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# COMPUTER INFORMATION SYSTEMS: PATHWAY TO MEET STUDENT AND COMMUNITY NEEDS

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# Computer Information Systems: Pathway to Meet Student and Community Needs

**Synopsis**:

Fresno Pacific University's mission is to educate underserved populations and to provide a pathway for the next generation workforce essential to strengthening the economy of the Central Valley. Newly designed computer information systems and software engineering programs were created to forge partnerships between academia and business. Housed within an innovative community based facility, FPU seeks to deliver cutting edge theory and accessible best practices.

# Designing Tech Programs to meet Underserved Student and Community Needs

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## Abstract

In order to provide successful academic programs, higher education must leave the ivory tower and speak to the felt needs, expectations, and cultural biases of the students and communities they serve.

To meet the gap between the demand for a prepared workforce and STEM readiness in underserved students, new technical programs need to address student preparedness and workforce expectations. Fresno Pacific University designed a unique Computer Information Systems (CIS) B. S. degree for adult students who are predominantly high poverty and Hispanic, Hmong, and African-American. The program runs one night each week for 18 months. It is delivered in a 2.4 million square foot complex that was established in 2015 and already houses over 65 tech companies. The complex has the capacity to grow to over 1,000 tech startup companies and is in downtown Fresno, identified as a revitalization district. This CIS program takes advantage of its physical location among these technology firms to ensure compatibility between educational outcomes and a prepared workforce. The juxtaposition of jobs with classes also enhances retention, persistence, graduation, and job placements. Known best practices for success in STEM education are embedded into the CIS program, including active learning, learning communities, academic coaching, practicum/research, role modeling, tutoring, and supplemental instruction. A unique technology business community and educational partnership with the potential to transform a pocket of poverty is presented.

## A. The Context

Fresno Pacific University's (FPU) mission is to serve the Central Valley of California by bringing liberal arts and professional preparation together to meet the economic needs of our region. FPU is located in Fresno, which has a population of over half a million, in a county of almost a million, of which 51% is Latino/a/x. The primary industry is agricultural production; primarily nuts, vegetables, cotton, and fruits. Fresno has a high rate of unemployment at 12% with pockets of extreme poverty. According to the American Human Development Project, which measures economic, education and other factors, the Central Valley's 20th Congressional district, which from 2003-2013 included most of Fresno, Kern, and all of Kings Counties, scored 2.60 out of 10.00, a score lower than Appalachia. This is the lowest score in the nation, 435th out of 435 congressional districts (Burd-Sharps, Lewis, Martin, 2008). However, Fresno is currently experiencing a new vitality in many business sectors; including agriculture, food enhancements, health care, manufacturing, and technology. The skills needed range from basic coding to strategic management, in addition to more basic aptitudes such as critical thinking, communication, etc., provided by a liberal arts preparation.

Indeed, an increased focus on computing appears to be enveloping this region. Sheehan (2014) reported on the efforts of Bitwise Industries to create a technology hub in downtown Fresno. The organization provides real estate so computer technology firms can be housed together in one location, trains students with technology skills with highly focused course offerings, and provides computer technology services for local industries. Bitwise CEO Jake Soberal made the case for a regional economy more focused on high technology in the traditionally agricultural area:

> If we can get a critical mass of people here in Fresno who are competent and capable, national and global companies will choose to expand their operations here. The Silicon Valley and Boston and Portland will continue to grow. And so will Fresno—and Des Moines and Wichita. Software and tech have not been a zero-sum game. (Fallows, 2015, para. 12)

Technology training classes have been part of the Bitwise strategic plan from the beginning, to develop the workforce to support industrial growth. They established six-week, intensive, non-credit bearing courses in computing technologies such as JavaScript and web design that were directly requested by regional industries. By September 2016, over 2,500 students had been trained in these courses. FPU began conversations with Bitwise in 2014 to round out the technological preparation by providing a more comprehensive four-year education. The Computer Information Systems (CIS) program is a direct product of this conversation and is aimed at working adults, particularly students who show growth promise in Bitwise classes and local community colleges. The CIS program helps technicians earn a bachelor's degree in computing with liberal arts strengths, which provides leadership in local computer technology industries.

### Student Population and Culture

FPU enrolls 38% Latino/a/x in undergraduate programs, approximately 40-45% of whom are first generation college students. Since studies show that only 27% of first generation students finish four-year degrees, compared to 42% of those with college attending parents (DeAngelo, et al., 2011), it is very important to provide best practices in college success for our CIS program.

As a Hispanic Serving Institution, FPU recognizes that when culturally diverse students try to acclimate to academic culture, their learning curve is increased. The academy, especially the STEM disciplines, can have a very different culture from anything else that a first generation, ethnic minority student has ever experienced. For example, academic culture typically reflects traditional middle class values, such as: independence and self-reliance, introversion, collegiality and social capital, critical thinking and future visioning, strong scheduling and tracking skills, self-motivation, and a high pace of learning. In comparison, Hispanic, first-generation, and low income families tend toward more extroverted and relational interpersonal, interdependent styles. Deference to authority is an implicit and explicit value guiding family relationships. There is strong emphasis on supporting extended family members, and on the importance of self-sacrifice for community survival. Deviation from cultural standards, such as challenging authority, carries the risk of being derided as 'superior' to others, or even sabotaged to re-establish long-held norms and protect family integrity. A competing driving force that emphasizes independent work or achievement runs contrary to relationship norms.

Since Latinos are a majority minority in Fresno and the national imperative is to increase Latinos in the STEM workforce (http://www.edexcelencia.org/media/press-releases/finding-your-workforce-stem), prioritizing issues of recruitment, retention, and success with Latinos is important for CIS. Latino males experience an identity paradox: they are privileged relative to women because of gender culture, but are systematically marginalized overall because of their ethnicity (Carera et al., 2016). Lopez et al. (2016) note that for California Latinas' of Mexican descent "educational success can be understood as resistance to traditional gender roles that deem them subordinate to males in the social order." (p 62) In contrast Latinos tend toward ideas of masculinity that create a "deeply rooted individualized notion of doing school (65)." "'Manliness' is frequently constructed as highly individualized, where help-seeking is framed as a feminine trait (Connell & Meserschmidt, 2005 in Cabrera)." Basically, to succeed Latinas need more self-efficacy and Latinos need more freedom to seek help supports.

Hill (2008) asserts that "learning is the process of making sense of experiences" (p. 89). Hispanic, first-generation, and low-income college students stand in an avalanche of learning experiences. They must ascertain internal (metacognitive) and external (cognitive) meaning at lightning speed in order to survive both socially and educationally. These students are immersed in a variety of subcultures while they are simultaneously challenged by academic content. New cultural experiences on a college campus may relate to any or all of the following categories: age, gender, sexuality, ethnicity, residence, religion, race, socioeconomic status, behavior, beliefs, and attitudes.

Disparities in academic achievement between races are attributed to social, rather than biological, factors (Boykin & Noguera, 2011). The absence of college attendance expectations from family members and the lack of "intergenerational transfer of knowledge about higher education" (Becker, Krodel & Tucker, 2009, p.3) creates a performance handicap for many Hispanic children. Once the values associated with non-collegiate pathways become internalized, students' decision-making processes unconsciously guide them away from academia. Reversing those internalized values requires attention toward developing new expectations by establishing support groups, helping with application process logistics, bringing new messages to family members (Gaitan, 2013), and even redefining 'la familia' (family). FPU's design of programs needs to acknowledge and accommodate cultural differences, learning curves, processes and programs in order for students to successfully thrive in the program, graduate and be well prepared to fill the professional needs of the Central Valley's workforce in technology.

## Curriculum Content Design Based on Industry Need

FPU's CIS program prepares students to work in practical, high demand occupations with liberal arts communication and critical thinking skills. The goal is to prepare graduates with a foundation and proficiency for work in careers that deal with analysis of and support for computing systems and databases and development of computing applications. These skills have uses in many fields including business, education, natural sciences, health industries, manufacturing industries, and marketing.

The National Association of Colleges and Employers (NACE) (2016) reported that business and computer science were in the top three disciplines being hired by employers responding to a survey on industry needs. Specifically, business ranked second, with 63.7% of respondents indicating demand for the major and computer science ranked third, with 51.6%. The CIS program addresses both these disciplines. The Education Research Board (2014) identified CIS programs as combining "computer science and information technology coursework with a tangible business-oriented approach" (p. 7). The program includes courses in programming, operating systems, data communication, systems analysis and design, database management, ethics, security, and project management. The focus of the coursework includes, but is not limited to, the necessary technical content to enable students to solve business problems with information technology aspects from computer science.

Preparing a successful workforce requires professional skills, sometimes referred to as soft skills, that define the mechanics one utilizes to perform job activities. Roach and Sahami (2015) discussed the importance of including these skills in a technical major by stating the curriculum "must prepare students for lifelong learning and include professional practice elements—communication skills, working in teams, ethics, and so on—as components of the undergraduate experience" (p. 116). The importance of these attributes has been well documented.

NACE (2016) identified the top essential career readiness competencies as "those skills, experiences, and attributes that broadly prepare students for a successful transition into the work force" (p. 8). The organization reported that critical thinking/problem solving and professionalism/work ethic were tied for most important, followed closely by teamwork and oral/written communications (NACE, 2016). Graduates from all types of majors, therefore, should have these attributes to prepare them for their careers. Prospective employers desire these skills so they know new employees will be able to apply their knowledge and contribute to an organization's mission and goals. While the items identified by NACE were from a national audience, the same skills are sought by industry members in Central California.

Already known for its billion-dollar agriculture industry, new developments in agricultural and food technology have accompanied Fresno's growing computing economy (Pratt, 2015). There has been an influx of small high technology companies looking to take advantage of low rent and other costs, and the available workforce offered by the region (Romero, 2014; Sheehan, 2014). Industry will need a properly trained workforce possessing the proper skills to fill the jobs created.

Sultana (2016) used a four-round Delphi study to investigate the Central Valley computing experts' recommendations on the most important competencies to develop in an introductory course in computer science. The most important reported competencies by industry experts were problem solving and critical thinking and reasoning, ahead of any technical or software engineering related capability. Additionally, this group identified teamwork and interpersonal group skills as the fourth most important competency for such as course. Academic experts listed problem solving and critical thinking and reasoning in their top five skills and included teamwork skills in their top ten (Sultana, 2016). Interestingly, both sets of experts stressed the importance of these professional skills as early as an introductory course. Therefore, it is necessary that teamwork, problem solving, and critical thinking are emphasized in the CIS curriculum.

### Teamwork

Although computing is often associated with an individual working alone at a computer terminal (Teague & Roe, 2007), this view is in error. In actuality IS professionals rely heavily on the ability to work with others. Effective computing programs have work to do to dispel misconceptions and show students that understanding can be developed most effectively in team situations (Lewis, Jackson, & Waite, 2010). Muñoz et al. (2013) specified the need to work both autonomously and in interdisciplinary teams. These programs, therefore, should be designed to offer students the opportunity to practice both types of exercises and to do so throughout the curriculum.

Methods to develop teamwork in the curriculum, such as pair programming, have been recommended in the literature. McDowell, Werner, Bullock, and Fernald (2006) found pair programming to specifically improve student persistence and quality of programs, and to increase enjoyment and confidence of students in an introductory course. They suggested the learning technique as a potential solution to improving the performance of underrepresented minorities. An emphasis on developing teamwork capabilities has perceived benefits for students. Sometimes this focus can provide students with chances to develop other competencies. Teague and Roe (2007) stated that:

> Encapsulating collaboration into learning to program can effectively utilize the resources already available, encourage more vigorous and active engagement by students; encourage them to think aloud and verbalize every step of their problem-solving process, as well as satisfy their intense need for interaction and support. (p. 17)

An emphasis on teamwork has other benefits. Law, Lee, and Yu (2010) studied the key factors that motivate students to learn in computer programming courses and found only "social pressure and competition" (p. 226) correlated with efficacy. These experiences provided within CIS courses, therefore, can help students to develop selfworth. Additionally, Barker, McDowell, and Kalahar (2009) found increased student-to-student interaction was the most significant factor in an introductory course determining whether computer science majors persisted in their program. It is, therefore, prudent to include these encounters early in and throughout the student experience.

### Problem Solving and Critical Thinking

Problem solving has been one of the most often mentioned competencies for computing courses in the literature (Enbody, Puch, & McCullen, 2009; Muñoz, Martínez, Cárdenas, & Cepeda., 2013; Roach & Sahami, 2015). This skill has been linked with other benefits, some that are especially important to computing majors. Teague and Roe (2007) stated that “the basic problem solving process template has been instrumental in highlighting the advantages of good documentation in the early stages of program design, especially for more challenging exercises by novice programmers” (p. 11).

Other authors have repeated the importance of structure in the problem-solving approach and considered further benefits, which are desirable to students from all disciplines. Poulova and Klimova (2015) argued for the importance of problem analysis as a key competency and identified it as the “ability to approach the problem broadly and consider connections, ability to structure the problem, its generalization or on the contrary, its specification” (p. 1999). Tackling a problem broadly relies on the capability to properly define it.

The ability to seek and analyze information from different sources is related (Enbody et al., 2009; Muñoz et al., 2013), and is a skill most effectually developed in the Liberal Arts. Sonnier (2013) reasoned about the role of computer science programs in liberal arts institutions, positing that “to tie classical logic to digital logic and integrate an understanding of modern digital concepts into the traditional liberal arts, the program should have a balance of theory and application and focus on problem solving” (p. 119). Thus, the ability to solve problems can indeed be viewed as a central emphasis for programs in computing. One can consider, though, that to be able to solve problems effectively, students must develop alternate ways of thinking. Voskoglou and Buckley (2012) pointed out that though a universal definition is elusive, critical thinking is a foundational skill for computational thinking and “plays a central role in knowledge acquisition and creation” (p. 41). FPU thus launched this CIS program to address the community needs of the Central Valley, in particular the growing need for a critical thinking, problem solving, and collaborative workforce.

## B. Addressing the Need

To meet the gap between the demand for a prepared technical workforce and STEM readiness in underserved students, the CIS program needed to address student preparedness, workplace desired competencies, and best practices for developing knowledge and skills. In addition to including practice and assessment of the aforementioned professional skills, the following best practices in STEM learning are incorporated into the design of CIS's working adult program: learning communities;

curriculum tied to practice, incorporating teamwork, and projects; and support of students with tutoring and writing support.

Fresno Pacific offers Degree Completion (DC) programs to address the needs of the working adult. DC programs are flexible and accessible. Classes meet one night per week for four hours at regional campuses that are conveniently located at major crossroads. CIS, like most DC programs, can be completed in three semesters, which equates to 18 months. Students take one course at a time, which allows for an intensive six-week immersion learning experience. All courses are blended to meet full Carnegie hours, with 4 hours of face-to-face instruction, 3 hours of online direct instruction, and 15 hours of homework per week.

Hrabowski (2012) discussed strategies that have been successful at improving graduation rates for underrepresented minority students including:

> encouraging study groups, strengthening tutorial centers, encouraging faculty efforts to give students much more feedback early and throughout the semester, emphasizing the need for clear expectations for the students in course work, and in essence, a focus on academic and social support (p. 326).

### Learning Communities

The DC program design promotes student learning in groups. Vygotsky (1986) asserted that development comes through dialogue between persons, i.e. learning occurs best through social interaction. The social dynamic of learning helped to spawn the learning community movement in the 1980s. CIS is cohort-based with students beginning the program together and following the same course sequence. The size cap for cohorts is 24, which creates a comfortable learning community. Each cohort elects a class representative, who serves to organize academic and social functions and helps to facilitate communication between the program director, faculty, service offices, and the students.

There is a large body of research showing that learning communities have a positive effect on retention, learning, and graduation; and more particularly, a beneficial effect in STEM disciplines (Dagley, Georgiopoulos, Reece, & Young, 2015; Heaney & Fisher, 2011; Inkelas, 2012) and with minority students (MacPhee, Farro, & Canetto, 2013; National Science Foundation, 2013). Additional literature has suggested that minority students have lower academic self-efficacy (Cech, Rubineau, Silbey & Seron, 2011; MacPhee et al., 2013), which contributes to their lower persistence in STEM careers. STEM learning community participants have shown increased self-report of self-efficacy, metacognition, and STEM professional/science identity. These positive attributes were co-occurrences with faculty, staff, STEM professional, and peer interactions (Carrino & Gerace, 2016). Group projects, therefore are significant forms of assessment in each class as students work together to develop their skillset in the various topics covered in the program.

## Curriculum

Content for the curriculum was modeled after the recommendations of Longenecker Jr., Feinstein, and Babb (2013). The authors presented a proposed model curriculum framework for a CIS program based on the Association for Computing Machinery's *IS 2010: Curriculum Guidelines for Undergraduate Degree Programs in Information Systems* and on a survey of the expected competencies for IS graduates according to industry employers. Longenecker Jr. et al. (2013) suggested a plan of ten foundation courses for CIS, nine of which were included in the planned curriculum for FPU's CIS program. These nine foundational courses were supplemented with a course in discrete structures and courses in computing ethics and biblical literature, to reflect FPU's mission. The context for this content is heavily reliant on opportunities for students to actively learn.

## Active Learning

The low graduation rates of beginning students in technical programs, like computer science and engineering, have long been regarded as an issue. Seymour and Hewitt (1997) reported almost two decades ago that these programs had among the highest attrition rates at the undergraduate level. As a result, there has been an increased focus on pedagogical efforts to address the situation. Among the most promising solutions is an increased focus on active learning. Crawley, Malmqvist, Östlund, Brodeur, and Edström (2014) argued that technical content, from fields such as computer science and engineering, should involve opportunities for design-implement experience and engage students via active learning. The authors indicated that "active learning methods help students make connections among key concepts and facilitate the application of this knowledge to new settings" (Crawley et al., 2014, p. 154).

The CIS program was designed to incorporate opportunities for students to learn content by actively engaging it. Online threaded discussions allow students to research and reflect on topics in the context of current examples. The instructor's role as facilitator ensures that discussions stay focused and delve into the depth required to promote high levels of learning. Projects comprise a significant portion of most courses and allow students to develop solutions to organizational issues.

## Projects

Project experiences allow students to learn by application of concepts and simultaneously develop teamwork skills. Savage, Chen, and Vanasupa (2007) reported that using project-based learning as a primary component in an undergraduate engineering program can provide challenges in assessment and requires students to act ultimately responsible for their education. The authors, however, found that students develop abilities to learn scientific principles and apply them confidently to solve problems (Savage et al., 2007). Though the focus of content is different in this instance, the goal is still to introduce new concepts to students and give them opportunities to actively use them in context.

A challenge, however, is the six-week length of courses. Because of the relatively short duration, flexibility in the curriculum design was required. Although only one course in computer programming is offered as part of the CIS program, programming is introduced in the final three weeks of the prerequisite introductory course. As a result, students are able to develop a stronger foundation in programming so they can contribute to a minor mini-project in the first course and a more complex one in the second course. Crawley et al. (2014) emphasized a need for curriculum to be rich with student projects in addition to internships in industry.

### Workplace Project Experience

The major summative assessment in the program is entitled CIS Project. Students form into teams and work on an industry or non-profit CIS project with external stakeholders. The program's embedded relationship with Bitwise Industries allows for the identification of project opportunities. Venables and Tan (2009) discussed the importance of including workplace learning into an information technology program and specifically noted the importance to first generation students.

The shorter duration of courses makes it challenging to offer students a valuable summative project experience in one six-week session. Therefore, the CIS Project course is designed to encompass multiple sessions. Students enroll in a one-credit course entitled CIS Project Proposal, in which they form their teams, meet with stakeholders, and spend six weeks developing a formal proposal for the project. Upon approval by the course instructor, they then have three complete six-week sessions to work on the project. Although students are not actively enrolled in the project course during this extended time and are taking other courses, they have the ability to communicate with their project coordinator to discuss progress and seek counsel.

### Student Support

Another program goal is to present students, especially underprepared and first generation students, with the support systems they need to successfully transition, thrive, and persist to graduation in STEM fields. An Academic Coach is assigned to each CIS student in the first semester in an intrusive counseling model. The coach addresses any issue that might interfere with academic success, including social, emotional, academic, and financial issues.

Lack of confidence and difficulties with mathematics courses has been found to be the top reason for attrition in engineering and technical programs (Costlow, 2001). Students in the gatekeeper course, discrete structures, have the ability to attend weekly meetings online in which example problems are worked out. Students may ask questions for clarification on specific areas of concern. Similar offerings are made available in other courses as needed. Also, the research-based best practice of supplemental instruction (http://info.umkc.edu/si/) is provided, enabling students to collaborate and assist one another in face-to-face sessions.

## Conclusion

Since it was accredited as a four-year liberal arts institution in 1963 (as Pacific College), FPU has worked to prepare students for their future lives and careers. The location in California's Central Valley provides an opportunity to address the underrepresentation of minorities in STEM fields. The State of California Employment Development Department (2015) reported that occupations such as computer systems analyst and applications software developer are expected to grow by 40% or more over the next decade in Fresno County. Many students in this region express a desire to remain in the area close to their families. This program was developed to meet regional needs and give students the background to begin in-demand careers.

The curriculum content incorporates input from various stakeholders and experts on both local and national levels. The classroom experience was designed with a focus on learners and their specific attributes and needs. Students have opportunities to actively learn about CIS through research, project, and workplace experience. A support system is in place to ensure that learners get help when and how they need it. Additionally, the location at Bitwise in downtown Fresno puts students in an authentic professional environment as they prepare for careers they observe firsthand. FPU aims to help contribute to the development of the local region by contributing to the preparation of a workforce that possesses the skills for in-demand careers in the Twenty-First Century.

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