Assessing the impact of online technologies on PBL use in US high schools

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Abstract

This study examines online technologies that can support project based learning (PBL) and how much use of these technologies relates to time spent on this approach to instruction, perceived preparedness and ability to overcome challenges. It examines the responses of 331 teachers, from intentionally varied types of high schools, who used PBL or similar practices to teach math, science, social studies or English. Findings suggest that teachers report more use of PBL, fewer perceived challenges, and a greater sense of preparedness when they use online technologies to support their practice. While use of technologies differs across school type and subjects, the relationship of their use to PBL use is surprisingly consistent. Results help us understand the prevalence of technology uses for PBL and how these are related to PBL use and perceptions, with implications for how new technologies might help extend the reach of PBL-related instructional reforms to more schools.

Introduction

In the last few decades there has been a concurrent growth in the availability of online technologies for educators and interest in supporting teacher use of constructivist-based instruction, such as project based learning (PBL) as a way to motivate students, engage them in "real-world" issues and learning of information age or 21st century knowledge and skills. In addition, hundreds of small "start-up" high schools have been designed to personalize instruction and meet students' needs. It is important to understand how these three areas of innovation -- online technologies, PBL and small schools – overlap and to what extent teachers are taking advantage of new practices and technologies.

Small schools and reform models

In districts across the country small start-up schools have been launched and large comprehensive high schools have been 'converted' into small learning communities (e.g., Bloom, et al., 2010). The purpose of small school efforts has been to remove the structural barriers that impede effective teaching and learning. These schools are testing the idea that students learn better when they experience a climate of trust and relationships (e.g., Cotton, 2001; National Association of Secondary School Principals, 2004; National High School Alliance, 2005).

Evaluations of small school initiatives suggest that instruction is still a key challenge to be addressed. While smaller schools have been effective at creating more personalized environments for teaching and learning, *instructional* reforms have lagged behind structural and cultural changes (American Institute for Research & SRI International, 2005). As noted by Kahne, Sporte, de la Torre & Easton (2006), "It appears that small schools are fostering more personal and supportive contexts for both teachers and students but they do not appear to be spurring increased instructional reform" (p. 2).

A few reform organizations have had some success pushing instructional boundaries. These organizations build on high-profile efforts to promote student readiness for the 21st century (President's Committee of Advisors on Science and Technology, 1997), to create "break the mold schools" (Bodily, 1996). Many received financial support from the Bill & Melinda Gates Foundation (American Institutes for Research & SRI International, 2005) or were the result of legislation and funding for comprehensive school reform (CSR) intended to change "all aspects of schooling" (Desimone, 2002).

The goals of many (not all) of these school reform models and the rhetoric for small schools in general, are "progressive" in the sense that they generally work against standardized, mechanical view of curriculum and lean toward one that promotes critical engagement, interactive meaning-making, and self-realization (e.g., Feinberg,

1999; Clinchy, 2003, Van Ryzin & Newell, 2009). A few reform model approaches have emphasized changes in the culture of schooling while retaining a more traditional approach to instruction (e.g., Tough, 2006; Viadreo, 2009). By and large, however, small schools have common origins, inspiration and goals tracing back to earlier work by the New American Schools Design Competition (Bodily, 1996), Coalition of Essential Schools (Meier, 1995; Sizer, 1992) and others.

The four model high school reform networks that participated in this study --New Tech High, High Tech High, Edvisions, and Envision Schools – have helped set the pace by establishing dozens of start-up schools based on their models. These schools have organized themselves around a consistent school design model, affiliate with a central organization that supports the reform model's philosophy and practices, and form at least a minimal professional learning community within and across schools.

To a large extent the reform models in our study embrace PBL as a central component of instruction (Pearlman, 2002; Newell, 2003). In addition, each of the models has a unique set of practices and technology infrastructures to help guide their work. New Tech High has a proprietary project management system and library, Envision Schools has a Project Exchange library and workspace for teachers, teachers in Edvisions schools have used Project Foundry™ software to help manage and assess student projects, while High Tech High has established a "digital commons" for sharing resources among teachers.

Project based learning

Project Based Learning (PBL) is a constructivist-based instructional approach that is designed to support more engaged learning (Duffy & Jonassen, 1992; Brooks & Brooks, 1993). This approach uses "projects" as vehicles to encourage student motivation and to provide a means for demonstrating and explaining what they have learned. This approach has much in common with problem-based or inquiry-based instruction (Barron & Darling-Hammond, 2008; Savery, 2006). Evaluations of small school initiatives have highlighted the prevalence of this general approach:

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

Evidence of growth of interest is provided by the growing number of teachers who have received PBL materials (our organizational database is almost 10 times larger today than when we undertook this study), the growth of web sites that emphasize PBL as a core instructional concept (e.g., Edutopia, 2001), inclusion of project-based learning in policy documents such as from the National Middle School Association (Yetkiner, Anderoglu, Capraro (2008) and the National High School Center (Harris, Cohen & Flaherty, 2008, p. 3), and even state-wide efforts, notably in West Virginia (Williamson, 2008) and Indiana (Indiana University, 2010).

No two teachers implement PBL in the exact same way, so this makes it difficult to define exactly what PBL is and then study its effectiveness. Over the years, research on PBL has expanded from a specific kind of problem-based learning in medical schools to a wider variety practices, subjects and grade levels (Walker & Leary, 2008). Taken as a whole, with the exception of memorization for short-term learning, PBL use has been shown to be as effective as traditional instructional approaches, and in many studies superior (Buck Institute for Education, 2010; Edutopia, 2001; Geier, et. al., 2008; Strobel & van Barneveld, 2009; Walker & Leary, 2009).

Challenges to PBL

Implementing PBL and other inquiry-based instruction can be challenging, requiring changes in classroom management and forcing teachers to be ready with a vast array of resources and knowledge (Blumenfeld, Soloway, Marx, Krajcik, Guzdial, & Palincsar, 1991; Mergendoller, Markham, Ravitz & Larmer, 2006). Teachers can report difficulty or feel under-prepared when making the transition to this more student-centered approach (Ertmer & Simons, 2006; Marx, Blumenfeld, Krajcik, & Soloway, 1997). On the other hand, when PBL is well designed and well supported, it is possible for teachers to be surprised by what their students can accomplish (e.g., Johnson, Smith, Smythe & Varon, 2008).

It does not seem reasonable to expect teachers to learn about and use this approach entirely on their own, although some certainly do. Effective use of PBL requires extensive planning and professional development for

teachers, a supportive environment, and tools and strategies for both teachers and students (Hmelo-Silver, Ravit & Chinn, 2007). If instructional reforms have had limited success in small high schools, this is likely due to challenges associated with how much preparation is needed to design and implement PBL effectively.

The Role of Technology - Untangling a Tangled Relationship

It is important to understand how much online technologies might be helping provide valuable PBL resources for teachers who are exploring PBL use. Teachers who want to use PBL and must confront the above challenges can start by gathering additional ideas and resources by going online. They can locate models or examples in their subject area or find tools that can be useful for coming up with ideas and planning projects. Examples of online features considered in this study include tools for linking to outside experts, mentors, or other schools, collections of projects, tools for managing or assessing student work, for planning and designing projects, and more general features such as blogs, WIKI, and others.

If teachers are already familiar with PBL, online technologies can help scaffold instruction and provide the kinds of supports that teachers and students need to be successful with PBL (e.g., tools for collaboration, feedback, managing work, etc.). Research suggests that both of these elements -- teachers' development of PBL-related knowledge and the availability of implementation scaffolds -- are critical to the implementation and effective use of PBL (Boss & Krauss, 2007; Cognition and Technology Group at Vanderbilt, 1992; Ertmer & Simons, 2006; Hmelo-Silver, 2006).

As a result of the Internet explosion many simply assume new technologies will play an important role supporting PBL (more than in the past, when connections were slow, resources were not widely available, etc.). As one reviewer of an earlier version of this paper noted "It seems implausible to suggest that PBL should be implemented without the use of online resources."

In some ways, it does seem implausible to not use new technologies. A convergence of interest in PBL use and new technologies has led to many interventions that intentionally incorporate technology as a key component of PBL use (e.g., Saye & Thomas, 2005). Many technology-related barriers have come down and opportunities for teachers to conduct projects in a technology-rich environment have never been greater. However, there is still a lot to be learned about how and in what ways teachers incorporate technology and PBL use in their practice. Importantly, because our definition of PBL does not require online technologies, we can see how PBL use varies with and without their use.

Research Questions

This study explores the relationship between PBL-related teaching practices and use of online features to support these practices. It addresses the following questions:

For teachers across different high school contexts and academic subjects…

What is the prevalence of PBL` use, preparedness and challenges?
What is the prevalence of online feature use to support PBL?
To what extent is online feature use related to preparedness, challenges, and use of PBL?

As noted for Becker & Lovitts, (2003), the only way we can hope to see how new technologies contribute to teaching and learning is to explore their use independent of pedagogy. Once we accept that some PBL-using teachers and projects do not require online technologies (e.g., for projects that involve designing a golf course for the moon, staging a debate about the death penalty, observing changes in bird populations, presenting a land use policy), it becomes possible to explore how use of technologies is related to differences in PBL use and to examine the apparent convergence of PBL and use of new technologies more closely.

Methods

Population and Sample

In the fall of 2007, over 400 PBL-using teachers completed an online survey -- a 35% response rate based on a sample of approximately 1200 teachers. This included teachers in the current analyses – 331 teachers who taught academic subjects (math, science, social studies or English) in public high schools and confirmed that they

used PBL in these subjects. These teachers came from diverse school types that we categorized as large comprehensive high schools (n=61), small schools and small learning communities (n=104), or one of the four reform networks New Tech High, High Tech High, Edvisions, and Envision Schools (n=166). To avoid biasing the results, we analyzed data separately for each of these school types.

The sample is considered to be fairly representative of PBL-using teachers, clearly representing a variety of schools, academic areas and geographic locations. Mid-west and rural states were under-represented as were a few key states in the south. In addition, a couple east coast organizations were not included whose participation could have boosted the number of PBL using teachers substantially, notably Big Picture Schools (Littky & Grabelle, 2004; McDonald, Klein, Riordan & Broun, 2003) and Expeditionary Learning Outward Bound (1999).

The sample of probable PBL users was based on information about sales of PBL materials and attendance at workshops. In addition to querying our own organizational database and searching for teacher lists on the web, this study received support from reform model staff who provided lists of teachers or schools receiving PBL professional development or materials, and professional development staff from the Center for Effective School Practices (with workshops held in NJ and OH), the San Diego Renewal High Schools initiative, and the North Carolina New Schools Project (see Ravitz, 2008 for full sample details). Each teacher received multiple contacts and both a social and economic incentive, with communications closely following strategies outlined by Dillman (2000).

Measures

The survey instrument was constructed after reviewing existing surveys and piloting different version of questions in 2006. Development of the instrument used methods similar to "cognitive interviews" (Desimone & LeFloch, 2004) and revising questions until they appeared to generate reasonable responses from teachers in vastly different kinds of schools.

Project based learning (*PBL)* was defined for participants minimally as an approach to instruction that a) features in-depth inquiry b) occurs over an extended period of time like a week or more, c) is student/self-directed to some extent, and d) requires a formal presentation of results. While there are other characteristics of PBL we might have included, these criteria represent a minimal definition that allows variation in other aspects like group work or technology use. Participants were invited to substitute a preferred term for PBL, as long as it included the above characteristics. Approximately 17% said they preferred problem-based, inquiry-based, or some other term.

In addition to be provided with the above definition, teachers saw a list of example types of projects (e.g., researching a community issue and creating an action plan, making observations and collecting data, creating a museum-like exhibit, etc.) so they would know what kinds of practices were being referenced. They were then instructed to pick the academic course in which they used the most PBL and report on their teaching of that course.

Time spent using PBL was based on teachers' response to the following item: "For a typical student in this course, how much of their overall TIME was spent on project based learning?" scored on a 6-point scale (1 = none or almost none, 2 = less than ¼, 3 = about ¼, 4 = about ½, 5 = about ¾, 6 = all or almost all).

Online feature use was based on a count of the number of features that were used at least "a little", because not many responded that they used any feature "a lot". The online features we asked about are listed below, with the accompanying prompt "For each of the following Internet-based features of capabilities, indicate whether you have seen or used this kind of online resource or tool for conducting PBL."

- Online collaboration tools (e.g., blog, Wiki, listserv, social networking)
- An online collection of high quality projects
- An online collection of PBL resources (e.g., rubrics, templates, examples, descriptions, suggestions, video)
- Tools created to help you or your students design and manage projects online
- A way for your STUDENTS to post work to get feedback or be assessed by you or others
- A way for YOU to get feedback from other teachers or adults on your projects or student work
- Tools for linking you or your students to outside experts, mentors, or other schools

Instead of focusing on specific web sites or software platforms, we described more general features of online use (e.g., for planning, giving feedback, collaborating, etc.) as might be provided by a variety of web sites or tools. We limited the features we examined to ones that teachers in our pilot study said they used in planning PBL or that helped them with PBL implementation. These online features (available using multiple software or web site configurations) provide the capacity to conduct projects or support them. They allow teachers to learn about PBL and manage projects more effectively, to share PBL examples, experiences and advice. They also may make it

easier for communication and feedback to occur between teachers and students, or across different schools. In each of these ways, the features can be expected to play a role in supporting PBL use. These online uses are probably related to use of more general online features (like search engines, email, or file sharing) and other computer uses that were not asked about because we wanted to focus on specifically PBL-related tools and practices.

Perceived challenges for PBL use was assessed using five items that were determined through conversations with teachers to be critical for the effective use of PBL (e.g., I lacked models or examples for using PBL in my subject area with my students"). Items were scored on a 4-point scale (ranging from 1 = not a challenge to 4 = a major challenge).

Preparedness for PBL was assessed using nine items that asked teachers how prepared they felt to carry out tasks related to effective PBL use (e.g., "To what extent do you feel prepared to assess individual student's content learning using PBL"). Items were scored on a 4-point scale (ranging from 1 = not at all prepared to 4 = very well prepared). An index based on the mean of all nine preparedness items had strong reliability (standardized alpha = .91), while the index for challenges was reliable enough for our purposes (standardized alpha = .80).

Finally, the *kind of school* was considered in our analyses and controlled for accordingly. Small schools and learning communities were defined as having less than 500 students and identified as being part of a reform model network or not.

Analysis Plan

Descriptive data helps us understand the prevalence of responses across a wide range of schools. Differences in mean scores used standardized z-scores, and ANOVA statistical tests, while percent differences used cross-tabulations and chi-square tests. The research questions use correlations between online feature use, perceived challenges, perceived preparedness and time spent on PBL with data presented using cross-tabulations and mean comparisons controlling for school type or subject taught.

Results

Although school context and subject limit use of PBL and online features, online feature use is clearly most prevalent among the most frequent PBL users. We see this in all three types of schools we studied. The more teachers used online features the more prepared they felt and the better they were able to handle PBL-related challenges. Some key descriptive findings provide an indication of differences across school types. The descriptive findings are not particular surprising, but they provide interesting contrasts regarding teachers in small schools that were and were not affiliated with a reform model. Overall, the most PBL use and the greatest amount of technology use were seen in the reform model schools, where teachers reported fewer challenges and greater PBL preparedness.

- 83% of reform network teachers reported spending more than "about ¼" of their time conducting PBL, compared to 48% of teachers in other small schools and 34% in the larger schools.

- The percentage of reform network teachers who reported feeling "well prepared" for PBL was higher than in other schools -- with statistically significant differences in preparedness for meeting state or district standards, assessing content learning and planning or designing new projects.

- Professional development for PBL was rarely a challenge in reform model schools and other small schools (reported by 17% in both), but was frequently a challenge in larger, comprehensive schools (reported by 40%).

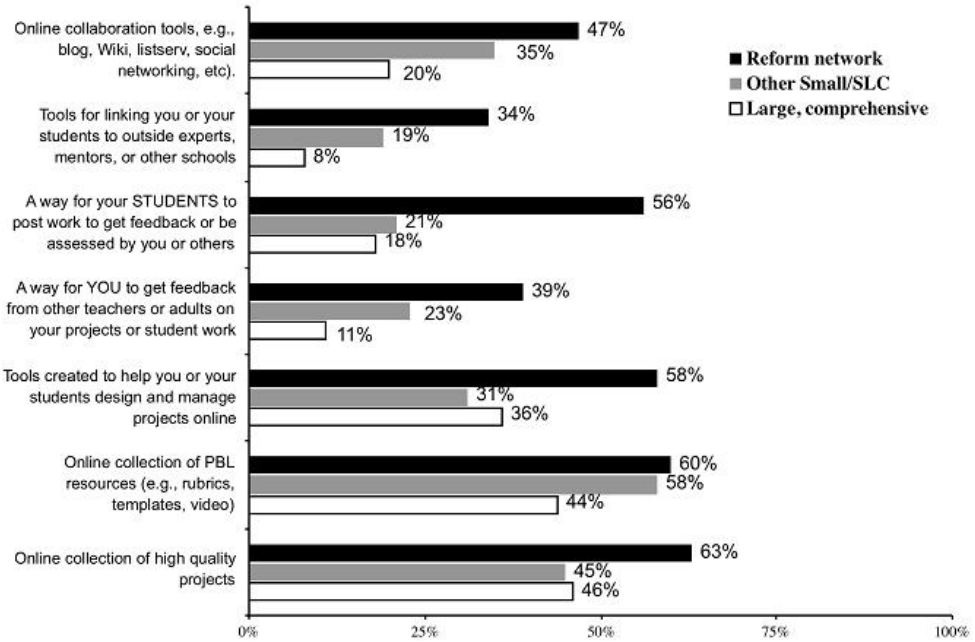
Some key differences in features used (as shown in Figure 1) include the following:

- More than half (56%) of the teachers in reform model schools had students post their project work and receive feedback, compared to 21% and 18% of teachers in the other two types of schools

- More than half (58%) of the teachers in reform model schools had designed and managed projects online compared to 36% and 31% of teachers in the other school types.

- Online collections of PBL resources were prevalent in reform model and unaffiliated small schools (reported by about 60% of each group), but online tools to plan and manage projects were only prevalent in the reform model schools (58% vs. 31% of other small schools)

Figure 1. Use of online technology features for PBL, by school type



These descriptive findings reinforce the idea that the most extensive use of PBL and supporting technologies are in the reform model schools, followed by the other small schools. This would indicate that overall, across school types, technology use is associated with PBL use. In fact, the overall correlation is 0.37 ($p < .05$). The next section examines a more significant question, whether this pattern exists even within school types.

Relating PBL use to online feature use

Findings clearly indicate that the more teachers used online features the more they used PBL, the more prepared they felt and the better they were able to handle PBL-related challenges (Table 1). The largest correlation with preparedness was in small schools outside the reform model networks (r=.46) but the correlation was positive for all three types of schools. The correlation between PBL use and online features was .33 for teachers in reform model schools, and .23 for teachers in other small schools (both $p < .05$). For larger schools, the correlation to time on PBL was not ssignificant, but feature use was significantly correlated to both preparedness and fewer challenges.

Table 1. Correlation of features used to time on PBL, preparedness and challenges, by school type.

	Correlation of number of features to…		
Correlations for…	Time on PBL	Preparedness	Challenge
All schools combined (n=330)	.37*	.35*	-.18*
Reform Model (n=161)	.33*	.25*	-.06
Small Schools (n=103)	.23*	.46*	-.13
Large comprehensives (n=61)	.10	.28*	-.25*

* $p < .05$

Table 2, below, presents significant differences in the percentage of teachers who reporting that they felt "well prepared" to handle common PBL-related instructional tasks by use of online features, analyzed separately for each school type. The comparison is between teachers who reported that they used the online feature "at least a little" versus those who reported that they did not use that feature within a particular school type.

Table 2. Significant differences in teachers reporting that they felt WELL PREPARED for PBL tasks by use of online features, within each type of school

(% of those who used the feature who felt "well prepared" for the task, % of those who did not use the feature)

PBL-related Task	Tools for linking you or your students to experts, mentors, or other schools	A way for your STUDENTS to post work to get feedback or be assessed	A way for YOU to get feedback from other teachers or adults on projects or student work	Tools to help you or your students design and manage projects online	An online collection of high quality projects	An online collection of PBL resources (e.g., rubrics, templates, suggestions)	Online collaboration tools (e.g., blog, Wiki, listserv, social networks)
Assess students working in groups	R (86%, 55%) S (85%, 52%)			S (79%, 50%)			
Teach and assess skills beyond academic content	R (91%, 66%) S (85%, 45%)	R (82%, 63%) S (86%, 58%)	R (83%, 69%) S (88%, 56%) L (100%, 59%)	S (82%, 56%)	S (77%, 53%)	S (75%, 48%)	S (78%, 57%)
Structure student presentations so the whole class learns	R (76%, 49%) S (85%, 45%)	S (73%, 48%) L (82%, 40%)	S (75%, 46%)	S (76%, 43%)	S (68%, 41%)	S (64%, 39%)	
Facilitate and manage students' work in groups	R (89%, 65%) S (85%, 62%)		L (100%, 61%)	S (85%, 58%)		S (75%, 55%)	
Promote depth or quality in student work during projects	R (86%, 63%)		S (92%, 54%) L (100%, 61%)	S (82%, 53%) L (82%, 56%)		S (71%, 50%)	
Assess individual students' content learning using PBL	R (86%, 69%) S (90%, 50%)	R (81%, 67%)	S (79%, 53%)	S (76%, 50%)			S (72%, 52%)
Meet state or district standards using PBL	R (88%, 73%) S (90%, 53%)		S (88%, 53%) L (100%, 56%)	S (79%, 51%)		S (72%, 43%) L (74%, 50%)	S (75%, 53%)
Plan and design new projects	S (85%, 61%)	S (96%, 58%)	S (92%, 59%) L (100%, 52%)	S (82%, 58%)	L (71%, 46%)	S (75%, 52%) L (74%, 44%)	L (88%, 51%)
Find existing projects that are high quality	S (80%, 51%)	S (82%, 50%)	S (79%, 51%)	S (82%, 45%)	R (71%, 56%) S (70%, 46%) L (68%, 34%)	S (69%, 49%)	R (76%, 58%)

R=Reform network (N=164); S =Small school / small learning community (N=105); L=Large, comprehensive school (N=61)

All comparisons are statistically significant, chi-square $p < .05$ Features are slightly abbreviated from the actual items as shown in the methods section above.

Preparedness and Feature Use

All significant differences in were in the expected direction with feature use relating to a higher percentage of teachers who felt "well prepared" and a lower percentage reporting major/moderate challenges (Table 2).

- In larger, comprehensive schools, use of a feature "to get feedback from other teachers or adults" was related to statistically significant differences five of the nine PBL preparedness tasks

- Use of tools created "to help you or your students design and manage projects online" was related to teachers' sense of preparedness in unaffiliated small schools across *all nine* tasks.

    - For example 82% who used this tool felt well prepared to "promote depth or quality" in PBL, compared to 53% of those who did not use this kind of tool.

- Use of tools for "linking you or your students to outside experts" related to significant differences in preparedness across *all nine* tasks for at least one of the type of school.

    - For example, 90% of teachers in unaffiliated small schools who used this feature felt well prepared to assess student content learning in PBL, compared to 50% who did not use that feature

- In large schools, use of a tool for "feedback from other teachers or adults on your projects/student work" was related to preparedness for five of the nine preparedness tasks.

    - For example, 71% of the larger school teachers who used "an online collection of high quality projects" felt "well prepared" to plan and design new projects, compared to 46% of teachers in those schools who had not used this feature.

Challenges and Feature Use

We see a similar pattern, although less extensive, regarding challenges for PBL. The challenge that was most substantially reduced with use of online features concerned "lack of professional development or coaching in PBL". Some key differences within school type include the following:

- In reform model schools, 8% who used online tools to manage student projects cited lack of professional development as a challenge, compared to 30% who did not.

- In reform model schools, 8% of those who had a way to get online feedback said professional development was a challenge, compared to 24% who did not use this feature.

- Only 7% teachers who used tools for linking to outside experts felt lack of professional development posed a major or moderate challenge, compared to 22% of the teachers who did not use these tools.

- Less than one-fifth (18%) of teachers in large comprehensive schools who used online tools to design or manage projects said professional development was a challenge, compared to more than half (53%) that did not use such tools.

The online feature that related to differences in perceived challenge across all five issues was "tools created to help you or your students design and manage projects online", although the type of school for which the significant difference occurred varied.

Across Subjects Taught

A final set of analyses concerns the correlation of the number of online features to the measure of PBL use measure and the challenges and preparedness indices, by subject taught. For these analyses we used correlations or compared mean z-scores on indices. Statistically significant ($p < .05$) differences by subject taught included:

- Among science teachers online feature use is associated with more PBL use ($r=.36$), a decrease in mean challenges ($r=-.34$) and increase in mean preparedness ($r=.51$).

- Among social studies teachers there was a strong relationship between the amount of PBL use and the number of online technologies used among social studies teachers ($r=.57$, $p < .001$)

- English teachers who used more online features felt better prepared for PBL use ($r=.33$, $p < .01$).

- Math teachers reported the least PBL use overall (mean z score = -.35) and felt least prepared for PBL use (mean z score= -.31), but there was a strong correlation between online feature use and PBL use ($r=.60$, $p < .001$).

Although these subject-specific relationships may be largely spurious – due to the fact that we did not have enough cases to control for school differences at the same time – it is useful to see similar patterns data across subject, indicating that the relationship is widespread, not limited to certain disciplines.

Discussion

This study is important because it concerns efforts to improve instruction by using online technologies and PBL. Regardless of school type, effective design and use of PBL requires ongoing professional development and support. Even in the best of circumstances, even in schools that have fully embraced PBL, the professional development and resources needed for effective use of PBL are unlikely to be fully met by most schools. Results suggest that online tools may provide an important way for teachers and schools to help address the challenges of PBL use.

It is helpful to know which technologies and practices have proliferated and which are only seen in reform model schools. For example, it appears far more teachers have used online libraries of projects and resources than have used tools to help with designing and managing projects. The latter feature is seen more frequently in reform model schools and is closely associated with PBL use and preparedness.

Sometimes teachers in non-network small schools (i.e., unaffiliated with reform models) reported similar practices or perceptions as reform model teachers, but not always. For example, in both types of small schools there appeared to have been ample professional development for PBL (with this being a challenge for only 17% in both school types). However, teachers in unaffiliated small schools reported that time in the curriculum for PBL use was much more frequently a challenge. This suggests that PBL is emphasized to a large extent even in unaffiliated small schools, but conditions and practices in the reform models are different.

Across school types, the technology feature that was most closely associated with PBL preparedness varied. This suggests certain technology applications are useful in different kinds of schools. For example, in larger comprehensive high schools the feature that best predicted preparedness was a way for teachers to get feedback from other adults, perhaps indicating a lack of effective feedback mechanisms in larger schools. In the reform model schools, the most predictive feature was access to outside experts to support projects, perhaps reflecting efforts to make PBL more authentic for students. In unaffiliated small schools access to outside expertise was also a predictor of preparedness, but so was using online tools for designing and managing projects. Perhaps without a reform model to help guide them, teachers in small schools may have to rely more on tools they find on the Internet to help them design and manage PBL.

To conclude, there is a robust relationship between use of online technologies and greater amounts of PBL use and preparedness. The correlation between online features and PBL preparedness was significant for numerous study strata, not just the three kinds of schools. However, the study data cannot answer questions about the causes of this relationship. The direction of causality that seems most important is how online technology use increases or improves PBL use. However, there is almost certainly a

mutually reinforcing relationship wherein technology helps teacher implement PBL but PBL also helps teachers integrate technology by providing reasons for its use.

It would be interesting to see more studies looking at how technology use differs when PBL is used, as well as how PBL differs when technologies are used, including perhaps technologies that we did not include –general online search features, or productivity software. However, the goal of promoting technology use seems less important than the goal of promoting effective PBL use. Educators are not in the business of coming up with uses for technology. As Ely famously asked "Technology is the answer, but what was the question?" In this case, how to improve preparedness for PBL use seems to be a question worth asking, and online technologies seem to provide part of the answer.

Although the experiences of individual teachers and schools may differ, the overall pattern suggests that technologies are probably helping teachers increase their PBL use and preparedness. Future research might focus on how reform model teachers are using online tools to support their PBL use and on finding ways to share these lessons and tools with other small schools to see if more teachers can be prepared to use PBL effectively. Clearly technology supports are only part of the answer to effective PBL use, and there are many other important differences (e.g., see Ravitz, 2010) but increased used of online technologies may be one way that instructional reforms like PBL can be disseminated from reform model schools to others.

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