EDTC 809 – Assessment and Evaluation

Project 2

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Qualitative Study

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Introduction

Among publications considered iconic and visionary in the area of computing, one article deserves its proud place and continues to be referenced by the researchers in multiple fields. Currently, the reference count to this twelve-year old article climbed over four thousand links. It was published in 2006 in the Communications of the ACM, by then the head of the Computer Science Department at Carnegie Mellon University, Dr. Jeannette Wing under the rubric *Viewpoint*. Entitled as *Computational thinking* and described in its opening statement as “a universally applicable attitude and skill set everyone, not just computer scientists” (Wing, 2006, p.33), the article continues making its mark as an artifact in triggering the change in mentality in and beyond the computing community.

Since its introduction to the wider computing community in 2006, the increased attention to the computational thinking has been noted by the members of K-12 educational sector. Due to the efforts of International Society for Technology in Education and Computer Science Teachers Association, computational thinking has been advocated for. A set of centrally available materials and resources utilizing computational thinking and adaptable to multiple subject areas have been implemented and accessible for the further dissemination and in K-12 community (Sykora, 2014).

In the landscape of the higher-level education, the attention to the computational thinking varies greatly. In some academic areas, unrelated to information technology or computer science, a community college student may earn a degree and not formally experience or get an opportunity to develop computational thinking skills. No centrally available resources or general education guidelines exist for adapting or implementing computational thinking into a core curriculum of the community college students. There is no support for centrally proposed toolset for the development of the computational thinking among community college students in the state of New Jersey. A gap in the research exists for supporting such initiative.

This study presents a practical qualitative inquiry of the proposed incorporation of the computational thinking discipline into a core curriculum of a community college in New Jersey. The purpose of the study is to explore the need for integrating computational thinking curriculum into various areas of study by employing a qualitative inquiry approach and conducting interviews with the academic department chairs across the institution (Patton, 2015). The study will focus on the following research question: (1) what is your interpretation of the need for the computational thinking ability in 21st century? (2) how can computational thinking education be achieved by the students in your academic area?

Literature Review

In 2006, Dr. Wing popularized the term *computational thinking*, but she did not create it. The concept was first introduced in 1980 by Dr. Seymour Papert, MIT Professor, researcher, and a developer of constructionism theory (Papert, 1980). The constructionism theory serves as a foundational framework for this study since it is a theory of learning about and with computers. Along with Jean Piaget, who supported the ideas of constructivism (Wadsworth, 1996), Seymour Papert coined the new term constructionism, related to the construction of the world, in which students can use computers as educational tools to explore and be create (Papert & Harel, 1991). Papert's constructionism theory became foundational for the further development of other computational thinking related theories, such as recent Positive Technological Development theoretical framework (Bers, 2012). According to Bers, "Constructionism advocated for technological tools that support children to become designers and creators of their own personally meaningful computer-based projects" (Bers, 2012, p.7). Constructionism allows for trial and error, tolerance towards complex or open-ended problems, working in teams and exploring and automating the process -- essential components of the computational thinking.

By 2006, the need for computational thinking development became more apparent. Dr. Wing's publication could be recognized as a call for action to embrace such development in all levels of schooling, since the early grades. She wrote, "Computational thinking is a fundamental skill for everyone, not just for computer scientists. To reading, writing, and arithmetic, we should add computational thinking to every child's analytical ability" (Wing, 2006, p.33).

The attention to the importance of the computational thinking continued, and more specifically to the conceptual understanding of it. In 2009 the National Science Foundation awarded sponsorship to the project *Leveraging thought leadership for computational thinking in the PK-12 curriculum*, dedicated to defining the concept and providing the relevant, age-appropriate examples, aligned with the learning objectives (National Science Foundation, 2009). In 2010, a committee of representatives from the higher education, PK-12 sector and the industry reached a consensus and finalized the operational definition of computational thinking along with a description of its components, to enable educators from various academic areas and grade levels to build relevant learning activities (Barr, Harrison, & Conery, 2011).

The development of the computational thinking process is related to the development of problem-solving abilities. Both use similar strategies and inductive and deductive methods, including but not limited to evaluating the validity of the logical expressions, eliminating circular pointers, drawing references from the various types of data and selecting descriptive examples for creating inferences (Krathwohl, 2002). Both computational thinking and problem-solving processes involve similar cognitive processes. They employ higher-level skills and abilities under the revised Bloom's taxonomy, such as analyzing, evaluating and creating (Krathwohl, 2002).

Defining computational thinking through the problem-solving lens became the focus of adapting it to PK-12 educational sector. By the recommendations of the committee from 2010, a computational thinking was defined as a problem-solving process that included: (1) stating the problems in such a way that a computer or another digital tool can be used to solve them; (2) presenting and analyzing data in a logical manner; (3) creating an automated process for implementing algorithmically-driven solutions (in a step-by-step manner); (4) developing and implementing optimized solutions with the most efficient use of resources; (5) generalizing and expanding this problem-problem approach to the problems in other areas (Barr, Harrison, & Conery, 2011).

With a spectrum of the problem-solving oriented tasks, the computational thinking supports the development of the learner's abilities and acquired behaviors. They include self-assurance and self-confidence in solving complex or challenging problems, acceptance of the multitude of viable methods, perseverance and tolerance towards open-ended scenarios, opportunity to collaborate participate in group work to achieve a common goal or create a shared solution (Barr, Harrison, & Conery, 2011).

With the rise of attention of the computational thinking, some researchers debated its independence from the mathematical thinking. Based on the findings supported by the International Society for Technology in Education (ISTE), it was concluded that computational thinking differs from the mathematical thinking due to the following reasons: (1) it allows for the new and effective way of problem solving due to the unique combination of the thinking skills used together; (2) it uses technological tools; (3) it provides the practical environment for automation and implementation of the previously contextual skills, such as trial and error, iterations and weighted guessing (Barr, Harrison, & Conery, 2011).

In 2011, the Association of Computing Machinery (ACM) supported the effort of bringing the computational thinking to K-12 sector. It identified the role of the Computer Science education community in spearheading this effort (Barr & Stephenson, 2011). Over the years, computer science and its related fields of information systems and information technology have grown to encompass a wide spectrum of multi-layered disciplines, including, but not limited to software design and programming, hardware design and programming, networking, graphics, databases and information retrieval, logic, programming paradigms, game development, web development and administration, artificial intelligence, cybersecurity and privacy, cloud computing, robotics. A great variety of computing disciplines allows for presenting a magnitude of digital tools and toolsets for developing computational thinking in students. Published in 2011 by ACM, *Bringing computational thinking to K-12: what is Involved and what is the role of the computer science education community?* provided K-12 educators with a brief guideline for on how to incorporate computational thinking into not only the subject area of computer science, but also to mathematics, science, social studies, and language arts (Barr & Stephenson, 2011).

In 2011, International Society for Technology in Education (ISTE) in the joined effort with Computer Science Teachers Association (CSTA) and under the sponsorship of National Science Foundation (NSF), published two documents defining providing a comprehensive framework and a set of guidelines for the leaders and educator in K-12 sector. The first document, entitled *Computational thinking leadership toolkit*, defined the field, presented a case, and included a list of resources for creating systematic change in incorporating the computational thinking into K-12 curriculum. The latter one included a model for the systematic change, the implementation strategies guide as well as talking points for stakeholder groups (CSTA & ISTE, 2011). The second document, containing teacher resources, incorporated not only the operational definition, vocabulary and the progression chart, but also learning experiences incorporating multiple scenarios and adaptable to the middle school and the high school settings as well as the comprehensive list of additional resources. (CSTA & ISTE, 2011).

Both organizations, CSTA and ISTE continue advocating for incorporating the importance of the computational thinking into K-12 curriculum and provide a wide range of resources to the educators and the educational leaders. In the article *Computational thinking for all*, hosted on ISTE's website, one may find a brief description of the concept and the joint effort project, a short video *Computational thinking: digital age skills for everyone* (ISTE, 2012), and a complete toolkit containing the definition, the multimedia, handouts and booklets and additional online resources on the topic of computation thinking in K-12 sector (Sykora, 2014).

The universal nature of the computational thinking framework makes it applicable to a magnitude of fields and professional environments. As it was envisioned by Dr. Wing in 2006, students across curriculum should be exposed to the discipline of computational thinking:

> "Professors of computer science should teach a course called "Ways to Think Like a Computer Scientist" to college freshmen, making it available to non-majors, not just to computer science majors. We should expose pre-college students to computational methods and models … we should look to inspire the public's interest in the intellectual adventure of the field. We'll thus spread the joy, awe, and power of computer science, aiming to make computational thinking commonplace".

Methodology

To inquire about the need for incorporating computational thinking into various programs of the study across a community college, the qualitative study will be conducted using practical qualitative inquiry approach. A purposeful sample will be selected from the representatives of all academic areas. Every attempt will be made to invite all academic department chairs to participate in the study. Provided there are fourteen academic departments in the institution, a purposeful sample of the fourteen participants will be constructed (Marshall, 1996). If, for some reason, an academic department chair may not be available to participate in the study, a full-time tenured faculty member will be asked to participate instead. Every attempt will be made to represent every academic area of the institution.

The Institutional Review Board will be notified of the intent to study faculty members, who are also academic department chairs. The exempt level IRB will be obtained since the department names or the chairpersons' names will not be exposed in the research results. No identifiable information will be reported. The participants names will be replaced with letters of the alphabet and the department names will be replaced by numbers.

The participants will be invited by the personalized email including a topic of the study and a brief description. An option will be given to the participants to scheduled 20-30-minute interview at their convenience. If the email is not replied to within a week, a phone call will be placed and the same information as in the email will be provided. If the phone call will not result in a scheduled interview (due to variety of reasons), an attempt will be made to connect with a different representative from the same academic area, preferably a full-time tenured professor. A period of four weeks will be allotted to conduct fourteen interviews. To assist with the main research questions, the following questions will be presented during the interview:

1. Are you familiar with the concept of computational thinking? If so, please explain. (The first question is an opener into the discussion. In case a participant is not familiar or slightly familiar with a concept, a researcher will provide a brief description)
2. Are there any courses in your discipline that introduce or cover some areas of computational thinking? If so, please provide detailed explanation.
3. Do you believe that the computational thinking should be included in the required community college curriculum for all students? Why so?
4. Would you have answered the previous question differently had your program not been limited by the number of total credits?
5. What required core disciplines should be included (or excluded) in/from the programs in your academic area? Why?
6. Do you believe that the jobs available to students in your academic area will involve the use of computing equipment? Please explain how so?
7. Do you believe that the employers related to your academic area value problem-solving skills? Please explain and provide examples.
8. Will you be comfortable with taking action in promoting the computational thinking course for all students in college? Why or why not?

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