CITYPOLYTECHNICAL HIGH SCHOOL: AN INTERDISCIPLINARY APPROACH TO ARCHITECTURAL AND CIVIL ENGINEERING TECHNOLOGY STUDIES

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ABSTRACT

As educators, we are entrusted with the responsibility of instilling our students with the necessary technical and soft skills needed to succeed. In order to accomplish this, we need to respond to the needs of the millennial or digital generation by incorporating multimedia into our classrooms in a structured, meaningful way well before students enter the college learning environment. City Polytechnic High School has embarked on this effort through their Integrated Projects course offerings.

The City Polytechnic High School of Engineering, Architecture and Technology (CityPoly) welcomed its first cohort of freshman in fall 2009. As a five year secondary school, these students will not only receive a high school diploma in three years but may also continue on to an associates degree in areas such as architectural, civil engineering and construction management technology at New York City College of Technology (CityTech), part of the City University of New York. CityPoly will be the first New York City High School to allow 12th grade students to attend a university full-time and interact directly with college students.

For the first three years of study at CityPoly, students take a series of Integrated Projects (IP) courses. The IP learning model focuses on project-based, interdisciplinary learning with multimedia applications. The disciplines of architecture and civil engineering serve as the medium for this learning. The mission of the IP courses is to develop the skill set students need to successfully transition into college or directly into the workforce. This paper focuses on the curriculum development methodology, implementation, and assessment of the Integrated Projects courses.

INTRODUCTION

Leading the IP curriculum development effort is an interdisciplinary team led by the partnership of a licensed Architect and a licensed Civil Engineer both full time professors at New York City College of Technology. This paper focuses on the curriculum development, implementation, and assessment methodology of the Integrated Projects courses.

1. THE CITYPOLY – CITYTECH PARTNERSHIP

1.1 Introduction to CityPoly High School

CityPoly is one of four State-approved Career and Technical Education (CTE) demonstration sites in New York City and has been named as one of 10 schools in New York City Chancellor Joel Klein's 21st Century Schools Initiative. The unique format of this CTE school is a 3 + 2 program in which students

complete a full 4 years of high school learning a three (3) year period followed by two (2) more years of college level work at CityTech, earning a 2-year associates degree.

With no scholastic admissions requirements, CityPoly serves a predominantly minority and disadvantaged cross section of New York City high school students providing opportunities for college study and career pathways in engineering, architecture and technology related fields. CityPoly opened its doors to its first 130 students in September 2009 and by the fall of 2010 will have completed its first full year, run two summer programs and will be welcoming its second group of incoming freshman.

The CityTech–CityPoly collaboration consists of members of the CityTech administration including the provost, CityPoly faculty and interim acting principal, architectural technology and civil engineering technology department chairpersons and faculty; CUNY's Early College Initiative; and the National Academy Foundation, which operates over 500 career academies in high schools nationwide. Funding for the project is through the Department of Education (DOE), CUNY and the Tortora Sillcox Family Foundation.

2. CURRICULUM DEVELOPMENT AND IMPLEMENTATION

2.1 Integrated Projects Overview

The mission of the IP courses is to develop the skills needed in order for the students to successfully transition into college or directly into the workforce. The architecture and civil engineering disciplines serve as the medium for this learning. Students are taught methods of analysis and critical thinking common to these professions while working to solve real world problems instead of memorizing solutions. Over the course of multiple trimesters, students will be introduced to, repeat, and finally master concepts and skills. In addition, the multidisciplinary learning environment provided by the IP courses exposes students to various fields of study in the architecture and civil engineering disciplines early on in their educational experience while encouraging collaborative and team building exercises.

In the first year, students engage in a series of daily analytical exercises with emphasis placed on the development of the individual. This course was offered to the first cohort of freshman in fall 2009. Offering this course before the subsequent IP courses were fully developed allowed the team to determine the appropriate depth and breadth of coursework for the second and third years. It was also a valuable way to identify the pre-existing skill set of the incoming freshmen.

While the second and third year IP courses are currently in the development stage, it is planned that students will embark on solving real-world architectural and civil engineering problems in the form of a comprehensive project that will span multiple trimesters. Here, emphasis will be placed on teamwork and collaboration to simulate the interdisciplinary approach to problem solving that often occurs between clients, architects, engineers and contractors in industry.

Teams of students will be presented with a series of design problems in the form of questions such as: how can people and goods get across a river, where is the best building site, how will the building site be utilized and how are resources shared in a community. Each of these questions will be further broken down into a series of tasks for the individual teams to solve. The extent and complexity of these tasks will increase as the students mature and strengthen their skill set. The IP course sequence will lead the teams through the entire project.

In the second year, the focus is on the investigation of the site, followed by analysis of conditions along the river to determine the best location and method of crossing. As the project proceeds, constraints are added to the problem solving process. After crossing the river, teams further study the other side of the river to begin evaluation of various building sites. At the end of the year, a formal presentation of each team's work is presented and discussed by the class. These presentations will be a record of the work completed and serve as a starting point for the next year.

For the third year, different building types will be assigned to each of the teams who will then research the programmatic space needs of each building. As the number of available sites is limited the project further asks the teams to work together as a community to interact and negotiate for the use of shared resources. Teams will be made aware of the differences between their design solutions for an ideal community to the realities of how these issues are managed in a real environment like New York City. Again, at the end of the year a formal presentation will be given. CityPoly is looking into designating a prominent permanent space to showcase the final designs as a means of instilling pride in the upperclassmen and to generate excitement among the freshmen. There has even been discussion of hosting a design fair in which family, friends, and professionals will be invited to view the students' work.

2.2 The Case for the Architecture/Civil Engineering Collaborative Model

In the *Global Achievement Gap,* Tony Wagner sites the lack of the development of what he terms "the new survival skills our children need." According to Wagner, the seven survival skills are critical thinking and problem solving; collaboration across networks and leading by influence; agility and adaptability; initiative and entrepreneurship; effective oral and written communication; accessing and analyzing information; and curiosity and imagination. Wagner emphasizes that curricula and teaching methods must teach students how to reason, analyze, and communicate well. Students need to be taught how to think and not merely memorize. Like many fields of study, these skills are the core of the architectural and civil engineering disciplines.

As such, architects and civil engineers are an excellent example of professional collaboration in the real world. There is a strong symbiosis as architects and engineers work together to determine the most appropriate form and function of a structure or space. Each profession has certain goals in mind during the project. For example, the architect is mindful of how people will use and enjoy the structure or space. The civil engineer looks to create a structure or space that is safe and efficient. Each professional needs to recognize what is important to them as well as their team members. Strong interpersonal skills such as: communication, patience, compromise, negotiation, leadership, listening, respect and others are needed by all team members to achieve a common goal. This collaborative model was used to develop the IP coursework, and the skill set needed to succeed in these fields became the guiding principle behind each lesson plan.

Another valuable feature of the Architecture/Civil Engineering collaboration is the critical thinking and analysis methods common to the both fields. This "Design Feedback Loop" (Figure 1) follows a set of logical steps that are a critical and unique part of how architects and civil engineers solve problems. By incorporating this process into the IP coursework, the student develops a set of critical thinking and problem solving skills that are applicable to a wide range of problem solving scenarios.

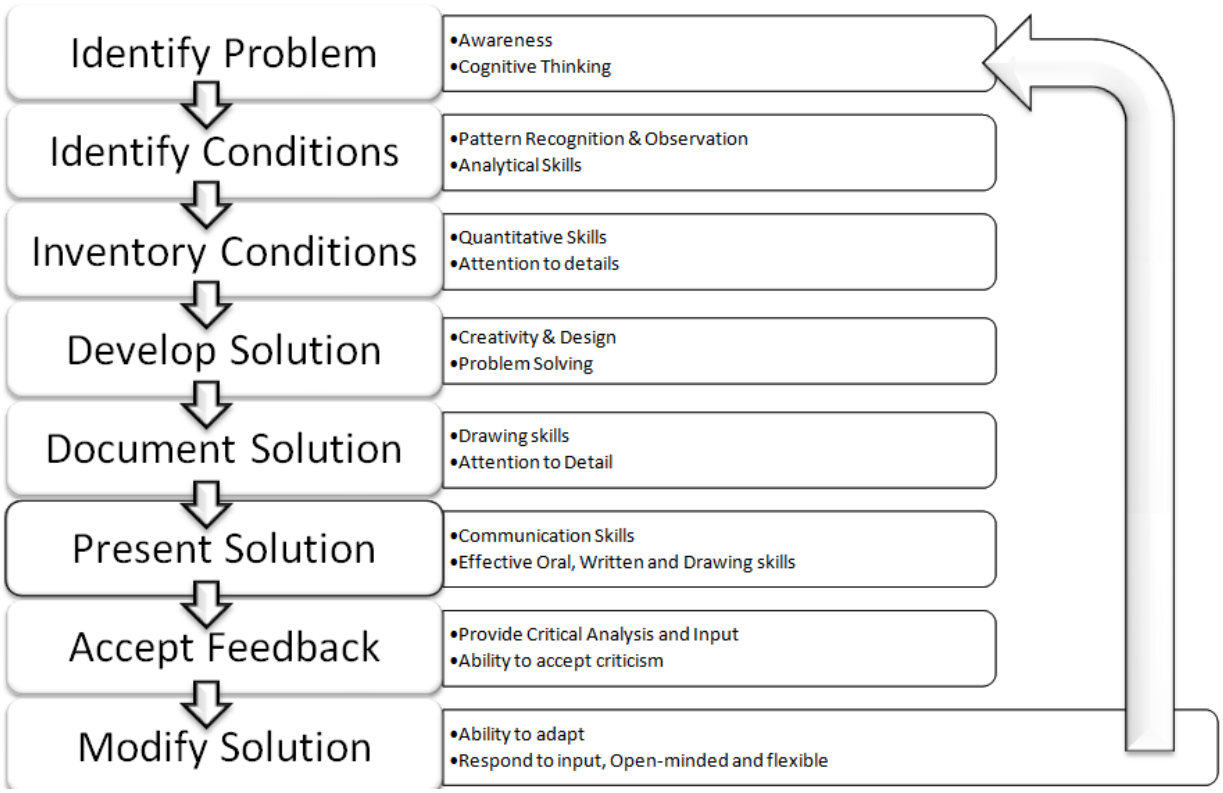


Figure 1: The Design Feedback Loop

2.3 Skill Set Development of the CityPoly Student

The same collaborative model and Design Feedback Loop methodology used in the architecture and civil engineering disciplines was used by the authors to develop the IP coursework. During the brainstorming process, the authors collaborated to determine which skills were to be developed by the students in the IP coursework. The authors identified specific soft and communication skills that both disciplines have in common. Once this was complete, technical skills were discussed and explored. Again, architects and civil engineers utilize a similar technical skill set which includes: critical observation, critical thinking, logic, problem solving, analytical thinking, scale and proportion, adaptability to new technology, creativity, hand sketching and drawing, blueprint reading and applied mathematics and science.

The IP coursework addresses the development of these skills by immersing students in the project-based learning environment. The specific soft, communication and technical skills identified by the authors are shown in Figure 2.

Figure 2: Soft, Communication and Technical Skills

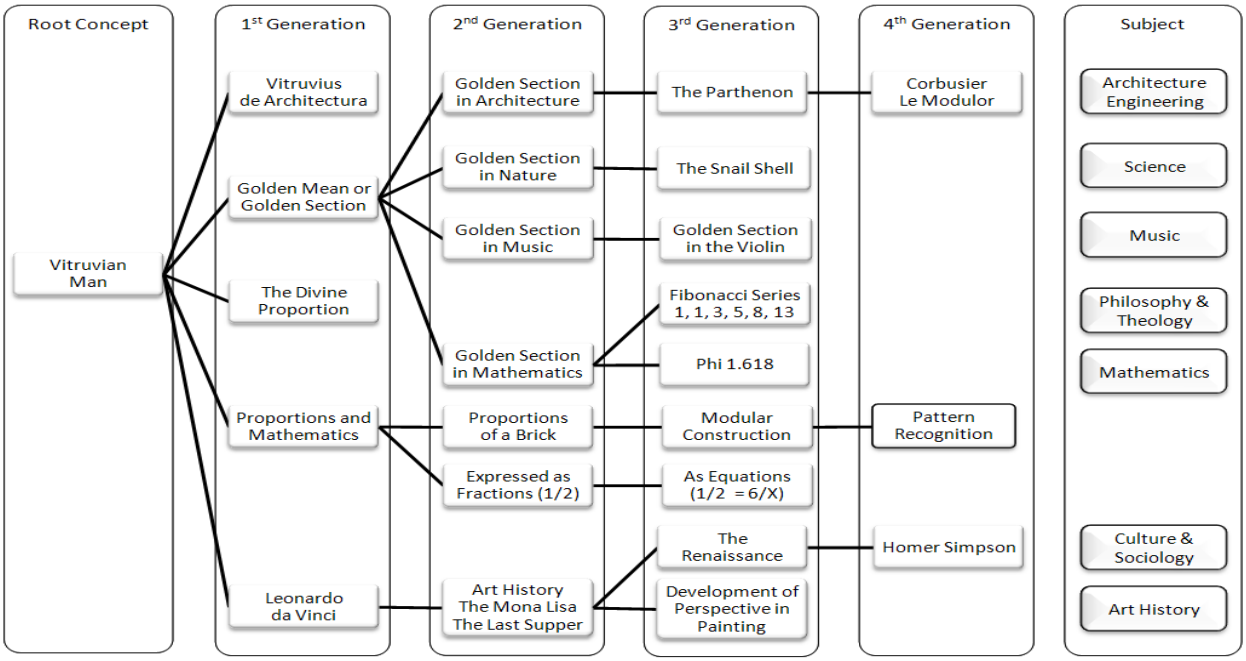
Soft Skills	Accountability	**Technical Skills**
Confidence	Setting Reasonable,	Data Collection/Management
Demeanor	Achievable Goals	Critical Observation
Patience	Time Management	Critical Thinking & Logic
Excitement for learning	Setting/Adhering to Deadlines	Problem Solving Process
Leadership	Respect for Diversity	Analytical Skills
Respect	Creativity & Imagination	Understanding the Problem
Listening		Scale and Proportion
Following Directions	**Communication Skills**	Hand Sketching & Drawing
Teamwork & Collaboration	Oral Presentation	Reading Blueprints
Compromise & Negotiation	Composition	Applied Mathematics
Social Responsibility	Technical Writing	Applied Science
Environmental Stewardship	Research	
Ethics	Technical Vocabulary	
Sharing Credit	Summarizing and Review	

As can be seen from Table 1, the IP courses will have a strong focus on soft skills. The skill set developed through the IP courses is designed to be applicable to a wide range of future career choices. While students are encouraged to pursue careers in the architecture and civil engineering disciplines, the mission of the IP courses is to successfully transition students into any career path that they choose.

2.4 Curriculum Development Process

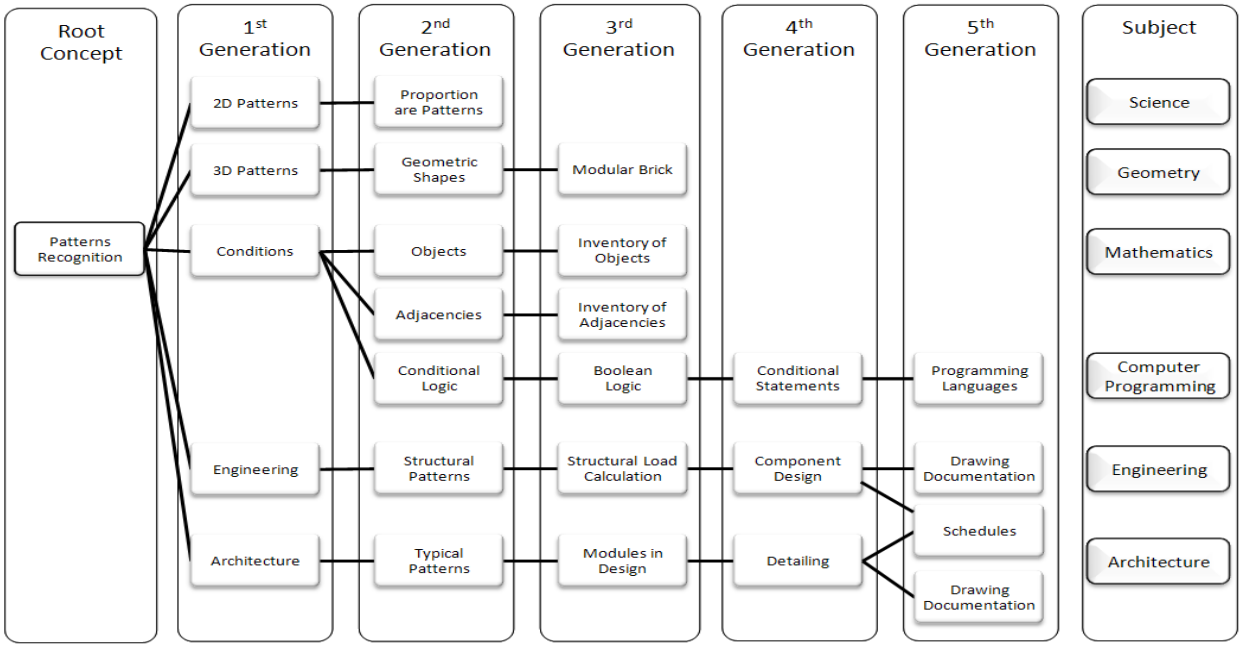
The team's curriculum development process typically begins with one simple idea. The following two case studies show how one idea generates multiple lesson plans that map to various subject areas. In Case Study 1 (Figure 3), the initial concept of the Vitruvian Man, a drawing by Leonardo de Vinci based on the writing of Vitruvius, was explored. This concept led to lessons such as: the Golden Section, Fibonacci's sequence, proportions and ratios, and the artistry behind the Mona Lisa. These lesson plans map directly to the subject areas of architecture, engineering, science, music, art, philosophy, mathematics, culture and sociology. Classroom activities and outside assignments will emphasize certain skills while exploring different subject areas thus creating an "integrated" learning experience for the students.

Figure 3: Case Study 1 - Vitruvian Man Permutations



Case Study 2 shown in Figure 4 began with the idea of pattern recognition, a 4th generation idea from the first case study and further develops this into a second series of lessons that touch on many of the same subjects. The goal of the brainstorming process is to develop a logical sequence of concepts that are engaging to high school students. Additionally, by touching upon multiple subject areas, the hope is that all the students will find a subject of interest and explore possible career paths based on this subject. This is directly in line with the goal of providing students with diverse career path opportunities.

Figure 4: Case Study 2 – Pattern Recognition Permutations



2.5 Incorporating Multimedia

Current college age students between the ages of 18 to 29 are known as the millennial or digital generation. According to a recent report by the Pew Research Center, 79% of millennials say there is a "major difference in the point of view of younger and older people today" (Gibbs). It is in the use of technology that millennials see the greatest difference between themselves and the older generations. Millennials use "technology to build community" and are "the most likely of any generation to think technology unites people rather than isolates them." They see technology as a means of connection, not competition. They want to bridge gaps and work as a team.

IP courses are utilizing multimedia in the classroom as a means of connecting with the students. Smartboards® with internet connectivity are used during lessons to explore the lives of scientists, engineers and architects; search for images skyscrapers and bridges to help students brainstorm solutions; and teams can present their work electronically to the class. Students will use palm-size digital video cameras to document learning and teamwork instead of a written journal in the second and third years. The video gathered is planned to be used in the digital media course that the students also take as part of the CityPoly curriculum.

3. COURSE ASSESSMENT

Through individual and team assignments, IP helps students to view their unique backgrounds and interests as assets and encourages them to see the advantages of being part of a diverse team. To encourage a more open, creative and less restrictive learning environment, grading is on a pass-fail basis.

Wagner asserts that "assessment drives instruction" (Colon). This was the guiding principle of the IP learning model. As previously discussed, specific skills were identified early on by the curriculum development team. Lesson plans are developed based on particular skills to be introduced, repeated and mastered. Rubrics are being developed to assess the skill set of each student, and benchmarks will be set that students must meet in order to pass each trimester of an IP course.

4. CONCLUSIONS AND MOVING FORWARD

As a new learning environment, the Integrated Projects approach and philosophy will require both teachers and students to adapt to a different way of thinking about how learning occurs. As a result, the curriculum development team realizes that course development will need to be a dynamic process to meet the needs of and connect with the students. Multimedia will be incorporated in a structured, meaningful way so as not to detract from students learning the necessary skills they will need to succeed.

In the future, IP courses which run concurrently with other courses in the CityPoly curriculum will complement each other by sharing assignments and integrating course content. The Integrated Mathematics courses and Art and Architecture courses are currently beginning this process.

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