Goals of project-based learning

Project-based learning achieves four goals: acquisition of knowledge, acquisition of skills, dispositions, and feelings (Katz & Chard, 1992). Learners will gain knowledge and skills through different activities and a variety of domains. In addition, they will develop dispositions or tendencies to act in a certain manner and they will develop feelings such as self-esteem and confidence.

Investigating teachers' perceptions of project-based learning, Akinoglu (2008) reports that teachers perceive building students' creative thinking skills as the benefit most gained, followed by learning and understanding the subject-matter.

Design features of project-based learners.

Although the literature on project-based learning presents several variations of design features, common threads define its basic components. First, project-based learning focuses on a driving question where learners interact with the concepts and principles of a discipline, make connections, and construct their knowledge (Barron et al., 1998; Thomas, 2002). The question should be feasible where students have the prerequisite knowledge and skills to conduct the investigation; worthwhile where it is consistent with the curriculum; authentic, addressing real-world problems, and meaningful to the learner (Krajcik, Blummenfeld, Marx, & Soloway, 1994; Marx, Blummenfeld, Krajcik, & Soloway, 1997).

Second, the outcome of a project-based learning activity is an artifact constructed by the learners, a result of their investigation and use of higher order thinking skills (Grant, 2002). On one hand, the construction of a concrete artifact allows the learners to reflect on and revise their artifacts (Krajcik, Blummenfeld, Marx, & Soloway, 1994). On the other hand, the use of higher

order thinking skills leads, not only to the acquisition of knowledge, but also to the awareness of the students of their own metacognitive skills (Barron et al., 1998) In project-based learning students are required to analyze, synthesize, and evaluate information, elaborate and organize their thinking, emphasizing thinking rather than facts (Marx, Blummenfeld, Krajcik, & Soloway, 1997; Snyder, 2008).

Third, the project activity is contextualized in real-life settings allowing for the authenticity of the tasks (Grant, 2002; Thomas, 2002).

Fourth, project-based learning is mostly based on collaborative work. Barron et al. (1998) call it "learning through social mechanisms" (p. 285) where learners collaborate with peers and outside audiences.

Fifth, in order for learners to benefit from the project-based learning experience, through understanding rather than just following procedure, scaffolds are provided (Barron et al. 1998; Grant, 2002). Scaffolds provide the learners with resources on the subject-matter they are working with as well as on the manner in which to conduct inquiry activities and management of tasks (Grant and Branch, 2005; Thomas, 2002). Teachers may design scaffolds that might not be used by their learners, nevertheless, theses scaffolds should be made available just in case they the learners need them (Grant, ?). Barron (1998) suggests two types of scaffolds that were found successful in providing scaffolding in project-based learning: problem-based learning to enable the development of concepts and solution strategies and contrast cases to help learners notice differences and common features.

Sixth, given the opportunities to reflect on their work through class discussions or journal entries learners internalize the knowledge and assess their learning (Grant, 2002; Seunghee, 2002). Therefore, reflection by students is another component of project-based learning.

Challenges for teachers in the implementation

Discussing the challenges of inquiry-based learning, a strategy closely related to project-based learning, Edelson, Gordon, and Pea (1999) list five challenges that prevent students from engaging in meaningful investigations. These challenges are the motivation of the students, accessibility to investigation techniques such as data collection and analysis, background knowledge, management of extended activities, and constraints of learning contexts such as the availability of resources and fixed schedule. Similarly, Akinuglo (2008) reports that teachers are challenged by the students' poor time management skills and by the difficulty they face in accessing informative sources.

Creating a balance between district curriculum, testing policies, and the large content that needs to be covered within a fixed schedule on one hand, and the successful orchestration of all the features of project-based learning is another challenge facing teachers ((Krajcik, Blummenfeld, Marx, & Soloway, 1994; Snyder, 2008). Negotiating the implementation of the project with the students, addressing the curriculum standards while maintaining their interest is what Mitchell, Foulger, Wetzel, and Rathkey (2009) describe as the Negotiated Project. Rathkey reviewed the district benchmarks to determine the skills and knowledge required to be learned, then, using a collaborative approach of negotiation with the students, she ultimately guides them through the construction of the project topic and questions, and the integration of the needed skills in the project.

Lam, Wing-yi Cheng, & Ma (2009) explored teachers and students intrinsic motivation in project-based learning. Looking at teachers and students in four secondary schools in Hong Kong, they studied the teacher intrinsic motivation, the student intrinsic motivation, and the

cognitive and affective support given to the students by the teachers. Their results showed a direct association between the students and the teachers' intrinsic motivation. The motivation in the students increased when they perceived their teachers to be motivated about the project and providing cognitive and affective support. Similarly, the motivation of the teachers increased when they perceived that their students were motivated.

Commonalities of challenges teachers face in project-based learning appear as Kolodner et al. (2003) describes challenges of problem-based learning. One challenge is the ability of the teacher to manage projects in a large classroom, all the while maintaining the engagement of all students. A second challenge is the ability of the teacher to maintain a balance between the investigative aspect of the project and the interpretation and reflective activities. Third challenge, especially for younger grades, is the lack of experience of the students in inquiry and investigation. This might require the careful design of preliminary activities to improve the students' skill before embarking on the project. The fourth challenge facing teachers is orchestrating activities in such a way to be able to evaluate students individually. The authors also discuss the importance of connecting design activities to science content. The authors report that teachers may not have enough expertise on the subject they are teaching to be able to coach the investigation properly, and students may have trouble starting the construction process when they have no experience with the tools and materials they have to use.

In a review on project-based learning, Thomas (2000) presents several challenges reported in the literature. Some of these challenges are the conflict project-based learning brings to the deep-seated beliefs of teachers in their approach to teaching and the degree of balance needed between student control and teacher control over the activities. As teachers get introduced to project-based leaning, they tend initially to rely on the transmission of knowledge approach, the way

they have been used to teach (Blumenfeld, Krajick, Marx, & Soloway, 1994). They need time to transition towards the constructivist approach to project-based learning, whether it is by sharpening their skills or changing their beliefs. In addition, teachers may be challenged by their inexperience of designing adequate project-based activities or by their lack of training in critical thinking methodology (Akinuglo, 2008; Snyder, 2008). In order for the students to be able to use critical thinking skills, teachers should be able to model the skills and coach the students because critical thinking is a learned skill that should be developed and practiced (Snyder, 2008). Moreover, Kolodner et al. (2003) posit that these skills represent a developmental process that needs consistent practice by students and modeling by teachers.

Another challenge teachers face in project-based learning is the selection of project topics (Akinoglu, 2008). Katz (1992) suggests twelve criteria for selecting a topic for project-based learning. Most important are the following: the topic must allow the integration of a range of disciplines, it must have sufficient potential for exploration and investigation, it must allow for the opportunity for problem-solving, collaboration, and cooperation and it must provide the opportunity for construction.

Kapp (2009) describes the ability of students to work together as the most difficult aspect of project-based learning. Attempting to remedy this problem, the author introduces a team-building workshop as an intervention in a higher education setting. In the workshop, students examine differences in personalities and explore ways to successfully work together, ending with a contract for team-membership. On the other hand, Kolodner at al. (2003) points to the creation of classroom culture of collaboration where students feel responsible of helping each other and iteration where they expect to make mistakes in order to learn from them. Meyer, Turner, and Spencer (1997) studied sixth grade students' challenge seeking during project-based instruction

in mathematics. Based on the results of their study, they stress the importance of creating a classroom environment that supports mastery and develop a constructive view of error, especially since students might defeat the learning goals of the project if they are worried about failing more than succeeding. They add that by collaboration students will try out ideas with their classmates and learn from mistakes.

Assessing student achievement in project-based learning is another skill that teachers must address. Grant (?) argues that assessment should include several learning products and not only the final artifact. He suggests portfolios as a learning product where students reflect on their learning experience as they go through the phases of the project. Similarly Marx, Blummenfeld, Krajcik, & Soloway, (1997) state that, in some instances, teachers ask students to produce artifacts that do not require the use of critical thinking and assessing these artifacts do not measure understanding. They add that assessing artifacts quality is difficult because of the several features that must be taken into account, such as design, organization, and accuracy.

Technology integration in project-based learning

An important feature in the success of project-based learning is the integration of technology. Helic, Krottmaier, Maurer, and Scerbakov (2005) suggest that a Web-based system can support project-based learning through support for project management, feedback from teachers and provision of project alternatives for the learners, support for project collaboration and communication, and support for data analysis. Trying to incorporate technology in project-based learning, teachers are faced with the challenges of learning how to use the different equipment (Blumenfeld, Krajick, Marx, and Soloway, 1994).

Inan, Lowther, Ross, and Strahl (2009) argue that classroom practices that integrate technology tend to be more student-centered. They report that in the majority of instruction used in technology-integrated classroom, technology was used as an instructional tool or resource more than a medium for instructional delivery, indicating that teachers are moving toward more student-centered and collaborative activities. Moreover, word-processing was more used for cooperative learning, independent inquiry, and student discussion. Presentation tools helped students present their ideas and artifacts, share ideas with others and create multimedia products.

Teachers may lack the skills and the confidence in incorporating technology in their teaching. Additionally, they may lack the resources such as Internet connectivity, training and technology support (Kramer, Walker, &Brill, 2007).

Assessment of project-based learning

In a study aiming at exploring students perceptions towards the incorporation of multimedia in project-based learning, Noe and Neo (2009) report that students' interest in the project, their critical thinking abilities, their presentation and communication skills, and their ability to work effectively on a team were enhanced.

Exploring how artifacts reflect learners' knowledge in project-based learning, Grant and Branch (2005) report that students were able to move from novices to experts in the domain of knowledge, as was revealed by their research papers and exhibits. In addition, students blended some of their learning abilities in the production of the artifacts, while other abilities remained unused.

Turnbull (2010) compared students' results on tests of general French proficiency and achievement tests reports in classes where teachers used a multidimensional approach to project-

based instruction. The students in these classes achieved statistically significant better scores than the students in classes where teachers did not use a multidimensional approach to project-based instruction.

Hernandez-Ramos and Pas (2009) explored the impact of technology integration and project-based learning on the experiences of students learning history in middle school. They report that students in the intervention classes that integrated technology-assisted project-based learning demonstrated greater knowledge gain when compared to students in the control classes, they did not limit themselves to the reporting of facts but attempted to interpret the information, they were more motivated about working collaboratively on their presentations, and they expressed a more positive attitude towards learning history.

Gubacs (2004) investigated physical education student teachers as they were asked to develop a non-traditional teaching unit, using digital-editing technology. Going through the phases of the project, the students showed deeper understanding of the content which was strengthened by the discussions among the team members. They also exhibited group cohesiveness and valued the fact that their projects can be used in real-life situations.