Competency Based IT Experienes

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***Abstract*— This paper introduces an ongoing National Science Foundation funded project that prepares high school students for college readiness and fosters student interests in careers in Information Technology. The project targets a mixed student population from urban, low-income settings. Based on the project's first-year results, the paper proposes significant changes that will be implemented in the project's second year. These changes include a competency-based education curriculum in which students' IT knowledge and skills can be assessed in a way that three college course credits can be awarded to students who are still in high schools, a 12-hour graduate certificate program that prepares both in- and pre-service teachers to teach college IT courses for University of Cincinnati at their high schools through an Ohio College Credit Plus program, and a more concentrated research in computational thinking, which has been brought up for national attention and recognized as one of the essential competencies among Science, Technology, Engineering, and Mathematics disciplines.**

Keywords*— *K-12 STEM Education, Information Technology, Competency-based Education, Computational Thinking, Teacher Preparation, Curriculum Development

I. INTRODUCTION

Design-based Information Technology Learning Experience (DITLE) project is a strategic educational initiative by the University of Cincinnati (UC) to prepare Cincinnati public high school students for post-secondary education and careers in Information Technology (IT). The project is funded by the National Science Foundation (NSF) and is implemented by a collaborative effort between UC's School of Information Technology (SoIT), UC's School of Education (SoE), and partner high schools in urbane Cincinnati. Through the project, a series of extracurricular activities, including after-school clubs, student internship, summer IT intensives, and teacher training were designed and implemented. In addition to the education and curriculum development contents, research is another key component of the project. The results of the research provided a picture of the complexities involved in engaging and retaining students with diverse backgrounds in IT programs and provided insights into the activities best suited to bring about student success in IT, whether by engaging them in career pathway or simply expanding their understanding of the role of IT in today's society.

The project is currently in the second year of its three-year funded period. A detailed first-year program review has been summarized and reported [1]. This paper will briefly summarize the summer camp component of the DITLE project and explain a completely redesigned IT curriculum and the innovation we are currently conducting in the second year that incorporates competency-based education (CBE) format, awards college credits through Ohio's College Credit Plus (CCP) program, and employs computation thinking (CT) concepts in the curriculum design. .

II. DITLE SUMMER CAMP PROGRAM

The DITLE Summer program is a 3-week intensive summer IT day camp designed to introduce high school students to a wide range of IT topics and foster their interests in pursing academic advancement and careers in IT. The IT domain knowledge covered in the camp include IT fundamentals, computer application development, database management, cybersecurity, and networking. The program creates a hands-on, project-based, and team-oriented learning environment at UC campus using UC's state of the art equipment and laboratories, led by the SoIT faculty and student volunteers.

2015

38 students from six Cincinnati public high schools were enrolled in the camp in summer 2015. Four of these schools are high needs schools with more than ninety percent of students from underrepresented population in urbane, low-income families.

A typical camp day starts with a motivational keynote speak. Fifteen keynote speakers were carefully selected from local IT industry leaders, UC faculty, former SoIT graduates, and minority and women IT organizations. The mornings also include a two-hour session of IT Essentials that teaches hands-on skills of conducting small IT tasks, such as assembling a PC, installing operating systems, creating a web page, and using software and social media. The afternoon sessions divide students into two groups to learn advanced and specialized IT topics in database management, cybersecurity, programming, and networking. Student groups meet during the last session of each day to design and implement an IT project. On the last camp day, student groups present their projects and demonstrate skills they learned through the camp to the faculty and student families. A set of project assessment instruments

were carefully designed and employed to evaluate student learning and project effectiveness.

Pretests and posttests of IT knowledge were constructed using existing test bank items for a college-level Fundamentals of IT course. These tests were given to all program participants on the first day and last day of the summer program classes. A significant improvement of IT knowledge among camp participants was identified through the pre- and post-test scores. Other assessments on self-efficacy, persistency, college and career aspiration, and engagement were also conducted.

2016

47 students from six Cincinnati public high schools applied, were accepted, and attended the orientation for the DITLE summer camp in summer 2016. 40 students attended the first day of camp. 3 of those students decided not to attend after the first day. 37 high school students attended consistently after the first day of camp. In addition to high school students, we also had 5 preservice teachers from the SoE graduate programs and 11 student teachers. Of the 11 student teachers, 2 students were high school rising seniors who had attended the camp in 2015 and continued to participate in their school IT club. They were invited by the director of the grant to a paid teaching assistant position. 1 student who attended the camp last year and was accepted into the SoIT BSIT program fall 2016 was also invited by the director to a paid teaching assistant position. A master's student in the college of allied health was invited to a paid teaching assistant position for organization skills and maturity. The other 7 teaching assistants were from the SoIT BSIT major with 4 taking the paid position and 3 using it as a volunteer co-op experience. We had 4 faculty members who developed the content of the 10 modules and attended the camp periodically.

The camp schedule started again this year with a motivational keynote speaker. Fifteen keynote speakers were carefully selected from local IT industry leaders, UC faculty, former SoIT graduates, and minority and women IT organizations. The 2015 DITLE camp highest rated speakers were invited back this year and new ones were selected to replace those not highly rated.

The 37 high school students were broken up into 2 groups: 1 group for the Fundamentals of IT modules in the morning and early afternoon and 1 group for the group project in the late afternoon. There were a total of 10 groups for each so the group size ranged from 3-4 members.

The Fundamentals of IT 10 modules ran concurrently from 10:00 am until 1:45 pm, minus an hour for lunch, for the first 12 days of the camp. A group was assigned to a module each day. 8 of the modules took 1 day to complete and there were 2 modules, cybersecurity and web development, that took 2 days each to complete. The modules are

- Keyboarding, the Internet, Directories and Operating Systems
- Hardware
- Networking
- Word Processing
- Web Development
- Cybersecurity
- Presentations
- Digital Media
- Databases
- Spreadsheets

All students passed the competencies for each module resulting in 37 out of 37 students receiving a letter for prior learning assessment in the Fundamentals of IT course at UC.

The group project ran from 2:00 pm – 4:00 pm for 12 days and from 10:00 am – 4:00 pm, minus an hour for lunch, for 2 days. The students had a 15 minute break after the fundamentals of IT groups to get a snack and move to their project groups. The preservice teachers were all assigned 2 groups each. We had a sample project during the first 2 days so that the students could experience a group together. The students were asked to download a free HTML 5 template and update the template to make a local landing page for their project team. This was to include a picture of the team mascot, a name for the team, and the team members' names. The teams had to present their landing page to the group. This helped to quickly form the teams and practice presentation skills. On the 3rd day, the teams were asked to brainstorm to decide on the project that they would like to complete. The teaching assistants helped the teams form a manageable project for the time allotted.

The teams were asked to solve real world problems with IT. They were asked to work as an agile team using an online scrum tool to manage work. All of the projects were completed and presented on the final day of the camp from 10:00 am – 12:00 am. All family members, high school liaisons and high school principals were invited to the last day to watch the presentations, enjoy lunch, and watch the awards ceremony from 1:00 pm – 2:00 pm. Approximately 110 people attended the last day celebration. The list of projects were impressive because most were unique ideas that solved a real world problem. For example, a project group created an Android application that would use your current location to find radio stations in a specified genre. This is to solve the issue of traveling by car and looking for new radio stations. The students were able to complete the application and run it on their phone even though they had no prior knowledge of Java nor Android app development. They were assisted by online tutorials and videos.

III. Lessons Learned

It was recognized that the pre-service teachers benefited greatly from the camp. These teachers were SoE graduate students who would be math or science teachers, but did not have an academic background in IT yet. They were motivated by the camp activities and demonstrated significant acquirement of IT knowledge by the end of the camp. The camp also created a positive environment for the pre-service

teachers to learn how to work with students in small project groups and to bond with high school students during group project sessions. Regarding to students' survey responses, group collaboration and coding were voted as the most engaging activities by the students. Furthermore, parents were really excited about the camp, especially during the last day attending the student project presentation. Parent and friend recommendations were voted as the most influential criteria for career choices by the camp students, therefore, getting parent involved and exposed to IT will affect students' decision in choosing a college degree in IT. The summer camp were followed up by "IT Family Night" events at each high school through the after-school IT clubs to further educate parents and families to interesting IT topics.

Although not all the students responded positively to the camp activities, some students were highly motivated and interested in IT through the camp. Four students went on to complete an IT internship after the camp in summer 2015 and spring break 2016. They worked full-time for two weeks at UC's IT Solution Center in the summer and designed and programed a software application based on customer requirements. They also worked full-time during their spring break to add an additional level to the game. They are coming back in the summer of 2016 for a 4 week internship. Eight out of ten students from Walnut Hills High School went on to sign up the Computer Science Advanced Placement (AP) class after the summer camp. Three of the students from Hughes STEM high school applied for the SoIT IT major at UC main campus. Two of the students did not have the GPA nor the ACT score for acceptance into the main campus program. They were accepted into the branch campus, UC Blue Ash, IT program. They hope to have a college GPA that will allow them to transfer to the main campus program after the first semester.

The project team was able to connect to the students using social networking tools through and after the camp. The camp Facebook page has been very active since the camp started. Students were able to be followed up using Facebook and LinkedIn social networking services they set up during the camp.

The class topics were well-designed that covered all learning objectives and outcomes of UC's IT1050, Fundamentals of IT Essentials course. Due to a recent change in how college credit is awarded, it was not possible to grant credit for the summer course in 2015. The summer camp had four classes during the day and a keynote speaker in the beginning. The three summer course instructors worked together to develop the course curriculum; one taught Java programming, a second taught networking and hardware, and the third instructor taught IT Essentials. They reviewed the material with each other to determine if they were meeting and actually exceeded the learning outcomes for IT1050.

Challenges were identified in the first-year implementation as well. Organizing students, especially during the first week was difficult. The format of the lectures and the large amount of classes were not effective ways to keep some students concentrate throughout the day; therefore there were students who got behind on the hands-on activities. In addition, the project in the first week took too long that students could not complete before the end of the day. In terms of research, the sample size we collected during the first year was small. Some of the findings were not statistically significant.

IV. Project Improvements

From the lessons and experiences learned from the first year summer camp, the project team is making significant changes to the curriculum and activities that will be implemented in summer 2016.

A. Competency Based Education (CBE)

A recent national survey conducted by Lumina Foundation shows that only 11% of business leaders and 14% of Americans strongly agree that college graduates have the necessary skills and competencies to succeed in the workplace [2], in which competencies are statements of what students can do as a result of their learning. CBE is an outcomes-based approach to earning a college degree or other credential [3]. CBE curriculum development and adoption have become a national trend for education institutions to bridge the gap between what the employers need and what competencies the graduates possess. CBE also provides flexible and personalized learning environment that students can learn in their own paces.

The project will divide the 70 participants (60 students from six partner schools and ten pre-service teachers) into eight small groups. The groups will be rotated to go through each day's camp activities. This design creates a smaller, more personalized learning environment. Each learning module is redesigned with specific tasks, learning outcomes, and an open-ended hands-on activities that the students will complete to demonstrate their mastery of the related IT knowledge and skills. For example, one learning module on basic web creation will ask each group of students to create a website that records their deliverables of the camp activities; and the web site will be used as a portfolio site that eventually be used to demonstrate student learning outcomes to the project team. Students will have to complete all the required tasks, or competencies to earn the course credits. This new approach employs CBE concepts and students will be assessed on their open-ended hands-on projects and created artifacts in a project- and team-based learning environment. Their implementation schedule is flexible enough for them to prioritize the tasks based on their capacity and schedule.

B. Earn College Credits

College Credit Plus (CCP) program is a vital and effective component of the state's integrated strategies to enhance students' college and career readiness and post-secondary success [4]. It provides free tuition for high school students to take college courses. Effective dual credit systems have been linked to positive student impacts at both high school and postsecondary levels. In addition, it has the benefit of creating a reliable and seamless pathway for students to transition from high school into postsecondary endeavors. Students who attended all the camp activities will receive certificates of camp completion that recognize their participation and encourage them to further explore academic and career development in

IT. Students receive a letter that indicates they have passed the competencies of IT1050 Fundamentals of IT, one of the SoIT's freshman year courses. This letter will be used for prior learning assessment and will guarantee that the student will receive credit for the course upon enrolling at UC. All students who complete all the required tasks, demonstrate related competencies, and are fully evaluated by the project team will receive this prior learning assessment opportunity at UC. Students are invited to take CCP courses throughout the school year. There are many IT courses available as CCP courses delivered to the high school for those students who have yet to take any college entrance exams, received a low score, or may not have a GPA appropriate for UC main campus admission.

C. Computational Thinking

CT can be defined as "a way of solving problems, designing systems, and understanding human behavior that draws on concepts fundamental to computer science" [5]. CT is inherently related to the use of computers and technology, but it is not specific to any particular field of study. The types of skills and competencies under the umbrella of CT can serve learners across domains and disciplines. It is recommended that all STEM (Science, Technology, Engineering, and Mathematics) students need to understand the role of computational thinking within disciplinary problem solving. Reports by the President's Council of Advisors on Science and Technology and the National Research Council indicate that CT skills are essential in the K-12 [6][7].

The summer camp activities will integrate CT competencies into the existing IT1050 curriculum by following the CT Practices defined by the AP CS Principles Curriculum Framework [8]. Each learning module is redesigned to incorporate problem and computing technique analysis, CT artifacts creation, and team communication and collaboration.

V. CONCLUSIONS

This paper summarizes an NSF funded K-12 outreach project through a 3-week summer IT camp. Based on the lessons learned from the first-year implementation, changes and improvements are proposed.

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