

Instructional Design Principles of Diversity-Focused Professional Development MOOC for Community College Computing Faculty: Lighthouse CC

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Abstract—Computing occupations increasingly dominate the workforce, but the discipline fails to attract sufficient and diverse students (i.e., women, underrepresented minorities) to meet workforce needs. To address this issue, LIGHTHOUSE projects provide computer science instructors with professional development MOOCs to recruit and retain more and diverse students in computing. We present how a professional development MOOC has been designed with relevant instructional design principles and theories to suit community college computer science instructors' learning needs. In this paper we share results from a needs assessment survey that, along with the relevant instructional theories and design principles, guided the design of an innovative diversity-focused online professional development learning environment.

Keywords—diversity in computing; instructional design; MOOC; professional development; community college

I. INTRODUCTION

Computing occupations increasingly dominate the workforce, but fail to attract sufficient and diverse students (i.e., women, underrepresented minorities, students with disabilities) to meet workforce needs. Lighthouse is a set of projects addressing the need for attracting and retaining diverse computing students by focusing on the professional development of computer science instructors. Lighthouse CC extends eight years of successful face-to-face professional development workshops to online professional development courses. For widespread and sustainable effective professional development, Lighthouse develops a research-based SPOC (small private online course) and a MOOC (massive open online course). A pilot online module was used to test the initial design. Based on these results, a SPOC (NSF grant #1432619) has been developed for community college computer science faculty in edX to open in July, 2016. We report here our innovative MOOC design framework established as a result of a needs assessment survey and the application of relevant instructional design principles.

The professional development content includes; the necessity for diversity and active recruiting; associated methods

and materials; pedagogical practices to engage a broad range of students; information for gaining decision-maker support; and instructional resources. The course contents and approaches were tested in the face-to-face professional development Tapestry workshops (NSF grant # 1042452) that resulted in more than 80% of participating educators increasing both total computing enrollments and female and underrepresented minority students.

II. ONLINE PROFESSIONAL DEVELOPMENT FOR COMMUNITY COLLEGE COMPUTING FACULTY

In recognition of the need for accessible, affordable professional development options, professional development is moving online [1]. A MOOC professional development course offers a potential solution by enabling wider access to opportunities for community college instructors. Some evidence suggests that online professional development has comparable student outcomes to other forms of instructor professional development. Fishman et al. [2] argued the most important ingredient for learning outcomes is the quality of the content. Others contend communities of practice are potentially powerful sources of continuous instructor learning and support [1]. Yet, evidence is lacking as to whether or not participant learning and student outcomes are reliably linked in any large-scale online professional development. Little research has been conducted on community college computing faculty's learning needs, preferences, or professional development readiness.

The main research focus of Lighthouse CC is to investigate the theoretical link between motivation and learning outcomes in the context of a MOOC learning environment created for a specific goal. The operation of this link is critical for effective MOOC learning environments, because many current MOOCs report dropout rates near 90% [3]. Capitalizing on this link would enable a potentially transformative learning environment that could quickly upgrade teacher skills and practices across the nation.

III. METHODS

With the support of National Center for Women and Information Technology, a needs assessment survey was distributed to current and former community college computer science instructors via online in Spring 2016. To measure community college instructors' prior learning experiences on professional development and online learning, we created a needs assessment survey. The survey has eight multiple-choice questions and one open-ended question. Three measured interests levels for active recruitment of diverse students, two measured interests and prior experiences on professional development, two measured preferences and prior experiences on online learning, and one asked about preferred contents to explore diverse learning needs and preferences that might be overlooked. Fifty community college computing instructors responded.

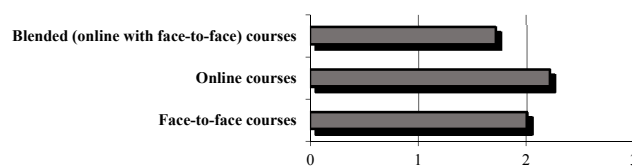
IV. RESULTS

We report the survey results first and then describe how these results influence the instructional design of a professional development MOOC.

To measure instructors' interests and prior experiences, three questions asked about professional development interests and prior experiences, and interests in getting a certificate. 68% of faculty (n=34) reported participating in professional development more than 6 times, 16% (n=8) of respondents reported 4-6 times, and 16% (n=8) reported 1-3 times. 98% of respondents expressed interest in promoting abilities to teach diverse students, including women, underrepresented minorities, or students with disabilities. A certificate is critical as it affects grading policies and achievement criteria. 65.3% of the respondents agreed that receiving a certificate after completing the online course is important while 34.7% disagreed.

To create an adaptive, user-friendly online learning environment, we asked about their prior experiences with taking online instruction and preferred delivery methods for professional development. 90% of the respondents did have some prior online professional development experiences. They took online instruction more than 6 times (49%), 4-6 times (12.2%), or 1-3 times (28.6%). We also asked respondents to rank the preferred delivery methods for professional development. The below figure 1 shows online courses are the preferred delivery method for professional development followed by face-to-face courses and blended courses.

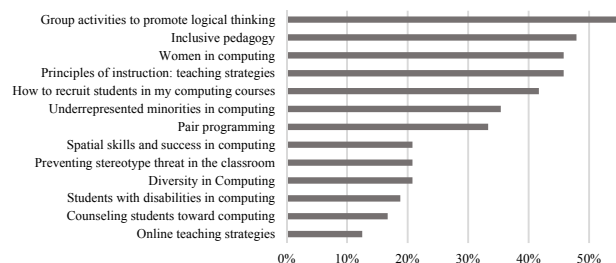
Fig. 1. Preferred delivery methods for professional development (3 is most preferred)



In response to the question about interest in recruiting diverse students into their computing classes, 97.9% (75.5% strongly agreed and 23.4% agreed) of respondents expressed their interest. In response to the question about their experiences in recruiting more students into their computing courses, a majority of respondents (71.4%) reported that they actively recruited (i.e., advertise their courses in any ways). While a minority 28.6% (n=14) of respondents never recruit, a majority of respondents reported that they actively recruit students into their courses almost every semester (38.8 %) or every month (20.4%). Some respondents reported recruiting students almost every week (8.2%) or every class (4.1%).

To meet the learners' interests and needs, we asked respondents to choose topics that would interest them to take in an online professional development course. We provided fourteen topics that Lighthouse has provided in the face-to-face workshop for a decade and asked respondents to choose the three topics of most interest. The response summary provided in Figure 2 shows that community college computing instructors are highly interested in developing knowledge on effective pedagogical strategies to teach diverse students. In particular, how to teach diverse students effectively (inclusive pedagogy) (47.9%), Principles of Instruction (45.8%), and how to do group activities to promote logical thinking (58.3%) were chosen as the most interesting topics to learn in a professional development MOOC. In addition, 45.8% respondents selected Women in Computing as one of their interesting topics to take.

Fig 2. Preferred topics to take in online professional development course



V. DESIGN FRAMEWORK AND INSTRUCTIONAL PRINCIPLES OF LIGHTHOUSE CC

Survey results show community college faculty have high interest and motivation in promoting their abilities to teach diverse students. Yet, faculty professional development has often been unsuccessful because it has failed to take faculty's existing knowledge, beliefs, and attitudes into account. In the context of community college faculty's work, practical knowledge integrates experiential knowledge, formal knowledge and personal beliefs. Sustainable professional development programs are needed to achieve lasting changes in teachers' practical knowledge [4].

To keep high motivation and interests on professional development to teach diverse learners and to enhance transferable learning, Lighthouse CC uses Community of Practice (CoP) model and Keller's ARCS motivational design model.

Considering community college computing instructors' higher preference for online learning environments than face-to-face or blended learning environments, Lighthouse MOOC design uses a Community of Practice (CoP) model to enhance online learning.

A CoP is defined as "a group of people who share an interest in a domain of human endeavor and engage in a process of collective learning that creates bonds between them" [5].

Learning communities are grounded in two assumptions:

- Knowledge is situated in the day-to-day lived experiences of teachers and best understood through critical reflection with others who share the same experience [6].
- Actively engaging instructors will increase their professional knowledge and enhance student learning [7].

The Lighthouse MOOC creates a sustainable CoP by building collaborative, networked online environments; providing real-life situated contents with activities; linking learners with peer learners; offering access to repositories; and encouraging an awareness of the context of information resources.

Keller's ARCS well-validated motivational design model predicts that increased learner motivation leads to improve learning outcomes when the learning environment is enhanced with focused motivational strategies [8]. By synthesizing theoretical components of motivation [9] [10] [11]. Keller provides a learning environment design framework of optimal instructional strategies and a directed analysis of these strategies.

ARCS examines both internal and external influences on a learner within an educational environment. Keller's motivational strategies consists of four major concepts: Attention, Relevance, Confidence, and Satisfaction (ARCS).

The model has been used successfully with different subjects, multiple instructional environments, and many different learners, from school age children to working adults [12]. Courses have been developed using ARCS in both traditional classrooms and e-learning environments [13] [14]. The components of ARCS model both direct the design of the

Lighthouse MOOC to overcome the high dropout rates typical of online learning and specify measures of participant engagement in the professional development contents.

To sustain students' motivation and intention to recruit diverse learners in computing courses, the Lighthouse CC MOOC develops anchored instruction through providing real-life situated multimedia content. According to the situated cognition theory, learning processes enhance when knowledge is situated in the day-to-day lived experiences that reflect real life processes. Anchored instruction, grounded in a story that presents realistic situations, engages students through authentic tasks [15].

Situated contents include presenting real-life characters or situations when providing instructional resources such as videos, PowerPoint Slides, assignments, or assessment items. For example, each module will include a short (2-3 minute-long) video clip showing question-and-answer type conversation between a community college computing faculty and a module instructor. The conversation will include possible questions that might be raised after completing the individual module.

As learners increase their learning motivation when situated examples (i.e., providing real-life characters like faculty) the online resources increase the relevance of the learners' real-life situations to reinforce acquired knowledge through the module. In addition, students will complete an assignment and peer-evaluation at the end of each module.

The Lighthouse CC team has designed and developed authentic and hands-on assignments that instructors can directly use in their real-life classrooms. Rubrics have been developed based on the learning objectives of each module. After submitting individual assignments, students will assess peers' assignment with a peer-assessment rubric. The purpose of peer-assessment is (1) to connect with peers and (2) to reflect individual learning achievement through assessing others. Detailed instructional design principles are summarized in Table 1.

TABLE I. EXAMPLES OF APPLIED INSTRUCTIONAL DESIGN PRINCIPLES

Instructional Design Application	ARCS Model			
	Attention	Relevance	Confidence	Satisfaction
Provide authentic teaching-learning contexts	✓	✓		
Using same characters as audiences	✓	✓	✓	
Using plain and simple talk		✓		✓
Providing introductory tutorial video				✓
Providing navigation bar and home button			✓	✓
Providing self-assessment quiz			✓	
Providing hyperlinked overview in the module	✓			✓
Providing progress tracker	✓		✓	✓
Providing formative assessment				✓
Providing Dropdown option in the navigation bar	✓			
Providing authentic resources within videos		✓		
Providing video preview/review AT beginning end	✓			✓
Video to be less than 10 minutes	✓			

VI. CONCLUSIONS AND IMPLICATIONS

The research results will enhance pedagogical practices of Computer Science faculty and, ultimately, the diversity of students and professionals in computing education and occupations. Research on the effectiveness of CoP-based MOOCs is also at an early stage. Recent studies report that rubric-based peer feedback enhances students' final learning outcomes in MOOCs [16]. Other research suggests that students who enroll in a MOOC with friends and colleagues have an increased course completion rate, higher levels of achievement, and greater usage of discussion forums [17]. Yet, it is inconclusive which CoP design feature (s) (i.e., peer collaborative work or anchored instruction or both) affect community college computing faculty's motivation and learning in professional development MOOC.

The proposed professional development study extends its research further by examining students' behavioral changes not only during, but after taking the course. It has not been conclusively demonstrated whether the community affects students' learning outcomes and the extent to which students apply the acquired knowledge from the course into their classrooms or real-life situations. In addition, substantial evidence is still lacking on whether participant learning and their student outcomes are reliably linked in any large-scale online form of professional development learning environment. Lighthouse CC MOOC, designed with relevant instructional design principles based on evidence of learning needs and

preferences, will ultimately study the effectiveness of professional development on increasing numbers of diverse students in CC computing courses.

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