Project-based Learning of Web Systems Architecture

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ABSTRACT

Effective technical communication, collaboration, and leadership are among essential skills required from computer scientists. Project-based learning using open-ended projects is praised for fostering these skills in the context of software development. Our observations, in the context of a systems course, suggest that while learning outcomes are achieved, open-ended projects are stressful for students. We investigate the appropriate methods, levels of specification, and scaffolding to help students learn the concepts while implementing real-world web projects in student-formed groups.

KEYWORDS

Project-based learning; PBL; Scaffolding; Web systems architecture

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Project-based learning (PBL) is an effective instructional technique in computer science and engineering [2, 5]. As a form of socially constructed learning, PBL draws upon the "learning by doing" philosophy of John Dewey and social support and scaffolding concepts of Lev Vygotsky.

This paper details our approach to PBL in the third offering of an undergraduate course in web systems architecture, currently in progress (Spring 2021). The course includes a multi-step group project. Student perception of the project specification and complexity in the first two offerings of the course inspired our approach in this offering. We examine the impact of providing specification and scaffolding throughout the project in changing this perception.

The theoretical components of this course are covered in lectures and tested in homework assignments, quizzes, and mid-term and final exams. According to Mills et al. [4] and Blumenfeld et al. [1], students who participate in PBL are motivated by the opportunity to work on real-world projects and also develop better understandings of the application of their knowledge in practice. A multi-step group project, worth 30% of the grade, is the course component designed for achieving this goal. As noted by Hmelo-Silver et al. [3], student-centered learning, like PBL, requires scaffolding and guidance to facilitate student learning. Weekly Interactive Sessions, which are bite-sized cloud-platform deployment instructions, are integrated into the course to achieve this goal. This has been the case since the initial offering. The project in the current offering of the course includes additional scaffolding through an elective project stream integrating templates and references to related course materials.

The group project starts in the second half of the semester. It includes multiple steps. In the first step, the students are required to form teams of size five. We also provide them with specification of roles and rotations that they need to perform in each step of their project in their group. In the second step, given the details about the scope, the teams choose their project title within the "social good" theme, independent from technical requirements.

In the next two steps called project iterations, project teams build their web systems. In each iteration, we define a set of technical goals. The students meet the technical goals in the context of their proposed title. Next, the project teams present their web system to the class and provide the link to the live web system for student interaction and reviews. In the last step, the teams submit project outcomes and argue learning and contributions.

To measure the effect of specification and scaffolding, we define two project streams with different levels of scaffolding. Our initial results suggest hurdles in measuring the impact of specification in a controlled environment. Therefore, we took an alternative approach: providing the scaffolded project stream as an accessible option while encouraging the alternative through bonus points. Students have the opportunity to switch streams during any of the later steps of the project. As their initial choice, only 7% of the students selected the open-ended non-scaffolded project stream.

We also examine team composition, perceptions of engagement and contribution, and the process of confidence building while working on a group project. We use surveys and interviews for quantitative and qualitative analysis and compare student perceptions of learning to course performance data.

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