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IMPACT OF COLLABORATIVE PROJECT-BASED LEARNING ON SELF-EFFICACY OF URBAN MINORITY STUDENTS IN ENGINEERING

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Abstract

This paper presents an interdisciplinary research project that studies the impact of collaborative project-based learning (CPBL) on the development of self-efficacy of students from various ethnic groups in an undergraduate senior-level computer networking class. Grounded in social constructivist and situated theories of learning, the study provides an in-depth analysis of how individual learners' characteristics, the social aspects of learning, and the pedagogical components in CPBL interact to affect student learning in an urban academic setting. The findings of this study indicate that significant learning outcomes and higher perceived efficacy in engineering design were directly related to the project experience. Moreover, although Hispanic students started with lower domain-specific efficacy, they demonstrated the largest growth of self-efficacy through CPBL. While subsequent studies have been conducted to create a more generalizable description, the current study suggests several areas to improve the CPBL learning experience for underrepresented engineering students within the urban context of this study.

Keywords**:** urban students, engineering education, project-based learning, self-efficacy, situated cognition.

Recruiting and retaining students is a pressing challenge in engineering education. While we do see a gradual increase in undergraduate engineering enrollment in the past ten years, it is far from adequate to meet the demand of the fast-evolving engineering workforce. The attrition rate of students in engineering programs remains high. According to Grose (2012), the retention

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rate for U.S. engineering schools was about 56% and it could go as low as 30% in some schools. Moreover, minority students remain underrepresented in engineering majors. Factors that contribute to the high dropout rate, particularly for engineering students in urban settings, include low income, minority groups, first-generation college students, commuters, and campus social isolation (Anderson-Rowland, Urban, & Haag, 2000). To address these factors, various campus inclusive programs have been created to provide a sense of belonging for engineering students (e.g., Anderson-Rowland, Urban, & Haag, 2000; Anderson-Rowland, Urban, Ighodaro, & Muchinshy, 2002). While important efforts have been made to retain engineering students, we must simultaneously explore suitable pedagogical practices that address the learning needs of underrepresented groups in engineering.

Recently, many engineering educators have begun to incorporate project-based learning (PBL) to stimulate students' interest via real-world design practice. The incorporation of PBL has been found to have a positive impact on student learning (Hadim & Esche, 2002; Stojcevski & Fitrio, 2008; Dong & Warter-Perez, 2009). This line of research has focused on the effectiveness of using PBL in various engineering classrooms (e.g., Mills & Treagust, 2003; Martínez-Monés et. al., 2005; Smith, Sheppard, Johnson, & Johnson, 2005; Cooper & Kotys-Schwartz, 2013; Mayer, 2013). In general, earlier literature (e.g., Mills & Treagust, 2003) considered PBL as an effective pedagogy to enhance student skills in solving complex engineering problems or designing practical systems, but less effective in providing rigorous understanding of engineering fundamentals. Recent studies (e.g., Mayer, 2013) indicated that a well-designed PBL process can help students achieve better knowledge and skill outcomes compared to the lecture-lab combo in traditional engineering education.

Currently, there are no existing guidelines on how to design an effective PBL process for undergraduate engineering classes, especially for educational disadvantaged students in urban settings. This paper presents the findings of an interdisciplinary research project that studies the impact of collaborative project-based learning (CPBL) on the development of self-efficacy of engineering students from various ethnic groups in an urban context. The findings allow us to begin to better understand minority engineering students' learning needs, which is crucial to the development of suitable pedagogical strategies to increase their success in engineering education.

Theoretical Perspectives

Self-efficacy has been identified as an important factor that influences students' pursuit of education. Bandura (1994) defined self-efficacy as "people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives." Notably, beliefs of personal efficacy are domain-specific and can be fostered through mastery experiences, vicarious learning, and social persuasion. To better understand how domain-specific self-efficacy might be fostered within the context of this study, a broader social constructivist perspective based on situated learning and cognitive apprenticeship (Brown, Collins, & Duguid, 1989; Collins, Brown, & Holum, 1991) is considered below. Project-based learning (PBL), as a way to implement situated learning, is also discussed.

Proponents of situated learning theory do not agree with the separation between "knowing" and "doing" by suggesting that learning should be situated in the context where the knowledge is applied. They regard knowledge as a product of the activity and context in which it is produced−if the goal of learning is to gain useable, robust knowledge (Brown, Collins, & Duguid, 1989; Brown & Duguid, 1996). Learning that occurs in authentic context is conceived as a process of “enculturation,” in which the learners learn to use knowledge as tools as they develop an understanding of the rules and culture rooted in the actual practice of a profession. This process can be guided by “cognitive apprenticeship,” which is a means of learning-by-doing where the thinking process underlying complex, problem-solving skills is made visible through teaching methods such as modeling, coaching, scaffolding, articulation, and reflection.

The “learning as enculturation” metaphor suggests learning as demand driven, identify formation, and a social act within a rich cultural and social context (Brown & Duguid, 2000; Hung, 2001). It emphasizes collaboration, social construction of knowledge, using knowledge as cultural tools, and learning as active appropriation of the beliefs and behaviors of the culture in which the knowledge is used. Herrington and Oliver (2000) identified the following critical elements of situated learning: 1) authentic contexts, 2) authentic activities, 3) access to expert performances and modeling, 4) multiple roles and perspectives, 5) collaborative construction of knowledge, 6) reflection, 7) articulation, and 8) coaching and scaffolding.

Project-based learning (PBL) provides a feasible way to incorporate situated learning in the classroom. The Buck Institute for Education (2003) defined PBL as “a systematic teaching method that engages students in learning knowledge and skills through an extended inquiry process structured around complex, authentic questions and carefully designed products and tasks” (p. 4). A review of literature shows that PBL can promote higher-level of cognitive development (Newell, 2003), and enable students to learn a wide range of skill sets such as research, organization, project/time management, communication, presentation, and metacognitive skills. Students in PBL environments have been found to be highly engaging, and the development of social skills is also evident (McGrath, 2003). More significantly, when students are empowered as a “knowledge designer” in PBL, they are able to re-evaluate their own beliefs about themselves as learners (Chen & McGrath, 2003; Chen & Chen, 2007). This important finding becomes even more significant for students who do not do well in the traditional learning environment. For them, PBL provides an alternative learning method to put them “in a better position to function as a learner” (Perkins, 1996, p. viii).

This study was the first of a series of studies devoted to understand the impact of PBL on the development of self-efficacy of minority engineering students in an urban setting. An exploratory case study was conducted in an undergraduate senior-level computer networking class at a public urban university with a predominately minority student population. A Collaborative Project Based Learning (CPBL) model developed by Dong and Warter-Perez (2009) was adopted to address the specific learning needs of under-prepared minority students within the urban context of this study. The CPBL model has been implemented in several engineering courses and positive impact on student learning has been reported (Dong & Warter-Perez, 2007; 2009; 2010; Guo & Dong, 2011). This study sought to answer “why it worked” through the theoretical lens of situated learning. Currently, there is a lack of research focusing on engineering education in urban environments. Thus, this exploratory case study was conducted to investigate little understood phenomena so as to identify important variables for future research (Marshall & Rossman, 2010). The research project was guided by this key question: “How did various learning components in CPBL model affect the development of self-efficacy of urban minority students?”

Methods

The Urban Context

This study was conducted at a state university located in the urban city of Los Angeles. As a minority-serving institution, the university's student body comprises of approximately 53% Hispanic, 22% Asian-American, 15.6% White, 9% African-American, and 0.4% American Indian. As many students come from socioeconomically disadvantaged communities, they encounter significant learning barriers that prevent them from achieving their academic goals. Similar to the high dropout rate of engineering students reported in the literature, the institutional research revealed that almost 50% of the students who began their study in engineering eventually dropped out or changed their major. So far there are no reports of rigorous research on campus that study the factors associated with this high dropout rate. Informal observations made by the engineering faculty suggested the following reasons:

1) Many students are first generation college students, less encouragement and guidance from their parents poses an obstacle for them to persist in their educational pursuits.
2) Many students have a low sense of confidence with respect to scientific and technological careers requiring quantitative skills. They usually do not ask questions or respond to instructors' questions to avoid public attention in class. The isolated learning environment and high peer-competition in the traditional engineering classroom are seen by the students as two "scary factors" that tend to drive them away.
3) Many students come from low-income families and need to work to support themselves through their college education. An estimated 70% of the students work 30 or more hours per week; they are limited in their time and energy to engage in intensive coursework.

Participants and CPBL Structure

Fifteen students enrolled in an undergraduate computer networking course in spring 2013 were the primary participants in this research. As the primary research participants, these students provided both pretest and posttest data presented in the results section of this paper. All primary participants were male students. Seventy-three percent of these students were seniors and 27% were graduate students. Five of the participants identified as Hispanic (33%), and 10 identified as non-Hispanic (6 Asian Americans and 4 Caucasians). All participants were U.S. Citizen/legal residents. Additionally, descriptive data obtained from 13 other students enrolled in the same course were included to provide a rich account of student perspectives. These students (10 males and 3 females) included 10 international students, 2 Hispanic students, and 1 Asian American student. In total, 28 students participated in this study.

The course integrated the CPBL model, which utilizes a series of small scope collaborative projects to build up students' competence to deal with open-ended design challenges in designing large-scale systems. In total, five projects were developed and implemented, including three small scope in-class projects, one medium scope after-class project, and one large scope term project. The small scope projects were designed to inspire students' interest in learning new theories, to reinforce theories with design examples, and to guide students through the design process. The project sequence allowed students to build up their design skills progressively, and gain sufficient knowledge and skills to tackle the authentic, ill-defined design scenarios presented in the term project. Students completed the series of projects over the course of 10 weeks.

Data Sources and Analysis

This study is an exploratory case study (Yin, 2003) framed as a single case with ten project teams as embedded cases. The data collection of this study followed the three principles suggested by Yin: using multiple sources of evidence, creating a case study database, and establishing a chain of evidence. To develop converging lines of inquiry, our study utilized the following data sources: 1) pre and post surveys, 2) team collaboration survey, 3) formal and informal interviews, and 4) participant observation. A pre-survey was administrated at the beginning of the course to measure students' baseline knowledge and skills related to the primary learning outcomes of the course. These knowledge and skills were critical for the students to meet the demands of the professional career in computer engineering. The pre-survey also included items to measure students' general and domain-specific (engineering) self-efficacy. Team collaboration survey was administrated electronically in the middle of the course. At the end of the course, students completed a post-survey which included additional items to measure their project experiences with respect to the critical elements of situated learning. Observations and informal interviews with course participants were carried out throughout the research period by the research assistant. In-depth interviews with the instructor, two teaching assistants, and a sample of students (n = 6) were conducted at the end of the course to verify data and interpretations obtained from other methods.

All data sources were collected and organized into a case file for each project team. Data analysis involved the procedures recommended by Creswell and Plano Clark (2011): preparing the data for analysis, exploring the data, analyzing the data, representing the data analysis, and interpreting the results. HyperRESEARCH was used for qualitative data analysis, which involved coding the data based on categories from the literature (e.g., Herrington and Oliver's critical elements of situated learning) as well as codes that emerged from the data, assigning labels to codes, grouping codes into themes, and linking interrelated themes. Quantitative data analysis involved the computation of independent samples t-tests and dependent samples t-test to compare students' pre and post self-assessment ratings of knowledge of networking concepts and self-efficacy on content specific skills. Various data sources allowed the researchers to triangulate observations and interpretations of findings. Member checking was employed in the form of ongoing discussions and clarifications among the researchers and teaching/research assistants throughout the research period.

Findings and Interpretations

Data analysis yielded interesting results regarding the relationship between CPBL pedagogy and the change of domain-specific efficacy across different student groups. Overall, students reported a high level of general and engineering self-efficacy at the start of the course. However, Hispanic students consistently exhibited a lower level of self-efficacy compared to non-Hispanics. To get a closer look into the differences among primary research participants, independent samples t-tests were computed to compare Hispanic students (n = 5) to non-Hispanic students (n = 10). Although there were no statistically significant differences between the groups, Hispanic students rated their knowledge of networking concepts and content specific skills consistently lower on the pretest. For example, as shown in Table 1 and Table 2, Hispanic students rated their knowledge of "network simulation" (1.40 vs. 2.40), "network performance analysis" (1.80 vs. 2.50), "knowledge of Automatic Repeat reQuest" (1.20 vs. 2.40), "ability to analyze the network performance using simulations" (2.20 vs. 3.10), "ability to use OPNET to explore and learn new network protocols" (1.80 vs. 3.00) lower than other non-Hispanic students. By the time of the posttest assessment, however, these differences were not evident. Hispanic students' posttest ratings were very similar and in some cases higher than those of non-Hispanic students.

Table 1

Knowledge outcomes: overall response from primary research participants: non-Hispanic students vs. Hispanic students

Knowledge Outcome Index	**Non-Hispanic Students (*n* = 10)**				**Hispanic Students (*n* = 5)**			
	Pre	*Post*	*D*	*t*	*Pre*	*Post*	*D*	*t*
Computer network design process	2.80	4.10	1.30	2.75*	2.00	4.00	2.00	6.32**
Network simulation+	2.40	4.10	1.70	**3.43****	1.40	4.20	2.80	**7.48****
Network performance analysis+	2.50	4.20	1.70	**3.79****	1.80	4.20	2.40	**4.71****
Data communication model	2.90	3.90	1.00	2.12	2.00	3.80	1.80	3.65*
Layered network architecture (OSI and TCP/IP model)	2.60	4.20	1.60	2.95*	1.80	3.80	2.00	3.65*
Various data encoding technologies (NRI, Manchester coding)	1.80	4.80	3.00	7.61***	1.20	4.20	3.00	9.49***
Network topology (bus, star, etc.) +	2.80	4.40	1.60	**4.31****	2.00	4.20	2.20	**2.99***
Knowledge of Automatic Repeat reQuest+	2.40	4.00	1.60	**4.71*****	1.20	3.60	2.40	**6.00****
Knowledge of Ethernet	3.30	4.20	0.90	2.21	2.20	3.80	1.60	6.53**
How to build and extent a LAN using bridge+	2.56	3.89	1.33	**3.02***	2.00	4.40	2.40	**4.71****
Knowledge of CSMA/CD+	2.60	3.80	1.20	**2.25**	1.00	3.80	2.80	**14.00*****

Note. Range of responses: 1 (None) to 5 (Expert); items with + are directly related to projects; D = Difference.
* $p < .05$, ** $p < .01$, *** $p < .001$.

Comparison between the pre and post survey results indicated a significant increase of students' self-efficacy in almost all learning outcomes. The dependent samples t-test revealed statistically significant differences between students' pretest and posttest ratings of networking concepts and content specific skills, especially on those items directly related to the project experience. In Tables 1 and 2, outcomes labeled with '+' are directly related to CPBL experience. It is clear that most of the top-ranked significant growths of knowledge and skills were directly related to the course projects regardless of the students' ethnic groups; while the growths of knowledge and skills that are not related to CPBL were either smaller or non-significant.

Table 2
Skill outcomes: overall response from primary research participants: non-Hispanic students vs. Hispanic students

Skill Outcome Index	Non-Hispanic Students (*n* = 10)				Hispanic Students (*n* = 5)			
	Pre	*Post*	*D*	*t*	*Pre*	*Post*	*D*	*t*
Ability to identify user needs and define specifications to design a network system.	3.10	4.10	1.00	2.24	3.20	4.20	1.00	**3.16***
Ability design a network scenario in OPNET+	2.80	4.30	1.50	**4.88*****	2.20	4.60	2.40	**4.71****
Ability to analyze the network performance using simulations+	3.10	4.50	1.40	**3.77****	2.20	4.80	2.60	**5.10****
Ability to optimize network design based on realistic constraints using OPNET+	2.80	4.00	1.20	**3.67****	2.00	4.40	2.40	**6.00****
Ability to use OPNET to explore and learn new network protocols+	3.00	4.30	1.30	**3.54****	1.80	4.60	2.80	**3.81***

Note. Range of Responses: 1 (Strongly Disagree) to 5 (Strongly Agree); items with + are directly related to projects; D = Difference.
* $p < .05$, ** $p < .01$, *** $p < .001$.

An in-depth look into the pre and post survey data also revealed some interesting findings about how students from different ethnic backgrounds responded to CPBL model. Regarding students' knowledge of networking concepts, the ratings on all items were significantly higher on the posttest for Hispanic students, while the differences between pre- and post-test ratings of non-Hispanic students on some of the items were not significantly different. Regarding students' self-efficacy on content specific skills, both Hispanic students and non-Hispanic students' pre- and post-test ratings were significantly different on the four items directly related to the project experience (see Table 2). In addition, Hispanic students' posttest ratings on "Ability to identify user needs and define specifications to design a network system" were significantly higher than their pretest ratings, while non-Hispanic students' pre- and post-test ratings on this item were not significantly different.

Qualitative results supported the quantitative findings in that the students reported the development of greater level of domain-specific self-efficacy (as opposed to general self-efficacy) related to the course subject and engineering design. They also reported the development of self-efficacy in people skills. Several themes emerged from the data suggested that a high level of student engagement was linked to the social characteristics of the learning environment based on situated learning and cognitive apprenticeship (Brown, Collins, & Duguid, 1989; Herrington & Oliver, 2000; Collins, Brown, & Holum, 1991). Below is a summary of major themes supported by examples of student comments:

Developing domain-specific self-efficacy in authentic context. Students found the authentic project experience useful and engaging due to the real-world application of practical skills that directly benefit their future career. The term project was most liked by the students due to its open-ended nature. The constructive, recursive, and social process of the project design experience (Ehrmann & Balestri, 1992) appeared to help them "boost their confidence" as future engineers. Examples of student comments include:

- *I felt like this project, the skills we gained in this project…by testing and running different designs, I felt like we learned a lot about engineering designs.*
- *You can see what type of networks are being used like at home or office, the things that we learned in class while other engineering classes are very theoretical you don't see the applications in the real world.*
- *I think in engineering classes when you learn an engineering concept you don't really know what it can be used for, or even though you know what it can be used for you don't know what it actually looks like so I think it's a very good practice for you to actually experiment with it and see how it works out.*
- *I think you get to see the design that you build and see how effective it can be so you can actually see the application of the materials you learned, so it's not just theories, you can actually test and simulate and see how well the results are or how bad they are.*

Learning from multiple perspectives and design scenarios. Students enjoyed working with people from different backgrounds and found it beneficial to learn from other's perspectives as they tested out different design scenarios with group members. Examples of student comments include:

- *The way that people approach doing the work is very different but ended helping me out.*
- *…for this whole experience in working in OPNET and working in groups, I felt like we actually solve the issues by finding and researching the different scenarios and designing them with different factors and scenarios and seeing what's the most optimal way of designing it. I felt like this project, the skills we gained in this project, engineering projects, like by testing and running different designs, I felt like we learned a lot about engineering designs.*
- *We used OPNET to implement different designs. We've seen the benefits and drawbacks. We were able to find the most interesting design and implement it. So I think that's the most important in this class. It was enjoyable to me.*
- *…it offers different perspectives on different projects. For example on the term project, we had the network design on the simulation, we each had an input and we came up with*

all the elements and a lot of things were like my other group member would come up with something that never occurred to me, like separating traffic.

Collaborating through social support. A high level of student engagement was reported across different ethnic groups, due in large part to the teamwork and peer support elements in CPBL. Examples of student comments include:

- *We encourage each other and inspiring each other, which help us to work hard on the course or project.*
- *Well, I enjoyed working with my team for several reasons. First reason is that we actually ate together, lunch, and in other classes you don't really do this. You don't really sit down and get to know each other. I think I can learn each other's strengths and weaknesses and in other class, we don't really do that.*
- *I totally engaged in the activities that I did and fully participate even when I was behind, and I asked my group partners if they can show me the ropes…*

Gaining communication and people skills. A higher level of self-confidence in students' people skills was also reported. Students indicated that the teamwork experience in CPBL not only enhanced their interpersonal skills, but also made them realize the importance of having this skill set for their future engineering career. Examples of student comments include:

- *The most important thing is working in a group. You have to have really good people skills and communication skills…because [in] engineering you have to have a lot of people skills. If you cannot cooperate with others to accomplish a goal or an objective then you're not going to be successful in engineering.*
- *I think it has boosted my confidence. It helped me work in groups. I am a bit shy person in terms of working with others. It's hard to get to know others and get to know them and work with them.*

Engaging in deeper learning. Qualitative data obtained from different sources suggested that the learning environment encouraged a more active and deeper approach to learning. Students reported that the projects were well designed and useful to deepen their understanding, as evident in the following excerpt:

You have a theory you have a prediction how something is going to turn out and you start looking at your data and you see how this is totally opposite of what I thought and you analyze your data even more and you go whoa, wait a second there are a couple of connections here and you look deeper and deeper and you sort of see how it works in different situations and it is actually very, very complicated. When you design a network, you have probability base and a little change to cause a big change for network and a lot of sub-nets for your network. And you can try to make sense of all of it but you have to analyze all the data and things in small simple steps in the things that you made to understand what's going on.

This deeper level of learning was also noted by the TAs and the professor:

- *TA#2—I think they enjoyed it. I mean some of the teams, designs they created this quarter were pretty out of the box type of things. I guess they wanted to test all sort of designs to see how the network would be able to handle it.*
- *Professor—"[Students] generally go beyond the minimum standards…Many teams were able to think about advanced factors like security issues, for instance, and some of the teams were able to think about liability or reliability issues. Instead of just creating the network that supports different applications, they were able to think about how to provide a more reliable service to different groups of users."*

Challenges. While teamwork seemed to foster a high level of student motivation and a sense of responsibility for some groups to go "above and beyond" the project requirements, it also created challenges such as scheduling conflicts, uneven distribution of workload, and dealing with disagreements among group members. Time constraint was recurrently reported as the most challenging factor in CPBL, especially for students who needed to juggle between work and a heavy course load. Factors like gender, ethnicity, and socioeconomic status were found to have little influence on individual students' engagement, while team dynamics appeared to play an important role in this regard. Although both positive and negative group dynamics were observed, most students still preferred learning in groups.

Discussion

Our analysis revealed that several factors associated with the social elements of situated learning were positively related to the students' learning and development of engineering efficacy. These factors include authentic activities, multiple perspectives, social support, and collaborative construction of knowledge. The real-world application of theory, the opportunity to explore and practice design skills, and peer learning were regarded by the students as the most valuable aspects of the project experience. The most significant learning outcomes in the students' knowledge of networking concepts and self-efficacy on content specific skills were found to be directly related to the project experience. This result is consistent with our multi-year assessment findings since 2010. More significantly, although Hispanic students started with lower domain-specific efficacy, they demonstrated the largest growth of self-efficacy through CPBL. By the end of the course, their learning outcomes and self-efficacy on content specific skills were comparable or even higher than non-Hispanic students.

Two aspects of the learning environment were found to be conducive to the development of engineering efficacy for the students within the context of this study. First, the situated and open-ended nature of the project experience was intrinsically motivating to the students by engaging them in the constructive and recursive process of design (Ehrmann & Balestri, 1992). Second, the social aspect of learning and peer support often functioned as a driving force pressing student participation. Peer discussion was essential for the students to evaluate the quality of their own work, which contributed to the development of content-specific efficacy as well as important interpersonal skills. Data obtained from classroom observations and informal interviews further indicated that the social characteristics of the learning environment were particularly beneficial to minority (Hispanic) students. However, this observation will need to be verified by future studies.

The findings of this study support the results of previous studies pertaining to the positive effects of PBL on student motivation (McGrath et al., 1996/1997; Monahan & Susong, 1996;

Scheidler, 1993; Liu & Rutledge, 1997). Similar to the work of Cooper and Kotys-Schwartz (2013), this study focused on the importance of "designing the design experience" for engineering students. We have found several areas that can be improved in the current CPBL model, including providing more opportunities for student reflection and articulation, and enhancing the conditions that foster students' acquisition of interpersonal skills and group processing (Kirschner, Jochems, & Kreijns, 2005).

Conclusion

This paper presents an exploratory case study to analyze the impact of CPBL pedagogical components on different student groups in an undergraduate senior-level engineering class. Grounded in situated learning framework, this study highlighted several critical factors that positively impacted students' motivation which leads to a better retention rate. In particular, the positive results on Hispanic students' development of self-efficacy are promising and warrant further investigation of the effectiveness of using CPBL to engage minority student groups in urban settings. As an exploratory single-case study with a small sample size, however, the study results are limited to analytic generalization as opposed to statistical generalization (Yin, 2003). To create a more generalizable description, we have implemented CPBL in several other engineering courses. This will allow us to perform a multiple-case analysis to increase the power of analytic generalization. As the first step in our series of studies, the current study allowed us to gain a better understanding of the learning needs of minority students within our urban context. With a better understanding of how students respond to various elements in CPBL, we can re-examine the pedagogical model and enhance the instructional system based on cognitive apprenticeship and its four building blocks: content, method, sequence, and sociology (Collins, Brown, & Holum, 1991). In the next stage of our research, we will continue to investigate students' perceptions of their engineering efficacy in the CPBL environment. More specifically, our research will focus on three areas: 1) course related knowledge and skill outcomes, 2) engineering efficacy in relation to situated learning, and 3) student engagement (deep vs. surface learning) and team dynamics. As higher efficacy is related to the use of self-regulated learning skills, we will examine students' use of self-regulated learning strategies in relation to the characteristics of the learning environment. Some tentative research questions include: How do various CPBL and cognitive apprenticeship components affect students' way of approaching the learning tasks (i.e., use of surface approach vs. deep approach vs. strategic approach)? How do various CPBL and cognitive apprenticeship components affect different student groups and their approaches to learning? Finally, we expect to develop general guidelines for designing an effective instructional system based on CPBL to enhance student success in engineering at urban schools.

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