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Redesigning Online Computer Science for Student-Centered Problem-Based Learning

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ABSTRACT

After launching an online Computer Science post-baccalaureate degree program, this study was undertaken to inform the redesign of an introductory Computer Science course using a student-centered, problem-based learning approach. The research team proposed a weekly/unit learning trajectory as they were engaged in student-centered, problem-based learning. Over a timeframe of three university terms, the research team used a design-based, iterative examination to refine the implementation of various instructional actions in the learning trajectory. Multiple small groups of students discussed their learning experiences each term, providing directions for improvements. The analysis directed successive iterations, refining the content, problem solving, and collaborations in the class. This research method assured authentic student voice in an iterative redesign of the course.

KEYWORDS

Collaboration, Communication, Community of Learners, Design-Based Research, Inquiry, Online Education, Post-Baccalaureate, Socio-Metacognitive-Constructivist

ONLINE COMPUTER SCIENCE POST-BACCALAUREATE PROGRAM

The Internet of Systems that utilize big data consistently has propelled the growing demand for computer scientists. Recognizing the shortage of computer science graduates across the country, this university developed and launched an entirely online post-baccalaureate Bachelor of Science (BS) degree program in Computer Science (CS) beginning in 2012.

The program designers for the post-baccalaureate program focused on attracting students with prior bachelor's degrees in fields other than computer science, noting the combination of skills through multiple bachelor's degrees was in high demand in a variety of fields, such as medicine, business and entertainment. They designed an academic program identified an entirely online program consisting of 60-term-hour credits with enrollment supporting up to 200 students per course, each term. The design challenge proposed an online learning environment with innovative learning experiences to prepare professionals for industry positions.

Problem-solving, critical thinking, design and knowing how to use the content knowledge are keys to the future success of software engineers. Reflecting on online computer science programs, the trend appeared to be toward an information focus, where content knowledge dominated the

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curriculum rather than a knowledge focus. The first iteration of this new online CS program paralleled the campus-based CS program, instructor-driven with little student interaction, where lectures were replaced with videos and assignments and tests assessed mastery of the concepts. Following the first two years of operation, while the program had a strong technical curriculum, the students did not and were not consistently challenged to think critically and deeply about the computer science concepts and processes. The program lacked problem-solving, critical thinking and design experiences, despite the fact that a major outcome for the program was to prepare graduates able to think critically and engage in problem-solving.

The program review identified the focus on content delivery more than attending to the social presence found in face-to-face educational experiences. The online students indicated that the online learning experiences were basically independent study, rather than educational experiences where they engaged in discussions around conceptual content ideas. Many reported feelings of being uncomfortable engaging in discussion with people they did not know. They lacked a feeling of security when proposing ideas to engage others in discussion. As per the literature on online courses, the students felt less supported in communication as well as interactions with the instructor and with other students (Shea, Li, Swann & Pickett, 2005; Song, Singleton, Hill, & Koh, 2004).

THE ONLINE REDESIGN CHALLENGE

With this assessment of the quality of the program, the program designers sought to engage in a redesign of the online program to incorporate more active learning, where students worked in groups, shared ideas and engaged in critical reflection such that they valued shared and individual knowledge development. After extensive analysis of many undergraduate degree computer science programs and best practices in online education, the research team proposed a redesign of the program to incorporate a student-centered, problem-based learning (PBL) approach in this online post-baccalaureate degree program (Jonassen, 2000). To direct the redesign effort, the research team identified the need for the addition of a social presence with the cognitive and teaching presences for the courses (Garrison, Archer & Anderson, 1999; Garrison & Cleveland-Innes, 2005) in order to activate the student-centered aspect.

To describe how this social presence was to be intertwined with the cognitive and teaching presences, the initial task was the formulation of an appropriate learning trajectory for guiding students as they grappled with informal and new ideas (Confrey & Maloney, 2010). With this vision, the researchers outlined a process for the online program redesign, focusing first on redesign in one of the initial courses in the program, CS 162. They selected CS 162 because of its focus on problem-solving and critical thinking through the course emphasis on computer program design.

CONCEPTUAL AND EMPIRICAL FRAMEWORK

The researchers relied on extensive scholarly work for framing the online learning trajectory for the course unit redesign. Consideration was given to best practices for online learning instruction to establish student-centered learning communities. These instructional ideas were then connected with design activities and best practices in problem-based learning.

Online Learning Instructional Practices

Significant scholarly work framed how digital technologies re-conceptualized teaching and learning in online learning, drawing from a variety of learning perspectives and educational venues (Chyung, 2007; Garrison, Anderson, & Archer, 2001; Guilar & Loring, 2008; Preece, Maloney-Krichmar, & Abras, 2003; Riverin & Stacey, 2008). Garrison, Anderson, and Archer (2001) conceptualized a Community of Inquiry framework for framing the online learning environment as a dynamic relationship of three