



systemwide implementation of project-based learning

The Philadelphia Approach

by Jason Schwalm and Karen Smuck Tylek

In summer 2009, the City of Philadelphia and its intermediary, the Public Health Management Corporation (PHMC), introduced project-based learning to a network of more than 180 out-of-school time (OST) programs. Use of project-based learning is now required of all city-funded OST programs that are managed by PHMC.

OST programs have completed nearly 1,700 projects since the fall of 2009, when this initiative began. Though project topics vary widely, from science exploration to community service, from studies of Greek mythology to modern media, all projects now share a common methodology. With the implementation of project-based learning, PHMC program specialists, who observe programs across the network, have noted improvements in key areas of program quality as defined in local and national frameworks.

This article describes Philadelphia's systemwide approach to project-based learning. First, we review the scholarly literature to define the strategy and discuss its outcomes. Next, we describe Philadelphia's systems approach to project-based learning in OST and outline its successes. Finally, we discuss the challenges presented by a systems approach to implementation, offering recommendations to other cities and their intermediaries that wish to implement project-based learning on a systemwide basis.

JASON SCHWALM is a program specialist with the Out-of-School Time Project at Public Health Management Corporation. Before joining PHMC, he was the site coordinator at an OST program in South Philadelphia. Currently he provides professional development and support to afterschool programs throughout Philadelphia and maintains the OST project-based learning blog. He holds a J.D. degree from the University of Louisville.

KAREN SMUCK TYLEK is the project-based learning coordinator with the Out-of-School Time Project at Public Health Management Corporation. She has nine years of experience in education and youth development. Currently Karen provides professional development and support to OST staff around project-based learning; she regularly contributes to the OST PBL blog. She earned an M.S.Ed. degree from the University of Pennsylvania.

No research analyzing the impact of systemwide implementation of project-based learning on an OST network exists. We hope to open this conversation in the OST community and in the scholarly literature. Meanwhile, PHMC continues to collect and analyze data provided by network OST programs. In the summer of 2012, we will complete a study of the impact of workshops on staff's knowledge and comfort in implementing project-based learning. This study will also analyze the effect of project-based learning on students' collaboration skills and confidence in learning.

Background

A rich body of scholarly literature discussing project-based learning (PBL) already exists, although most of it focuses on schools. Though the strategy is only loosely defined in the literature, most scholars agree that PBL is an effective, engaging way to teach both core concepts and non-curricular skills. However, less research details implementation of PBL in OST, and we have found no research discussing the systemwide implementation of PBL in a network of OST providers.

Project-based Learning Defined

PBL is an approach to instruction that emphasizes "authentic learning tasks grounded in the personal interests of learners" (Grant, 2009, p. 1). The Buck Institute for Education calls PBL "a systematic teaching method that engages students in learning knowledge and skills through an extended inquiry process structured around complex, authentic questions and carefully designed products and tasks." (Markham, 2003, p. 4). However it is defined, PBL presents students with real-world, multidisciplinary problems that demand critical thinking, engagement, and collaboration.

In the PBL model implemented by PHMC, every project begins with an open-ended "driving question" that prompts interdisciplinary, student-initiated inquiry. Throughout the project, activities flow naturally from the driving question to the "culminating event," a public presentation of the results of the investigation.

A good driving question is one of the critical components of PBL (Blumenfeld et al., 1991; Markham, 2003). The driving question should be open-ended enough to

sustain many weeks of inquiry and investigation. It should also be authentic and relevant to students. A successful project speaks to the interests of students in a concrete, meaningful way, encouraging students to see the real-world applicability of the concepts they are learning. This kind of question allows students to "[engage] in more idiosyncratic investigations, directing their own learning and making decisions about what they are going to do and how they will do it" (Yetkiner, Anderoglu, & Capraro, 2008, p. 1).

A good culminating event involves the public presentation of students' learning (Savery, 2006). In preparing the event, students synthesize and apply what they have learned. Instructors can use the culminating event to assess students' mastery of the skills and concepts learned during the project.

Many Philadelphia OST providers find that PBL benefits their programs by engaging both staff and students in a coordinated effort. Rebecca Mulligan, youth program director at the Norris Square Neighborhood Project (NSNP), says that "PBL gives a bigger purpose to each day's activities and engages students in a broader perspective." Neida Quinones, a group leader of second and third graders at NSNP, says, "I see the youth excited about the projects and suggesting possible themes and driving questions." PBL

gives purpose to the staff's work as well. Loretta Crea, chief financial officer of Sunrise, Inc., says that most of her afterschool staff "are looking for direction, and PBL gives them that." The structure of PBL keeps youth and staff working toward a goal. "The driving question puts them on the path, and the culminating event brings it all together," Crea says.

The Impact of Project-based Learning

A growing body of research demonstrates that PBL is an effective way to teach core content, as well as higher-order thinking skills. Students in classrooms that incorporate PBL perform at least as well on standardized tests as their peers in traditional classrooms (Thomas, 2000). Walker and Leary arrive at a similar conclusion, noting that "even when the scope is limited to standardized tests of concepts, PBL is able to hold its own in comparison to lecture-based approaches" (2009, p. 27). Additionally, PBL seems to facilitate success for students who have

A successful project speaks to the interests of students in a concrete, meaningful way, encouraging students to see the real-world applicability of the concepts they are learning.

trouble learning in the traditional classroom (Barron & Darling-Hammond, 2008).

PBL is also an effective tool for imparting essential non-academic 21st-century skills, including collaboration, critical thinking, and communication. Traditional educational methods that rely on rote memorization don't develop these vital skills (Barron & Darling-Hammond, 2008; Bransford, Brown, & Cocking, 1999). In contrast, PBL has been demonstrated to improve students' ability to reason and argue clearly (Stepien, Gallagher, & Workman, 1993), to answer conceptual problems (Boaler, 1997), and to hypothesize accurately (Schmidt et al., 1996).

PBL in Out-of-School Time

While most existing research on PBL focuses on school-day application, the PBL approach also supports established quality indicators and youth development principles in the afterschool setting. PBL capitalizes on the strengths of OST programming: smaller student-to-teacher ratios and informal learning environments. It also aligns with Philadelphia's OST standards, as described below, as well as with national frameworks including the Massachusetts Afterschool Research Study (MARS) by the Intercultural Center for Research in Education and the National Institute on Out-of-School Time (2005).

The PBL method is well suited to application in afterschool because of the strengths and unique features of OST programming. Afterschool programs are not burdened by rigid class schedules or formal learning requirements. Additionally, afterschool programs tend to require smaller student-to-teacher ratios. Schools operate under different requirements. As Seidel, Aryeh, and Steinberg (2002) note, "increasingly, advocates of project-based and experiential learning are looking to after-school as an excellent setting for this type of work" (p. 16).

PBL gives afterschool programs an opportunity to integrate rigorous academic content without losing the fun and informality of OST programming. At the end of a long school day, many students have a natural desire to move and play; they may be less open to teacher-driven instruction. However, "unlike the rather serendipitous learning that can occur through play, project-based learn-

ing activities can provide more intentional and planned learning experiences, while still offering many attractive qualities of play" (Alexander, 2000, p. 1).

Additionally, PBL supports OST quality indicators. The MARS study identified five key quality indicators: staff engagement with youth; youth engagement; high-quality, challenging activities; quality homework time; and family relationships at pick-up time. PBL strongly supports the first three of these indicators. In PBL, staff members engage with youth to guide them through the projects, and youth work in teams, engaging with one another as well as with staff. PBL also facilitates hands-on learning in student-driven investigations, resulting in high-quality, challenging activities.

The PBL model also supports key youth development practices. California's Community Network for Youth Development (2006) lists five key supports and opportunities for youth development: safety, relationship building, youth participation, community involvement, and skill building. Leaving aside safety as a basic necessity of all programs, PBL addresses the remaining four key supports, particularly meaningful youth participation and skill building. In PBL, youth drive their own learning rather than serving as passive recipients of programming. Community service or involvement often emerges when youth choose a project that tackles a community need. PBL also emphasizes collaboration when youth work in teams, often building strong relationships with peers and facilitators.

Because of its flexibility, PBL is well suited to system-wide application. The PBL method does not prescribe content, so it can be easily tailored to the needs of specific groups and even of individual learners. Because it emphasizes authentic learning and student engagement, PBL is an effective tool to ensure program quality across a diverse network of OST providers.

Because of its flexibility, PBL is well suited to system-wide application. The PBL method does not prescribe content, so it can be easily tailored to the needs of specific groups and even of individual learners. Because it emphasizes authentic learning and student engagement, PBL is an effective tool to ensure program quality across a diverse network of OST providers.

The Philadelphia Approach

The Philadelphia approach to PBL attempts to preserve the flexibility of the PBL model while introducing the structure and uniformity needed to facilitate systemwide implementation. Other city or regional networks interested in implementing a similar approach can learn from

Because it emphasizes authentic learning and student engagement, PBL is an effective tool to ensure program quality across a diverse network of OST providers.

the experience of the Philadelphia network. This section outlines the history of PBL implementation in Philadelphia, the network's structure of expectations and supports for OST providers, and the successes PHMC program specialists have observed.

History

The Philadelphia OST network, created in 1999 and funded by state and city dollars, comprises more than 180 programs operated by 66 different community-based organizations, many of which have little in common. In 2008, the City of Philadelphia and PHMC sought a way to unify the network and ensure quality in this diverse group of programs. Deciding on PBL, a model at once structured and flexible, PHMC contracted with the Buck Institute for Education to adapt its school-day model of PBL for the OST setting.

OST programs in the Philadelphia network were required to adopt PBL by fall 2009. Site directors, having participated in a two-day train-the-trainer workshop given by the Buck Institute, were expected to deliver the content of this workshop to their staff. However, as the deadline drew near, providers began to request assistance and additional training. In response, PHMC held workshops to support project planning. These workshops were the beginning of what would become a full menu of free PBL workshops offered by PHMC to city-funded OST providers.

Structure of the Philadelphia Approach

Although PBL is a student-driven and flexible model, the Philadelphia approach requires concrete administrative standards. PHMC developed guidelines for OST providers to structure the PBL process, including timeframes for project completion and required documentation. Some of these guidelines have evolved over time in response to programs' feedback.

Project Timeframes

As Table 1 shows, older students complete longer projects that explore subjects in greater depth than do younger students.

During the school year, OST programs spend at least three or four hours per week implementing PBL. This amount of time takes into account the need for homework help, snack, physical activity, and other activities typically included in elementary OST programs. The hourly requirement also accommodates middle and high school programs that operate as clubs, where youth may attend only two or three days per week.

Documentation

The Philadelphia approach to PBL includes forms for planning, tracking, and evaluating projects and student performance. Staff and participants use the project planning and group task list forms to plan and implement projects. At the project's end, students complete debriefing forms to reflect on the project, and staff complete rubrics to assess student performance. From a systems perspective, these documents also help the funder or intermediary to track programs' implementation of PBL. All of the forms are available on the Philadelphia PBL blog at www.ostprojects.wordpress.org.

Supports

The Philadelphia approach emphasizes the delivery of support, resources, and assistance to OST providers. These supports empower OST programs that, individually, might lack the capacity or familiarity with PBL to train staff or implement the model effectively.

City-funded OST programs are supported by their PHMC program specialists, who provide monitoring and technical assistance. Program specialists observe program delivery during site visits and make targeted, site-specific

Table 1. Project Duration by Grade Level

	ELEMENTARY SCHOOL	MIDDLE SCHOOL	HIGH SCHOOL
Minimum number of projects per school year	4	4	4
Duration of a project	3–5 weeks	4–6 weeks	4–10 weeks

recommendations. When needed, they also refer staff to workshops or more intensive coaching provided by the project-based learning coordinator.

Since the introduction of PBL in fall 2009, PHMC has delivered more than 80 sessions of PBL workshops to more than 1,000 OST staff. These workshops range from basic courses outlining the driving philosophy of PBL and the rudiments of PBL implementation to more advanced workshops that suggest strategies for the incorporation of literacy, youth leadership, and higher-order thinking skills.

Additionally, the Philadelphia PBL blog details best practices, provides sample projects, and houses essential information and required documents. PHMC has also created a 12-minute instructional video outlining the basics of effective PBL implementation. The video, which is available on the PBL blog, is often shown at training sessions.

Successes

After two years of systemwide training and implementation, the PBL model is employed year-round by every program in the city-funded network. PHMC program specialists have observed that implementation of PBL is having a positive impact on the quality and rigor of program activities, as defined not only by national frameworks like the MARS study but also by the Core Standards for Philadelphia's Youth Programs (City of Philadelphia, 2002). These local standards are organized into categories that include human relationships, program implementation, and activities. Each category carries a quality level of 1–3. PHMC program specialists have observed that PBL supports programs in reaching level 3 standards. Their observations show that PBL has enabled programs to better incorporate youth voice, develop students' 21st-century skills, offer structured activities, and improve staff development.

Incorporating youth voice is a central tenet of PBL. Youth are generally invested and participate actively in projects that revolve around their interests, questions, or needs. We have observed that a majority of programs in the Philadelphia network now consult with youth to select project topics. Youth in the elementary program at Centro Nueva Creación, for example, decided that they were tired of seeing trash in their community and wanted to investigate ways to improve the local and global environment. They launched a community clean-up, planted a garden, and performed a play to educate the community about environmental issues.

PBL develops 21st-century skills including critical thinking, collaboration, and communication. The essence of PBL is problem solving, a key critical thinking skill. The

approach also requires students to work in teams and to communicate their findings. Cardinal Bevilacqua Community Center staff member Vinh Nguyen works with high school students who recently completed a project to raise funds for local charities. "When these teens come here...they're developing a lot of skills that they're not normally developing in schools," he says. "When they come here and they engage in projects... they are learning how to work together as a team, how to problem solve, and how to really accomplish goals that they're setting for themselves."

PHMC has seen an increase in the incidence of structured activities and learning opportunities across the OST network. The PBL approach requires staff to plan activities with purpose and to tie each day's work to the project's ultimate goal. Whether the project involves kindergarteners planning an imaginary vacation to Hawaii, middle school students repurposing trash into jewelry and selling it for a profit, or high school students learning culinary and business skills to win a Restaurant Wars-style competition, project activities demand forethought and preparation because they are building toward a larger purpose.

In many programs, PBL has had a positive impact on staff development. Some providers embraced PBL from the outset, recognizing it as a way to develop staff talents alongside students' skills. PHMC also found that some providers who were initially resistant to PBL came to recognize its value over time. Teri Mitchell, the site director of the OST program at Catholic Social Services, Our Lady, Help of Christians, explained that, while staff were initially skeptical of PBL, "staff have really taken ownership of their projects." Moreover, Mitchell noted, "Using PBL, staff members design creative, diverse projects that really engage the children."

Philadelphia's principal motivation for implementing PBL systemwide was to introduce a baseline standard of quality and rigor for OST programs throughout the network. Although many afterschool programs offered planned and experiential activities long before PBL was introduced to the system, other programs were less purposeful about program design. Since the introduction of PBL, OST programs have completed over 1,700 projects. Elementary students complete at least four projects a year, and high school students complete at least three projects a year. PHMC is currently collecting and analyzing data, with plans to measure the impact of PBL on students' collaboration skills and learning confidence. However, the effective implementation of PBL systemwide, and the minimum standards of quality this method ensures, have already demonstrated success.

Challenges and Recommendations

After two years of implementing PBL across the OST network, PHMC and the City of Philadelphia have created a systemwide approach that could be adopted by other cities and their intermediaries. Admittedly, implementing PBL on a systemwide basis is not without challenges, and little expert research exists to help. This section details some of the challenges and offers recommendations to those interested in implementing PBL across an OST system.

Tension between PBL and Other Academic Goals

A number of OST providers in the Philadelphia network reported that they encountered a conflict between PBL and other academic goals, most commonly homework help. Afterschool program hours can be frustratingly short, and OST providers must balance traditional OST programming—snack, homework help, and physical activity—with PBL activities. Initially many Philadelphia OST providers saw PBL as another scheduling demand to be incorporated into an already overcrowded day.

To some extent, this conflict exists. The PBL approach emphasizes planned, rigorous activities of a kind some OST programs are not accustomed to implementing. However, PBL is not meant to be another item on the schedule, sandwiched between one activity and another during an already busy day. Ideally, PBL is an integral part of the program—not a discrete activity but a methodology woven through each activity. Many PHMC program specialists observed that the OST providers who reported tension between PBL and other program activities were often still struggling to grasp the nuances of PBL.

Recommendation: Incorporate PBL into Other Activities

The PBL methodology emphasizes experiential, student-driven activities covering a wide range of subject areas. Effective PBL implementation can be woven into art and music enrichment, academic instruction, gardening, health and fitness activities, and any other common afterschool activity. For example, a program with an arts focus may already offer music and dance classes. This program could incorporate those classes into a larger project to examine the cultural roots and evolution of music and dance styles. Project activities enhance, rather than compete with, the program's existing enrichment.

Any intermediary implementing PBL throughout an OST network should emphasize that PBL is a methodology rather than a new type of activity. It is a way of thinking about OST programming, and a way of planning after-

school activities, that enriches the work OST programs are already doing.

Recommendation: Help Parents Understand

Many parents, uncomfortable with helping their children with homework or simply unable to do so, expect the primary focus of the afterschool program to be homework help. The Philadelphia OST providers who successfully integrated PBL into their programming communicated extensively with parents about the OST program's goals and how PBL fit in. Parents who understand how PBL contributes to a child's educational development can become stakeholders in the afterschool program and the PBL process. As a short-term solution, a number of successful programs offered homework assistance at the end of the afterschool session, rather than at the beginning, to discourage parents who were primarily interested in homework help from picking up their children before PBL activities had been completed.

Lack of Staff Training and Buy-in

Successful PBL requires the effective participation of an engaged staff. PHMC program specialists observed that poor implementation often resulted when staff members were not well trained or were not committed to PBL.

In Philadelphia, sometimes lack of staff buy-in resulted from simple confusion. After the train-the-trainer workshop in June 2009, some site directors were more successful than others in relaying the content to their own staff. Additionally, turnover in the months between June and October left some sites without any staff trained in PBL.

At other times, lack of buy-in was the result of the staff's resistance to the PBL instructional model. School districts that have attempted to incorporate PBL on a systemwide basis report a similar phenomenon. "Changing an entire school culture is really hard work," says Corey Sholes, a former principal in the Bonner Springs School District near Kansas City, Kansas, where Expeditionary Learning Schools use a project-based model. "You just can't do it without the support of both administration and the teachers" (Barron & Darling-Hammond, 2008, p. 3).

Recommendation: Establish a Training Pipeline

Because professional development for OST program staff is essential to successfully implementing PBL on a systemwide basis, a training pipeline should be in place at project initiation. PHMC now offers a full menu of free PBL workshops, from introductory workshops on the basics of PBL planning and implementation to more specialized

workshops. These workshops are offered on a rotating basis and are available on-site when a program requests coaching. To encourage attendance, workshop facilitators are certified by the state agency that licenses afterschool programs in Pennsylvania. The workshops count toward the mandatory professional development hours required of licensed programs.

Because professional development for OST program staff is essential to successfully implementing PBL on a systemwide basis, a training pipeline should be in place at project initiation.

documentation in particular. At best, documentation is a useful tool that encourages program staff to think deliberately about project design, gives students a forum for reflecting on their experience, and allows program specialists to provide concrete, targeted coaching and assistance. However, any required documentation can easily become a *pro forma* exercise that loses meaning over time if staff members lose sight of its purpose.

Recommendation: Train Direct-Service Staff

PHMC initially offered training to site directors and agency leaders but not to direct-service staff. However, frontline staff members were widely responsible for implementing and, at some sites, planning projects. To address this gap, PHMC expanded its trainings to include direct-service staff. As they attended trainings, frontline staff members learned the PBL philosophy and method firsthand. Many came to embrace PBL because it gave cohesion and direction to their own best practices. Moreover, PHMC found that training veteran staff members empowered them to become PBL advocates in their own OST programs.

Uniform Implementation of PBL in a Diverse OST Network

Any attempt to reshape programming throughout an entire OST system will meet challenges, particularly in a diverse network of providers. The introduction of PBL in the Philadelphia OST network marked a paradigm shift. For some providers, PBL presented a significant change from the traditional OST pattern of snack, homework assistance, and physical activity. For others, the PBL approach mirrored the kinds of enrichment activities they were already implementing. PHMC created a series of administrative reporting requirements—observations by PHMC’s program specialists and PBL coordinator as well as site self-reporting on project plans, task lists, rubrics, and debriefing forms—to encourage uniform, high-quality implementation of PBL.

While PBL emphasizes fluidity and individualized learning, administrative standards are, by their nature, one-size-fits-all. Administrative requirements necessary to ensure rigorous, thoughtful PBL implementation were often in tension with flexible, organic PBL methods. Resolving this tension was a significant challenge. Program specialists reported resistance to the required

Recommendation: Implement a Pilot Program

Every OST program is different, and every network of OST providers has its own needs. Piloting PBL with a small number of programs before introducing it to the OST network can allow the intermediary to respond more easily to concerns and requests for assistance. Because PHMC did not implement such a pilot, it was not fully prepared to provide the extensive, network-wide professional development that proved to be needed. A pilot would enable the intermediary to anticipate the requests and challenges unique to its OST network. Additionally, a pilot would allow successful OST providers to share their best practices with colleagues so program staff could learn from others’ experience.

Recommendation: Set Clear Expectations

PHMC set clear expectations for its network of providers, minimizing confusion in the early stages of PBL implementation. Any other city or intermediary attempting systemwide implementation should be prepared to answer concrete questions about the number of projects per year, number of hours per project, number of hours per day, and number of days per week that PBL activities are expected to be implemented, as well as about any required documentation. Though a looser, case-by-case basis approach may seem appealing, especially given the flexible nature of PBL itself, the resources and support offered to OST providers are most effective if expectations are uniform.

Opening a Conversation

PBL is an integral part of the day at many primary and secondary schools and at colleges and universities. Its effectiveness has been repeatedly demonstrated in the scholarly literature. While most literature on PBL focuses on formal learning opportunities, the PBL approach supports key ar-

as of OST quality and youth development principles. Despite the challenges of adopting PBL systemwide, PHMC has found PBL to have a positive impact on the quality and rigor of program activities. Implementing PBL has enabled programs to better incorporate youth voice; develop students' 21st-century skills; offer structured, planned activities; and improve staff development. PHMC has found that the benefits of PBL outweigh the challenges of managing tight schedules, obtaining staff buy-in, and training staff systemwide. We hope that this case study and recommendations from Philadelphia will open a conversation in the OST community and in the scholarly literature.

In 2011–2012, PHMC is conducting research on the effectiveness of various aspects of its systemwide approach to PBL. PHMC will assess the impact not only of PBL workshops on staff's knowledge of PBL and comfort in implementing it but also of PBL activities on students' collaboration skills and confidence in learning. The results of these studies will be available in summer 2012.

References

Alexander, D. (2000). *The learning that lies between play and academics in afterschool programs*. National Institute on Out-of-School Time. Retrieved from <http://www.niost.org/Publications/papers>

Barron, B., & Darling-Hammond, L. (2008). *Teaching for meaningful learning: A review of research on inquiry-based and cooperative learning*. Retrieved from <http://www.edutopia.org/pdfs/edutopia-teaching-for-meaningful-learning.pdf>

Blumenfeld, P., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., & Palincsar, A. (1991). Motivating project-based learning: Sustaining the doing, supporting the learning. *Educational Psychologist*, 26 (3 & 4), 369–398.

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

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

City of Philadelphia. (2002). *Core standards for Philadelphia's youth programs*. Retrieved from http://www.sp2.upenn.edu/ostrc/resources/core_standards/documents/CoreStandardsfor-PhiladelphiaYouthPrograms.pdf

Community Network for Youth Development. (2006). *Framework for youth development*. Retrieved from <http://www.cnyd.org/framework/index.php>

Grant, M. (2009, April). *Understanding projects in project-based learning: A student's perspective*. Paper presented at Annual Meeting of the American Educational Research Association, San Diego, CA.

Intercultural Center for Research in Education and National Institute on Out-of-School Time. (2005). *Pathways to success for youth: What counts in after-school*. Massachusetts After-School Research Study (MARS). Arlington & Boston, MA: Authors.

Markham, T. (2003). *Project-based learning handbook* (2nd ed.). Novato, CA: Buck Institute for Education.

Savery, J. R. (2006). Overview of problem-based learning: Definitions and distinctions. *The Interdisciplinary Journal of Problem-Based Learning*, 1(1), 9–20.

Schmidt, H. G., Machiels-Bongaerts, M., Hermans, H. Tencate, T. J., Venekamp, R., & Boshuizen, H. P. (1996). The development of diagnostic competence: A comparison between a problem-based, an integrated, and a conventional medical curriculum. *Academic Medicine*, 71, 658–664.

Seidel, S., Aryeh, L., & Steinberg, A. (2002). *Project-based and experiential learning in afterschool programming*. Boston, MA: Harvard Graduate School of Education.

Stepien, W. J., Gallagher, S. A., & Workman, D. (1993). Problem-based learning for traditional and interdisciplinary classrooms. *Journal for the Education of the Gifted Child*, 16, 338–357.

Thomas, J. W. (2000). *A review of project-based learning*. San Rafael, CA: Autodesk Foundation.

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.

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>