Project-based learning in education: integrating business needs and student learning

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Abstract

Purpose – The purpose of this case study was to investigate how project-based learning (PBL) is being practiced in Columbus Signature Academy (CSA), a high school located in Columbus, Indiana, USA.

Design/methodology/approach – The authors used the case study method to provide qualitative details about CSA’s use of PBL that is being practiced in a natural education setting.

Findings – The authors identified six emergent themes (community partners, dedicated facilitators, student group work, authentic projects, school culture, and science, technology, engineering, and mathematics (STEM)-focus) as the essential elements of the high school’s PBL use. The authors also evaluated CSA’s use of PBL using strengths, weaknesses, opportunities, and threats (SWOT) analysis and generated eight challenges that CSA should tackle to make it more sustainable.

Research limitations/implications – This study is contextualized in a high school located in Columbus, Indiana, so the authors cannot generalize the results of this study to other contexts.

Practical implications – This study showed that PBL holds outstanding potential to be an innovative approach to teaching and learning, and teacher professional development.

Originality/value – Major strengths of CSA’s use of PBL come from the integration of the workforce needs of local businesses and the broader educational needs of students. Active involvement of community partners to make a project authentic is an essential element of CSA’s PBL that distinguishes it from problem-based learning.

Keywords Case study, Project-based learning, SWOT analysis

Paper type Research paper

I just can’t help but think they’re going to be very, very successful, whether it be in college, or in the workplace, or whatever they choose to do because they’ve got skills that are valued today both by postsecondary institutions and by the workforce (William Jensen, Director of Secondary Education at Bartholomew Consolidated School Corporation, Columbus, Indiana, USA).

Project-based learning (PBL) is a means to meet business needs (Pearlman, 2009). In the mid-1990s, local business leaders in Napa, California, were concerned that meeting...
basic educational standards would not be enough to ensure that students were graduating with the skills needed for the new economy. Working with the local school districts, business and community leaders began searching for innovations in education. This led to the establishment of Napa’s New Tech High School, the first PBL School, in 1996. Ten years after the establishment of the school, an evaluation report (Rockman et al., 2006) revealed that the two most valuable aspects the alumni learned in the school were the use of technology as a tool for learning and the project rich curriculum.

In line with the PBL school reform, Columbus Signature Academy is a network of schools spanning grades kindergarten through 12, all with the same mission, “to prepare socially engaged citizens who excel in an information and technology rich society” and all with PBL at the heart of their instructional approach. Columbus Signature Academy New Tech (CSA, hereafter) is the high school campus of this unique learning system in Columbus, Indiana. Perhaps, the best way to capture the school’s PBL approach is to share an example of a PBL unit in an American Heritage class.

American Heritage addresses the academic standards of both US History and English in Indiana. In the spring of 2011, students posed a driving question, “What were the causes and course of the Second World War, the impact of the war on US society and culture?” Student responses resulted in a documentary titled The Last Generation: A World War II Documentary. Students worked in teams to create the documentary, interviewing 12 Second World War veterans for five weeks and shared it with the public at a local theater. With minimal guidance from facilitators (the term for teachers at CSA), all juniors (86 students) were involved in the division of labor including researching, interviewing, operating, editing, marketing, and recruiting local sponsors. When asked why it was titled The Last Generation, a junior responded, “We’re the last generation that will be able to talk with World War II veterans, so we wanted to document that for future generations” (Alspaugh, 2011).

This project highlights the essential elements of PBL and is an example of collaboration between community partners and education that enables learners to develop twenty-first century skills (e.g. critical thinking, problem-solving, communication, and collaboration).

The value of PBL for human resource development
The use of projects for both learning and task achievement has been an essential part of organizational life because teams are a fundamental learning unit in an organization and play a crucial role in organizational learning (DeFillippi, 2001; Senge, 1990). Projects serve as the ideal setting for developing inquiry skills in all levels within the organization, to reveal deeper aspiration and construct shared understanding (Ayas and Zeniuk, 2001). The connection between learning and work through projects led to the link between PBL and human resource development (HRD), though there have been only a few studies of PBL in HRD (Poell et al., 1998, 2009). Compared to action learning that has been frequently used in business (Cho and Bong, 2013) and problem-based learning in education (Hmelo-Silver and Barrows, 2006), PBL has been used both in business and in education but has not garnered sufficient attention from HRD. This case study of a high school’s use of PBL, therefore, will provide an outstanding
opportunity to pay close attention to distinctive features of PBL that can be better embraced in HRD research and practice.

**Theoretical background**

PBL has been used in business and education for decades. *Management Learning* published the first special issue (Vol. 32, No. 1) of PBL in 2001 to draw upon diverse practice and research experiences with PBL in business (DeFillippi, 2001). PBL is defined as “the theory and practice of promoting individual and collective learning through projects” (DeFillippi, 2001, p. 5); thus, PBL is a significant aspect of organizational learning (Keegan and Turner, 2001). Project success can be evaluated in terms of both the project’s achievement of its technical and financial goals and the project’s generation of participant and company learning (Arthur et al., 2001). In her exploratory study of learning processes in 12 project teams in a manufacturing company, Edmonson (2002) explored how those project teams allow an organization to engage in radical and incremental learning, as needed in a changing environment.

PBL in education is defined as an approach to teaching and learning that is designed to engage students in investigation of authentic problems (Blumenfeld et al., 1991). According to Kilpatrick (1918, p. 320) who first coined the project method, projects help students learn best when “wholehearted purposeful activity” is present. Two essential components of PBL require a question or problem that serves to drive activities and artifacts or products that address a driving question (Blumenfeld et al., 1991). Krajcik et al. (1994) add three more features:

1. projects allow students to engage in investigations;
2. projects involve students, teachers, and community partners; and
3. projects promote students using cognitive tools (e.g. technology).

Research on PBL reports positive outcomes on student content knowledge (Barron et al., 1998; Geier et al., 2008; Mergendoller et al., 2006a; Walker and Leary, 2009), student engagement and motivation (Belland et al., 2006; Brush and Saye, 2008), and twenty-first century skills such as problem-solving, collaboration, and communication skills (Belland et al., 2006; Blumenfeld et al., 1991; Grant, 2011; Mergendoller et al., 2006a) as well as positive results with low achieving students (Geier et al., 2008; Mergendoller et al., 2006a).

Barron et al. (1998) showed that fifth graders working on a geometry project linked to architecture and design utilized measurement skills, of which 84 percent met architectural building standards, thus leading to substantial gains in their abilities to understand, use, and present geometric concepts. Mergendoller et al. (2006a) provided evidence that PBL was found to be a more effective instructional approach for teaching macroeconomics knowledge than traditional lecture-discussion. Additionally, PBL was more effective with 12th grade students of average verbal ability and below, students who were more interested in learning economics, and students who were most and least confident in their ability to solve problems.

Brush and Saye (2008) suggested that a multimedia problem-based unit provided an authentic context for encountering historical content so as to encourage 11th grade students’ deep engagement with a historical problem. Student motivations to complete projects are highly encouraged when projects are personally relevant. A national survey (Ravitz, 2010) revealed that high school teachers who used PBL in core
academic subjects believe PBL teaches such twenty-first century skills as collaboration and communication beyond academic content. Belland et al. (2006) showed that PBL benefited special education students in developing collaborative skills such as patience and compassion. PBL can also achieve affective learning goals while accomplishing cognitive goals (Grant, 2011).

PBL appears to be as effective as traditional instructional approaches and there are studies that show PBL to be better. Implementation of PBL in Detroit Public Schools has demonstrated that standards-based, inquiry science curriculum can lead to standardized test gains with historically underserved urban students of sixth to eighth grade, when the curriculum is highly aligned with professional development and administrative support (Krajcik et al., 1998; Marx et al., 2004; Geier et al., 2008). Students in 16 New Tech high schools in Indiana performed better on the end of course, assessments than comparison schools and improved attendance and behavior as they progressed from one academic year to the next (Bradley-Levine et al., 2011). Students of the extensively trained PBL-using teachers in West Virginia performed no differently on standardized tests than a matched set of students taught by non-PBL-using teachers who had not received extensive training (Hixson et al., 2012).

**Problem statement**

PBL addressing both business and educational needs has rarely been conducted. It seems that there are at least two reasons for that. The first reason has to do with the established status of research on problem-based learning in the past three decades, resulting in an extensive list of outcomes that largely favor problem-based learning (Walker and Leary, 2009; Wirkala and Kuhn, 2011). Problem-based learning is an instructional method in which students learn through solving problems and reflecting on their experiences (Hmelo-Silver and Barrows, 2006). PBL, labeled as being "under the broad umbrella of problem-based methods" (Ertmer and Grant, 2011, p. 4) has been overshadowed by problem-based learning research and practice instead of being recognized as a unique, independent learning approach.

The second reason is the lack of research on "authentic" PBL practice in education addressing business needs. PBL in education has been actively used in diverse contexts including computer-based learning environments (Cognition and Technology Group at Vanderbilt (CTGV, 1992); Grant, 2011; Land and Greene, 2000). Researchers tend to employ “packaged” projects (Thomas, 2000, p. 17) to examine the effectiveness of the use of a learning platform for student learning. The CTGV’s (1992) Jasper experiment is an example of a video-based instructional macrocontext for complex program generation and problem solving. Preservice teachers developed projects for integrating the World Wide Web unit in the curriculum (Land and Greene, 2000). Grant (2011) implemented a web site to examine eighth graders’ experiences in PBL.

In this study, “authenticity” means to see authentic, natural student learning without any interventions enacted by researchers. In many cases, researchers design and implement a learning platform to investigate the learning process in which learners use resources to solve problems. Packaged projects allow for the possibility that students’ performance on posttest measures is more attributable to guided inquiry (Thomas, 2000). These studies, however, had limitations to see the essential elements of PBL such as authenticity, student engagement, and a natural learning process, particularly in line with business and workforce development needs in the region.
Thus, the field needs more empirical studies of PBL that would provide authentic PBL practices, investigate essential elements of PBL, and evaluate the effectiveness of PBL. This study is an attempt to meet that need through a case study of one high school’s use of PBL. We investigate how CSA’s PBL is meeting business and educational needs.

Methods

The purpose of this case study was to investigate how PBL is being practiced in CSA, a high school located in Columbus, Indiana. Research questions for the study were:

RQ1. What are the essential elements of the use of PBL in CSA’s particular learning environment?

RQ2. What are the strengths, weaknesses, opportunities, and threats (SWOT) of CSA’s use of PBL?

We used a SWOT analysis to evaluate CSA’s use of PBL. The SWOT analysis is most often used as a tool for scanning an organization’s internal strengths and weaknesses that are controllable as well as its external opportunities and threats that are difficult to control (Chermack and Kasshanna, 2007; Leigh, 2010). The SWOT analysis of CSA’s use of PBL addressed the workforce needs of local businesses and the broader educational needs of students.

Case selection

We chose the case study method in this study. The case study approach is appropriate when the researcher is interested in “how,” “what,” and “why” questions and emphasizes the rich, real-world context in which the phenomena occur (Eisenhardt, 1989; Ellinger et al., 2005). We used the case study method to provide qualitative details about CSA’s use of PBL that is being practiced in a natural education setting.

We selected CSA, a New Tech high school established in 2008 in Columbus, Indiana for this case study because the school immerses students in PBL. The school has a total of approximately 370 students in four grades with 21 teachers. The school has a science, technology, engineering, and math (STEM) focus, so students take STEM-focused, interdisciplinary courses such as Global Science Perspectives (GSP) combining geography, science and English, taught by two teachers.

Data collection

We used multiple data collection methods. We visited the school 11 times from February 2012 to May 2012. Interview and observation were used as primary data collection methods. We also visited the school for four days in August 2012 to do member-checking with interviewees. We performed interviews with a total of 34 stakeholders from the school (teachers, students, alumni, parents, administrators, and community partners) for a total of 17.35 hours (Table I). Each interview took between 30 minutes and 1 hour to conduct. We audio-recorded interviews and took careful notes. In order to ensure facilitators’ anonymity, their names were not specified.

We observed and video-recorded several classes and extra-curricular activities. We visited Cummins (a neighboring company) to observe how students learn from an engineer to drill an aluminum pole for a wind turbine shaft for a class project. We also observed and video-recorded a critical friends group (CFG) meeting where teachers
exchange feedback on projects on a weekly basis. A total of 6.8 hours (407.8 minutes) were video-recorded.

For secondary data, we reviewed web sites of CSA, New Tech Network (a PBL school development group), Center of Excellence in Leadership for Learning (Indiana University-Purdue University Indianapolis’s Research Center for PBL), Buck Institute for Education (a PBL dissemination group), and EcO15 (a workforce development group in Southeast Indiana) to get more information about the context of CSA’s use of PBL. We also reviewed local newspaper articles of successful projects and products (e.g. a documentary).

Data analysis
Data analysis in qualitative studies is emergent and is concurrent with data collection (Eisenhardt, 1989). Tabular displays and figures were used as a means of accomplishing the overlap between data collection and analysis. We also used direct quotes to ensure the fidelity of the primary sources. Completely transcribed interview data were analyzed coding the data (reducing the data into meaningful segments and assigning names for the segments), combining the codes into broader categories, and making comparisons in the data (Creswell, 2013). The “constant comparative method” (Glaser and Strauss, 2008, p. 101) was used to compare one segment of data with another to determine similarities and differences. As a result of the iterative process of the constant comparative method, six themes of CSA’s use of PBL emerged.

To ensure reliability of the study, we examined six emergent themes and reached consensus through discussion. Video-recorded data were used to either confirm or falsify emergent themes from interview data. We also used member-checking to establish credibility (content validity). We asked all interviewees (except students and parents) to review and provide comments on the initial analysis of the interview data. We made use of their comments on minor mistakes and clarification in finalizing this article.

RQ1: essential elements
As a result of qualitative data analysis, we identified six essential elements of CSA’s use of PBL: community partners, dedicated facilitators, student group work, authentic projects, school culture, and STEM-focus.
Community partners

In this study, we define community partners including the school district (Bartholomew Consolidated School Corporation (BCSC)), business leaders (e.g. Cummins), and non-profit organizations (e.g. EcO15) advocating CSA as a learning environment. Community partners view CSA as being crucial to economic development in their communities. Teachers and administrators believe that CSA should meet the needs of community partners—graduating students with twenty-first century skills of a work ethic, written and oral proficiency, critical thinking skills, and technological proficiency.

BCSC was one of the first school districts to bring PBL schools to Indiana. In 2005, Bill Jensen, Director of Secondary Education for BCSC, with community leaders, visited New Tech high schools in California to witness their use of PBL. BCSC and community leaders committed to creating CSA—including K-12 schools in their vision. CSA’s principal and a design team of teachers were recruited to design curriculum and open a school centered on school-wide learning outcomes and twenty-first century skills.

Cummins is a global engine company headquartered in Columbus. Because education is regarded as an important initiative in the company, it supports CSA. Cummins is “trying to see what we can do to bridge the gap between our needs and what the school is able to provide with curriculum to help prepare students to come to work” in its coordinator’s words. The company is a part of the “School to Work Opportunities” program in Columbus where juniors and seniors work in a field and can be paid.

The purpose of EcO15 (Economic Opportunities through Education by 2015) is to prepare the population of Southeast Indiana (including BCSC) for manufacturing and healthcare industries. Its workforce development initiative involves an annual PBL Academy, an opportunity for teacher professional development. The PBL Academy began in 2009 as “Math Matters” with about 50 secondary mathematics teachers. Since that time it has expanded to include teachers of all subjects at all grade levels and other educators Pre-K through post-secondary education. To date, approximately 400 educators have participated in the PBL Academy.

Based on this forward-looking partnership, CSA and community partners recently developed a pilot program titled, “Collaboration for an Engineering Immersion Program,” led by EcO15 with neighboring colleges (Ivy Tech Community College and Indiana University-Purdue University Columbus). In this initiative, CSA students can enroll in college courses without cost. The program goal is not only to create a seamless transition from high school to college to increase the number of local qualified engineers but to mitigate the “brain drain” that Indiana faces so high school graduates can stay and be the workforce that the state needs.

Dedicated facilitators

Teachers at CSA are facilitators, a title that reflects a change in their role. A facilitator in CSA is someone who “is flexible, takes advice from others, and is willing to have relationships with kids.” Most facilitators express that they have greater teacher satisfaction because “it is more fun to teach PBL than the traditional.” CSA’s facilitators vary greatly in years of teaching experience. A number of facilitators have spent years teaching in traditional schools. Reasons they chose to work at CSA include “I needed to be professionally challenged.” A number are first-year teachers, graduated
from college with no prior experience in teaching. These teachers reported that they applied to work at CSA because “I thought it would be a great place to learn.”

Facilitators design projects, often in collaboration with other facilitators and/or students. Projects are always designed to address standards students are required to meet in a particular course. Projects are launched through an “entry event,” which provides students with information, context, a question, problem or challenge. Some time is spent understanding the task, articulating what they know and what they need to know in order to accomplish what is asked of them. Then students get to work, generally in teams, but sometimes alone. Students learn to be self-directed learners, responsible for their own learning. Facilitators plan “workshops” on content that students need to know. Facilitators suggest or students request these workshops as they become relevant to complete the project. The role of a classroom teacher then changes from giving students information to making sure that students have access to the information they need.

Facilitators in PBL classrooms appreciate the diversity of the learners with whom they work and the use of strategies (Mergendoller et al., 2006b) to address diverse learning needs including: Universal Design for Learning (UDL), student engagement, and feedback/reflection. BCSC uses UDL as a conceptual framework in the school district and is committed to educating all children through the principles of UDL. UDL is defined as “a set of principles for curriculum development that give all individuals equal opportunities to learn.” Facilitators find a balance in what they do and how they do PBL because of UDL. Facilitators provide students with different avenues to learn and be assessed so that all student learning styles and interests are addressed.

As for student engagement, facilitators get buy-in from students early on in order to engage students in projects. Students report that they are engaged because they are learning content through authentic projects that have real life applications and because they can solve real problems for community partners. To motivate students, facilitators give them specific tasks to do, so they know what they are doing. Facilitators find an aspect of a project that appeals to students the most and allow them to take control over it. It is also important to make sure there is an alternative option (e.g. writing) for students who feel uncomfortable sharing. Along the way, students learn to develop self-initiative in order to engage themselves. How to engage students in projects is a critical issue that causes facilitators to be aware of their attempts at making CSA’s use of PBL successful.

Facilitators use reflection in two ways. In class reflection students learn how to see the bigger picture, while in individual journal reflection students have opportunity to reflect on their own work. These reflections allow facilitators to get feedback from students directly and indirectly. A facilitator suggests an outstanding feedback strategy:

I call it “Skyrockets in Flight” because students made paper airplanes. They enjoyed the idea of getting up and throwing up a paper airplane, but then they were able to take whatever they picked up back to their seat and read what they wrote. I asked them to think about that and then respond with, “what do you think of what they said?”

For facilitators, creating project ideas can be a daunting task, particularly for first-year teachers. CFG surfaced as an excellent tool for teacher professional development. In a weekly meeting, facilitators share project ideas and give each other feedback. Facilitators find practical tips for projects and locate community partners through
weekly CFG meetings. For facilitators to create project ideas and to engage student interest, they need diverse professional development opportunities including internal tools (e.g. CFGs) and external tools (e.g. PBL Academy) (Table II).

**Student group work**

PBL gives students opportunities to work on authentic projects, and build collaboration, presentation, and communications skills, all of which are twenty-first century skills. Students work together to complete projects by approaching problems and finding solutions. However, just doing projects is not PBL because it takes time and a community of people that understand what PBL is for students.

In PBL, it is easier for students to be distracted, depending on the grade level. Seniors understand how PBL works and require little direction, whereas freshmen need more guidance and need steps on how to go through group work. Facilitators start by teaching students to hold each other accountable by asking them to write a group contract concerning what to do and what not to do in group work. An immediate challenge in group work, therefore, is how to choose a group. Facilitators teach students that it does not matter who is in their group but it matters how they act within the group; that group dynamics can be the same as long as they work with a common goal; and that setting up a goal, keeping the end goal in mind, and coming up with ways to get there are crucial.

One story about a failed group is legendary in CSA. A student in the group took the initiative and made a presentation about why her group failed. It turned out that they did not communicate, no one was accountable, and the group never visited their group contract. This was the time when a community partner from Cummins came in:

> The school had just gotten started. I was talking to my wife [a CSA facilitator] and she was saying that the project didn’t go over very well. The students didn’t know what to do. We brought four or five employees into the center cafeteria and we modeled the behavior for how to plan and how to organize schedules. This was very simple for us because it was the stuff we do every day. But for the students, it was very enlightening, so there were other projects went a lot better.

Another challenge that facilitators face in student group work is how to balance group work with individual work because students need foundational knowledge and essential skills before they work on projects. In CSA, students are graded not only on how the project turns out as a group, but what they individually put into it. Students

<table>
<thead>
<tr>
<th>Internal tools</th>
<th>External tools</th>
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<tbody>
<tr>
<td>Student feedback</td>
<td>New Tech Network Conference</td>
</tr>
<tr>
<td>Reflecting on “what didn’t work?”</td>
<td>Network with Napa people</td>
</tr>
<tr>
<td>Classrooms</td>
<td>Meeting of the Minds (with the regional New Tech schools in Indiana)</td>
</tr>
<tr>
<td>Reading</td>
<td>PBL Academy and PBL Institute</td>
</tr>
<tr>
<td>Research</td>
<td>Workshops (e.g. UDL Conference)</td>
</tr>
<tr>
<td>Mentor</td>
<td>Summer courses (required)</td>
</tr>
<tr>
<td>Critical friends group</td>
<td>Enrollment in a PhD program in education</td>
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<tr>
<td>Principal’s feedback</td>
<td>Twitter</td>
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</tbody>
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Table II.

CSA facilitators’ professional development tools
have group collaboration evaluations in which they give group members the grades they deserve. Lately, individual work (e.g. reading comprehension quizzes and personal journaling) is considered as important as group work, though facilitators do not intentionally make a distinction between the two.

**Authentic projects**

In CSA, PBL is defined as students learning content standards while engaged in authentic real-world projects. An experienced teacher who came from a traditional school defines the meaning of “authentic” in context: “In the other [traditional] school, I didn’t always worry about the authentic piece that a community partner really needed.”

In CSA, all projects start with standards – Indiana State standards and the Common Core standards. A set percentage of weighting of the school wide learning outcomes is the standard for every class. When faced with the task of covering many content standards in a project, there is prioritization that has to occur. There is a push and pull between accountability to the content standards and looking for ways that facilitators should apply those standards to projects.

We identified successful (or failed) projects in CSA (Table III). Two projects (a house wiring project in Physics and a documentary of Second World War veterans in American Heritage) stand out in terms of collaborating with community partners. For the house wiring project ([http://cell.uindy.edu/e-news/april2012/0183.php](http://cell.uindy.edu/e-news/april2012/0183.php)), students studied electricity and magnetism and then went out to wire low-income houses. The documentary project ([www.youtube.com/watch?v=OQTolEuzpBo&feature=youtu.be](http://www.youtube.com/watch?v=OQTolEuzpBo&feature=youtu.be)) was successful in terms of being professional and touching.

**School culture**

CSA has a strong culture embracing shared values of trust, respect, and responsibility. An important element of the school culture is that it truly aims to be “our school” by attempting to facilitate a sense of ownership in the school. The students have a voice that matters and that is what “our culture” strives for. In advisory meetings, students meet for 20 minutes and discuss how to be responsible for their school. Students are required to live their shared values in everything that they do. There are no bells because students are responsible for getting to class. There are no rows of lockers – students must be trusted not to steal from one another. If there is a student that has their feet on the furniture, the principal will ask the students around him, “Why are you letting him do that?”

Many facilitators stated that their role is to ensure the school culture by creating events, lessons, and curriculum that are consistent with CSA values. Facilitators also teach students how to resolve conflicts. They believe that student gossip damages the school culture because students talk about other students instead of having heartfelt conversations. When a conflict happens, students have a responsibility within 24 hours to check-in with the principal.

The school building is another critical element for CSA’s culture. To create an open school culture, the design team had to build a separate facility that used to be a large, empty warehouse. Bill Jensen, the Director of Secondary Education at BCSC, stated:

We told architects several things for the design of the building. Number one is that we did not want to look like a high school. Number two was we wanted it to reflect the twenty-first
### Table III.

<table>
<thead>
<tr>
<th>Class</th>
<th>Project (title)</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics</td>
<td>(House-Wiring): students studied electricity and magnetism and wired low-income houses (with the help of a CELL grant)</td>
<td>Awarded “Best in the Network” (2011)</td>
</tr>
<tr>
<td>Environmental Science</td>
<td>(Louisiana Fieldwork): we had a one week trip to Louisiana in October, 2011. In January 2012, students worked on coordinating things and doing background research. We planted 3,200 black mangrove plants on one island and 300 beach stabilization grasses on another part. We talked to environmental scientists from BP. Someone from the Audobon Society came and then we built bird shelters for baby birds. Students were in charge of making all of the contacts. They raised and paid money. They (Louisiana) would like us to come back. The hardest part of it was getting it set up, finding contacts, finding a place to go, finding what we wanted to do.</td>
<td>A large project spilled over from the first semester.</td>
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<tr>
<td>Biology</td>
<td>(Salad Dressing): we did a salad dressing project and ours was the worst tasting one ever. It was terrible, but we still learned everything everyone else did. That would be a failure in the aspect of taste, but success we got one of the highest grades in the class because of our presentation.</td>
<td>“Failed success”</td>
</tr>
<tr>
<td>Calculus</td>
<td>(Robotic Cars): we partnered with Robot Town (a start-up foundation in Detroit, Michigan) where was working on robotic cars and looked at their cruise control systems through observations. This seven-week project was powerful in helping students learn the content, but it is a distant project so collaboration was difficult.</td>
<td>The facilitator contacted the company through a TED Talk.</td>
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<tr>
<td>Algebra</td>
<td>(Systems and Equations): we had to create this thing called an x-mag, make a formatted PowerPoint, and turn it into a pdf file online. It turned out to be a math magazine. Not only did we learn how to make a magazine and become reporters, but we learned how to interpret math into paragraphs that way that people could understand and to put it into three different perspectives.</td>
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<tr>
<td>Geometry</td>
<td>(Truss Bridges): we made truss bridges out of little corndog sticks. When we finished the design we strapped weights to it to see how much it could hold. Our bridges held it was 25 pounds out of little corndog sticks and school glue. Eventually it broke, so that would be when it failed, but it was a success because we learned about truss bridges and triangles.</td>
<td>“Failed success”</td>
</tr>
<tr>
<td>Global Science Perspectives</td>
<td>(Green Audit): each group visited a business in Columbus, did an assessment of their green practices, made recommendations that would reduce their carbon footprint, and that reduce cost for the business (Amazing Race): they (facilitators) were trying to teach us climate and geography. We had these clues to our next location every week and we would have to figure out where it was. But the pictures and the clues they would give us were so vague that it would take us days to figure it out. That one was dragged on for a month. They are giving students not enough direction to go anywhere. We need a little bit of a structure.</td>
<td>“Failed”</td>
</tr>
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</table>
century workplace. Number three was we wanted to make sure that the instructional space accommodated PBL.

Due to the innovative design of the school building, CSA has hosted about 1,100 visitors from 19 different states wanting to witness the importance of a facility for PBL. In this open school environment, facilitators are being pushed and challenged:

I’ve got glass walls. So everyday I’m being observed and I notice if someone hangs outside my room for a while, I try to follow up and ask questions. We have the opportunity, because we have such an open school, know what’s going on. That is what’s really important to professional learning community, is that openness and transparency and not being afraid to be observed.

However, there are two issues evident in the school culture. First, facilitators know that CSA’s open culture can be fragile like “a leaky dam. The dam is strong, but there’s always a little hole in it, so you just got to maintain all the time.” Second, facilitators must work hard continuously because it takes a long time to prepare for PBL. For CSA to be successful, it takes dedicated facilitators who are willing to do PBL.

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<th>Class</th>
<th>Project (title)</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Heritage</td>
<td>Documentary titled <em>Last Generation</em>: we interviewed Second World War vets, because they are not as easy to find in this day and age, and so we wanted to get their story of the war first hand. The juniors completely did the project on their own. We (facilitators) scheduled and gave them the project calendar, deadlines and benchmarks along the way, but they did the interviews, the transcriptions for the project, and the filming. We had lots of workshops along the way to help teach them how to do the lighting and the filming and how to talk to a war vet in a sensitive manner. They did all of the editing of the film and producing of the film. We did fundraising to help support the cost of putting this film together. We showed the film at a local venue, the Yes Cinema, which is a privately owned movie theater. We opened it up to the public and sold tickets and raised over 2,000 dollars. We paid for the expenses of the movie and donated the rest to the Wounded Warriors Project. It really was a total package.</td>
<td>“Very successful, emotionally touching, and professional”</td>
</tr>
<tr>
<td>Social Justice</td>
<td>(Mock Interviews): we said, “You guys are turning sixteen. You are going to be looking for jobs. You are going to have to use these skills to get there.” We set up with different companies, and future careers that they were potentially interested in. And then I hit standards on resumes and cover letters. We had about eight kids really use their resume and get a job after that.</td>
<td>Social Justice</td>
</tr>
<tr>
<td>Spanish</td>
<td>(Community Heroes): students invited community heroes, firemen, policemen, and different people came in. They put on this wonderful little event for them. I guided them but they put on the event, they set up the room, they had a little ceremony, they had a video.</td>
<td>Spanish</td>
</tr>
</tbody>
</table>

*Note:* In this table, we used direct quotes of teachers and students to clearly witness what they did for those projects

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Table III. Project-based learning in education
As a STEM-focus school, the school integrates science and language arts classes, and uses technology for PBL. An important assumption of curriculum integration is that “The language arts are channeled through the science content and we never sacrifice the humanities for science.” In GSP, for example, Global is the geography, Science is scientific thinking, and Perspectives are there to represent the language arts. While GSP is a freshmen level course, sophomores take Social Justice (English and Social Studies) and juniors take American Heritage (US History and American Literature). GOIRED is Geometry integrated with Engineering and BioLit is a remedial course for students who failed literature or biology. As a result of the school’s emphasis on language arts and writing in every class, CSA outperforms traditional neighboring schools in the standardized English tests.

The technology in CSA is used to support instruction. CSA’s technology team has worked closely with the instructional design and curriculum team as they work through new buildings and programs. Mike Jamerson, Director of Technology at BCSC, informed us as to how the school ended up using laptop computers:

New Tech had said, “Well, here’s our vision for the New Tech. It’s a one-to-one program and it’s done with desktop computers.” We came back to them and said, “We want to use wireless laptop computers.” And they said, “Well, you can’t do that. It’s non-negotiable. You have to use desktops.” We said, “Laptops are non-negotiable. It’s an instructional issue. We’re working in a mobile environment.”

When a project is identified, technology is there to help students forward in their project. CSA provides a laptop computer to every student because it makes PBL more relevant. Echo is a built-in learning management platform in PBL, which is used by facilitators and students as well as parents. Additionally, students are expected to use their computers as professionals would. In the GSP class, for example, students use Twitter to research experts, follow those experts, and look at resources that those experts post. To be more forward-looking in the use of technology, CSA’s next priority is to support “Bring Your Own Device” as a way to provide more anywhere and anytime access for students.

**RQ2: evaluation**

To answer the RQ2, we used a SWOT analysis tool to evaluate CSA’s use of PBL. Table IV summarizes the results of the SWOT analysis and the challenges that CSA faces in meeting business and educational needs.

**SWOT analysis**

Table IV shows the SWOT of the CSA’s use of PBL. Internal factors (strengths and weaknesses) are relatively easy to manipulate within a short timeframe, whereas external factors (opportunities and threats) are difficult to control and take time to make happen.

Internal factors (strengths and weaknesses) revolve around four major factors: PBL, facilitators, students, and culture. These four factors have two different sides, positives and negatives. PBL surfaced as best for developing twenty-first century skills for the new economy but it is not for everyone and is difficult to apply content in all projects. CSA’s facilitators are fully dedicated to students but recruiting best fit facilitators has been a challenge. Facilitators invest extra effort to build PBL so a work/life balance
issue surfaces from a longer-term perspective. Students are engaged in authentic projects to solve real problems and are learning twenty-first century skills to be ready for their careers. However, some students become distracted in PBL and face unengaged group members who equally share their group work. Due to CSA’s small size, students cannot enjoy many extra-curricular activities, classes, spaces, and resources. CSA’s culture has been self-managed based on shared values of trust, respect, and responsibility and everyone enjoys a small, welcoming, family-like environment. However, school culture is vulnerable to student disrespect and disengagement so it requires constant management. Faced with the two sides of four major factors, a critical issue becomes how to balance positives and negatives to make CSA’s use of PBL more sustainable.

In line with external factors (opportunities and threats), PBL is regarded as a natural fit in the digital age, and CSA has many opportunities to diversify with people who have not experienced PBL with the support of thriving community partners. CSA

<table>
<thead>
<tr>
<th>Internal Strengths</th>
<th>Weaknesses</th>
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<tbody>
<tr>
<td>Building on twenty-first century skills through authentic projects</td>
<td>PBL is not for every student</td>
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<tr>
<td>Students’ opportunity to lead</td>
<td>Easier for students to be distracted</td>
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<tr>
<td>Students are held accountable</td>
<td>Fragile student culture (e.g. student disrespect)</td>
</tr>
<tr>
<td>Students can mature quicker because PBL goes beyond content</td>
<td>For some students (e.g. students with disabilities), the amount of support could be less than they received elsewhere</td>
</tr>
<tr>
<td>High student engagement</td>
<td>Small size: not many extra-curricular activities and courses, spaces, and resources</td>
</tr>
<tr>
<td>School culture: trust, respect, and responsibility</td>
<td>Fitting content in all projects is difficult</td>
</tr>
<tr>
<td>Small, family culture</td>
<td>Finding teachers who fit into PBL is not easy</td>
</tr>
<tr>
<td>Interdisciplinary classes</td>
<td>Teachers have a tendency to revert to things that they feel safe doing</td>
</tr>
<tr>
<td>Teachers care for students</td>
<td>First-year teachers are not tight with rules</td>
</tr>
<tr>
<td>Teachers’ immediate feedback through Echo</td>
<td>Depends greatly on technology</td>
</tr>
<tr>
<td>Greater teacher satisfaction</td>
<td>The work/life balance issue due to extra work required</td>
</tr>
<tr>
<td>Combination of young and experienced teachers</td>
<td></td>
</tr>
<tr>
<td>Free college credits</td>
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<td>Supportive administration</td>
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<table>
<thead>
<tr>
<th>External Opportunities</th>
<th>Threats</th>
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</thead>
<tbody>
<tr>
<td>PBL allows innovation and creativity</td>
<td>Pressure to perform on standardized tests</td>
</tr>
<tr>
<td>PBL is natural in the digital age</td>
<td>Negative perceptions of the school (e.g. “the nerd school” or “the reject school”)</td>
</tr>
<tr>
<td>Opportunities to reach out to people</td>
<td>Funding</td>
</tr>
<tr>
<td>Opportunities for vocation training for students with learning disabilities</td>
<td>Teacher union</td>
</tr>
<tr>
<td>Thriving business community</td>
<td>Lack of public awareness of PBL</td>
</tr>
<tr>
<td>Opportunities to tie into community partners</td>
<td>Threat to higher education because students are not going to learn in college the same way the traditional college students learn</td>
</tr>
<tr>
<td>A partnership for an engineering immersion program with IUPUC, Purdue School of Technology, and Ivy Tech Community College</td>
<td>Overemphasis on standardized testing for the evaluation of student performance, teachers, and schools</td>
</tr>
<tr>
<td>Opportunities to push how testing should be done at the state level through a network of PBL teachers and organizations</td>
<td>Brain drain: students who received education leave so the community loses workforce</td>
</tr>
<tr>
<td>Friends of the New Tech community</td>
<td></td>
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</tbody>
</table>

Table IV. SWOT analysis of CSA’s use of PBL
and higher education institutions are collaborating in a timely manner to form new partnerships with which students can benefit when planning their careers. CSA also contains factors that are threatening the adoption and diffusion of PBL to a wider audience. An overemphasis on standardized tests for the evaluation of student performance, teachers, and schools has been a major threat for CSA. Because standardized testing is just one piece of evaluation to measure student learning, PBL practitioners are faced with a challenge regarding how to put in place an evaluation process that best fits with PBL. Other threats involve a lack of public recognition of PBL and negative perceptions of CSA (e.g. being regarded a “nerd” or a “reject” school) because of the big school mentality that the general public is familiar with.

**Challenges**

Based on a SWOT analysis, we present major challenges that CSA should tackle to make PBL more sustainable (Figure 1). Figure 1 shows eight challenges that CSA faces, including four immediate challenges (inner circles) and four distal challenges (outer circles). Immediate challenges (facilitators, students, community partners, and school culture) are the ones that can be tackled immediately. Distal challenges (CSA’s infrastructure, technology, public recognition, and standardized tests) are the ones that take time and resources to make happen.

In terms of immediate challenges, first, CSA should recruit competent facilitators who are passionate about PBL and should support inexperienced teachers by providing professional development opportunities. The recruiting and hiring process

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**Figure 1.** Challenges for CSA’s use of PBL.
for facilitators is extensive, and parents and students are part of the interview committee. Parents seem generally satisfied with most facilitators but they still hope to have all facilitators having equal levels of competency. To sustain a healthy school culture, CSA needs constant management of vulnerable areas (student disrespect and disengagement). An impending issue that CSA faces is to revamp advisory meetings, an indispensable venue for discussion between students regarding their school culture. Beginning the first day of classes with meetings on culture building has been a recent tradition, which helps set expectations for school culture. CSA needs a wide range of community partners in diverse contexts so students can experience more fulfilling projects.

With respect to distal challenges, first, we define infrastructure including the school facility, budgets, and resources as well as parents. Although some facilitators seek external grants, they need enough in their budgets to buy equipment so they can focus on teaching. We also consider parents as part of the infrastructure because of their potential influences on the public through word of mouth. Many graduating seniors came to the school four years ago even when there was no building because their parents saw the potential of CSA’s use of PBL. Parents can be a strong advocate to help make PBL visible to the public better than anyone else. The use of technology in this school has always been innovative as in the use of laptop (not desktop) computers from the beginning and moving forward to support student needs anytime and anywhere. However, as some facilitators opined, CSA’s use of technology needs to be more inclusive in curriculum and project work. CSA should develop technology integration courses for facilitators and students. Benchmarking pioneering New Tech high schools whose major emphasis is on the development of technology skills can be a first step.

Discussion
Recent resurgence of PBL in education is telling in terms of business leaders’ initiative to make education innovative in cultivating twenty-first century skills for students to be well prepared for the new economy. Major strengths of CSA’s use of PBL come from the integration of the workforce needs of local businesses and the broader educational needs of students. Active involvement of community partners to make a project authentic is an essential element of CSA’s PBL that distinguishes it from problem-based learning.

We found that teachers came to CSA to be “professionally challenged” or to be “revolutionary” in their use of PBL. PBL was new to them but motivating enough to develop themselves through professional development tools so they can provide detailed guidance for student group work. We also found that the role of students change from being passive learners to becoming actively involved in authentic projects to solve problems that community partners face. In the process, students not only learn content knowledge but also learn soft skills (oral and written communications) needed to work in teams and with community partners. We witnessed that students can mature quicker in this learning environment because they learn more than just content through experiencing group work. Typical students in this school are articulate, confident, and willing to share what they know. We also witnessed that PBL works best for self-motivated and self-directed students.

Implications for practice
New approaches to instruction present challenges to both teachers and students (Grant, 2011; Helle et al., 2006; Krajcik et al., 1994, 1998; Marx et al., 2004; Mergendoller et al.,
Implementation of PBL is challenging in terms of taking more time, balancing learning content and inquiry, work load for students, student motivation and engagement, grouping strategies, a variety of scaffolds (verbal, textual, and technological) from teachers, peers, and technology, the need of comprehensive assessment, and community involvement. The PBL approach requires a teacher to shift their orientation from one of provider of information to one of facilitator of problem solving (Rogers et al., 2011). As the process of learning become more important as well as the products in PBL, teachers must develop ways of judging students’ abilities which are more congruent with the premises of PBL (Morgan, 1983); thus, there is a strong need for the use of multiple measures capturing both learning processes and outcomes in PBL. Effective use of PBL requires extensive planning and professional development, a supportive environment, and tools and strategies for effective instruction (Krajcik et al., 1994; Mergendoller et al., 2006b; Ravitz, 2010). Initial difficulties with implementation and disappointment with student performance, therefore, can lead to a premature rejection of PBL (Krajcik et al., 1998).

National and regional professional development efforts in PBL provide teachers with such an opportunity to improve their teaching for better student learning. These teacher professional development efforts using PBL address the workforce needs of local businesses. In a study performed at the Indiana statewide level (Ravitz et al., 2012), teachers who used PBL and received extensive professional development reported more teaching and assessment of twenty-first century skills overall. The evaluation of PBL implementation in West Virginia (Hixson et al., 2012) also showed that extensively trained PBL-using teachers taught twenty-first century skills more often and more extensively. The Detroit Public Schools’ professional development program (Geier et al., 2008; Marx et al., 2004) was designed to engage teachers in the intensive learning needed for them to change their practices to support standards-based, inquiry instruction. These researchers were able to accomplish success because “the work was embedded in a systemic reform context” (Marx et al., 2004, p. 1073). Successful implementation of PBL, therefore, requires extended professional development for teachers, sustained classroom support, and collaboration and commitment from school personnel (Krajcik et al., 1994).

**HRD research agendas**

In terms of research on PBL in education and its connection to HRD, this study delivers two implications: the comparison of the two closely related learning approaches and the inclusion of career and technical education (CTE) in HRD research.

Recently, the New Tech Network (a PBL school development group) made the decision to go to problem-based learning for math because teachers struggle with getting math to fit into a project, getting the content standards to be addressed, and doing well on the end-of-course assessments. Facilitators in CSA viewed PBL as a broader concept and problem-based learning as more focused and appropriate for learning foundational knowledge. They believe that the New Tech Network’s recent decision to use problem-based learning for math is taking away the depth of the project piece.

In essence, both project and problem-based learning are grounded in practice and in student engagement with real-world problem and project challenges that require students to learn by doing (DeFillippi and Milter, 2009). While problem-based learning
is designed to improve students’ problem-solving and reasoning skills through working on ill-structure problems (Grant, 2011; Mergendoller et al., 2006b), PBL involves the construction of a concrete artifact or project deliverable as an outcome of project work (DeFillippi and Milter, 2009; Grant, 2011; Helle et al., 2006). The two learning approaches emphasize an interconnection of learning and work, and value the power of teamwork, problem-solving processes and reflection, and the use of a facilitator. Differences between the two appear to lie in a particular context where each learning approach is used, the learning goal, the extent of using structure in the learning process, and the role of a facilitator. Investigation of the comparison of the two learning approaches, therefore, will be informative in the proper use of a particular learning approach in a particular context.

As PBL schools become more welcomed in meeting regional business needs as in this study, PBL has huge potential in adoption and diffusion in education. Indiana’s regional workforce development leaders have dubbed Economic Growth Region 9 (Southeast Indiana), The Project Based Learning Region, believing that PBL should be a means to improve STEM education and therefore the production of a much-needed supply of STEM-proficient workers. In this context, Indiana has the largest concentration of 23 PBL schools in the USA (New Tech Network, 2013).

The recent renewal of the Perkins Act of 2006 has enabled to pay more attention to CTE as a strategy for increasing school engagement and relevance for college and career readiness (Meeder, 2008). Stone et al. (2008) provided evidence that high school students’ math skills can be enhanced in the CTE courses based on the premise that math is a component of most jobs in STEM fields. Greens et al. (2011) shows a NSF-funded, three-year project that is developed to strengthen the STEM pipeline from high school to college. In this study, surveys of participating students’ postsecondary plans confirmed increased interest in STEM fields.

CTE and HRD have critical roles to play in the contexts of preparing individuals for work in which problem-solving, collaboration, and communication skills are required (Greens et al., 2011; Hill et al., 2013). However, due to the two fields’ isolated evolution and HRD’s business-focused research, interest in the scholarly and applied connection between the two (Kuchinke, 2013) was minimal, and, thus, calls for interdisciplinary collaboration.

Conclusion
When it comes to study limitations, this case study is contextualized in a high school located in Columbus, Indiana, so we cannot generalize the results of this study to other contexts. Although our single-case study richly describes CSA’s use of PBL, multiple-case studies will be more compelling and provide a stronger base for theory building in the field (Eisenhardt, 1989; Ellinger et al., 2005). Another issue has to do with our limited observations of CSA’s use of PBL because we have visited the school for 15 days total over seven months. Instead of focusing on student learning, however, we examined how CSA’s use of PBL integrates business needs and student learning. Because of the lack of interdisciplinary collaboration, we were not able to pay sufficient attention to theoretical background related to CTE/workforce development and its implications for HRD.

How would educators evaluate the success of the use of PBL in CSA? It appears that there are three intertwined, visible evaluation criteria: transformed students who
became equipped with twenty-first century skills, CSA’s high graduation rate, and school culture. Regarding students, CSA’s principal succinctly commented: “When community leaders visit our school, they want to hire our students not because of their test scores but because they know how to navigate the world.” In May 2012, CSA delivered its first 79 graduating students (94 percent graduation rate) and 64 students (81 percent) went to a college. In comparison to large neighboring schools that had 85-89 percent graduation rates, CSA had only six dropouts. Major reasons for dropouts had to do with factors that the school had no control over. However, facilitators still felt that they failed to have all students connected to the school as a family-like learning environment. This led CSA to be more concerned about culture, so it began with “culture building” in the following fall semester.

Followed by this case study of CSA’s use of PBL, immediate research agendas call for further investigation concerning:

• How do we compare PBL and problem-based learning and in what contexts can each approach be used most effectively?
• How do we integrate comprehensive assessment in PBL in an era of the predominance of standardized tests?
• What evidence do we have that the PBL Academy is improving teacher effectiveness leading to student learning outcomes in STEM?
• How do we know the STEM-focus curriculum in PBL schools is contributing to students’ future jobs and careers in STEM fields?

References


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Yonjoo Cho is an Assistant Professor of Instructional Systems Technology (IST) at Indiana University. She had worked as an HR professional for more than ten years in South Korea, both in business and academic sectors. Her latest position was MBA Director and Visiting Professor at Korea Advanced Institute of Science and Technology (KAIST) Business School. Her research interest centers on action learning in organizations, based on her experience as an external facilitator in large companies. Other research interests include interdisciplinary collaboration between human performance technology and HRD. Recently, she has expanded her research strands into involving project-based learning in education that is akin to action learning in business. She received her PhD degree in Instructional Technology from the University of Texas at Austin, USA. Yonjoo Cho is the corresponding author and can be contacted at: choyonj@indiana.edu

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