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Teaching Online Computer-Science Courses in LMS and Cloud Environment

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ABSTRACT

The author shares his experiences teaching various online computer-science courses (via the Canvas™ and synchronous web conferencing tools) using state-of-the-art free-license software tools for conducting online virtual labs and numerous students' projects. The labs were designed to help students explore modern, sophisticated techniques in several areas of computer science: computer-system analysis and design, programming in C/C++ and Java, software quality assurance, data communication in networking systems, computer security, system simulation and modeling, numerical analysis, image processing, multimedia applications, Web development, and database design and management. All the online courses include "warm-up" exercises and lab-based projects that provide students with knowledge, instructions, and hands-on experience, and that motivate them in selecting topics for technology overviews and research. To concentrate mostly on the students' hands-on training, the "flipped classroom" pedagogy and individual or team tutoring were used in the online classes. The preventive strategies on plagiarism and cheating among students were developed and successfully implemented in the virtual classroom using the Cloud environment.

KEYWORDS

Cheating, Cloud Online (Virtual) Lab, Computer Security, Computer-Science Curriculum, Database Management, "Flipped Classroom" Pedagogy, Free-License and Open Source Software, Interactive Development Environment (IDE), Java Applets, Numerical Analysis, Online Portfolio, Plagiarism, Programming Fundamentals, Project-Based Approach, Software Testing, Networking Technology, Unified Modeling Language (UML), "Warm-Up" Exercises, Web Authoring, Web Conferencing Tools

INTRODUCTION

The collapse of networking industry in 1999-2000, the world economic crisis of 2008-2010, and visa restrictions for international specialists and students (that were enforced after the terrorist attacks of September 11, 2001) changed dramatically the student population in colleges and universities nation-wide (Bollag, 2004). Enrollment continues to decline in both undergraduate and graduate computer science programs (Zweben & Aspray, 2004; McCormack, 2005), particularly putting at risk small computer science programs in liberal arts colleges, which heavily depend on the international students' enrollment. At the same time, companies still demand fewer, but better prepared computer engineers with solid knowledge and hands-on experience.

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According to the USA Today review, "… there are more than 500,000 open computing jobs nationwide, but less than 43,000 computer science students graduated into the workforce last year, according to Code.org, a non-profit dedicated to expanding access to computer science. The U.S. Bureau of Labor Statistics predicts there will be 1.4 million more software development jobs than applicants who can fill them by 2020" (Swartz, 2017). The Wall Street Journal confirms this data (Simons, 2017), pointing that only about 85,000 H1-B visas have been granted annually to the foreign high-tech workers.

Rob Paul, president of DeVry University, which conducted research online for Career Board Advisory Board and offers educational services that includes boot camps for tech skills, made a statement that "…the emergence of boot camps has slightly eased the problem in getting thousands of Americans up to snuff in skills for coding, Internet of Things, big data, cybersecurity and high-tech manufacturing, but doesn't go nearly far enough" (Swartz, 2017). "A fertile area is data analysis: 59% of organizations expect to increase positions requiring data analysis skills over the next five years, according to the Society for Human Resource Management and the American Statistical Association. Departments most in need are accounting and finance (71%), human resources (54%), and business and administration (50%)," the review report concluded.

All these factors have to be considered seriously and must be reflected in searching new approaches for teaching online the computer science courses. In this paper, the author shares his experience in re-designing the computer science curriculum for teaching courses online. His teaching methods (Riabov, 1997; 2000a; 2000b; 2006a) are based on several techniques (Riabov, 2002a; 2002b; 2005b; 2006a) that challenge and motivate students to become passionate in their studies and be active in the virtual classroom environment. Starting every class session with small challenging "warm-up" exercises (Sabin et al., 2005; Riabov, 2006a; Riabov & Higgs, 2011), the instructor encourages students to select and develop their own projects. He provides them with examples of the best achievements of professionals in the related fields of expertise (Riabov, 2004; 2005a; 2006b), the best projects of students (available on the instructor's Website, rivier.edu/faculty/vriabov/), who took similar courses in the past, and the challenges of the discipline (Riabov, 2012a).

This paper demonstrates the advantages of using a project-based approach (Riabov, 1997; 2000a; 2000b; 2002b; 2003; 2006a; 2007; 2011) in online course delivery that motivates students in studying and learning modern computing technologies. "Warm-up" exercises, online discussions of recent research publications, lectures, and virtual labs stimulate students in selecting topics for their technology overviews and research projects and provide them with knowledge, instruction, and hands-on experience. The students, who accept the challenge of innovation in computer science areas, display their successes by presenting their work at national and international conferences (Milkovits, 2005; Selent, 2011), publishing their project reports in the *Rivier Academic Journal* (2017), and promoting their findings among their college peers and their colleagues in companies and organizations (Riabov, 2005c; 2005d).

The paper is organized as follows. In next section the author presents an overview of computer science curriculum and various courses that are taught online (via the Canvas™ and synchronous web conferencing tools) at Rivier University. Examples of "warm-up" exercises, lecture notes, and course assignments offered online in the LMS environment are discussed. The software tools available for students and instructors are analyzed in the special section. The core of the paper includes the sections, in which the author describes what makes the online courses challenging and valuable for students. These sections also include students' responses on conducting online virtual labs by using various state-of-the-art free-license software tools and lab manuals, examples of their overviews of modern computing technologies with demonstration of computer-system simulations, and examples