002). Designing, and making, the new American high school. *Technos, 11*(1), 12–19.

Ravitz, J. (2010a). Beyond changing culture in small high schools: Reform models and changing instruction with project-based learning. *Peabody Journal of Education, 85*(3), 290-312.

Ravitz, J. (2010b). Assessing the impact of online technologies on PBL use in US high schools. Paper to appear in *Annual Proceedings of the Association for Educational Communications and Technology*. Anaheim, CA. Retrieved from http://www.bie.org/research/study/online_supports_for_pbl_use

Ravitz, J., Becker, H., & Wong, Y. (2000). *Constructivist compatible beliefs and practices among U.S. teachers: Teaching, Learning & Computing, 1998 National Survey, Report #4*. UC, Irvine. Retrieved September 10, 2009, from http://www.crito.uci.edu/tlc/findings/report4/report4.pdf

Silva, E. (2008). *Measuring skills for the 21st century*. Washington, DC: Education Sector. Retrieved from http://www.newtechfoundation.org/press research/ MeasuringSkills 11-08.pdf

Smith, T. & Ravitz, J. (2008). Problem based learning in college economics. *Academic Exchange Quarterly*, 12(1). Retrieved from http://www.bie.org/research/study/ problem_based_learning_in_college_economics

Social Studies School Service (2010). *Project Based Economics.* http://www.socialstudies.com/c/product.html?record@TF43284

Strobel, J., & van Barneveld, A. (2009). When is PBL more effective? A meta-synthesis of meta-analyses comparing PBL to conventional classrooms. *Interdisciplinary Journal of Problem- based Learning, 3*(1), 44-58.

Van Ryzin, M. & Newell, R. (2009). *Assessing what really matters in schools: Building hope for the future*. Lanham, MD: Rowman & Littlefield.

Walker, A., & Leary, H. (2009). A problem based learning meta analysis: Differences across problem types, implementation types, disciplines, and assessment levels. *Interdisciplinary Journal of Problem-based Learning, 3*(1), 12-43.

Walstad, W.B. (2001). Economic education in U.S. high schools. *Journal of Economic Perspectives, 15*(3), 195–210.

Walstad, W.B., and Rebeck, K. (2001). *Examiners Manual, Test of Economic Literacy, Third Edition*. New York: National Council on Economic Education.

Watts, M. (2006). *What works: a review of research on outcomes and effective program delivery in precollege economic education*. New York: National Council on Economic Education.

Williamson, C. (2008, August). *Why project based learning? Stages 1, 2, and 3.* Teacher Leadership Institute presentation by C. Williamson, Executive Director of the Office of Instruction. Charleston, WV: West Virginia Department of Education. Retrieved April 9, 2010 from http://wvde.state.wv.us/teach21/ProjectBasedLearning.html

Yetkiner, Z. E., Anderoglu, H., & Capraro, R. M. (2008). *Research summary: Project-based learning in middle grades mathematics*. Retrieved from http://www.nmsa.org/ Research/ ResearchSummaries/ProjectBasedLearninginMath/tabid/1570/Default.aspx

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