Work in Progress: Adaptive Lessons for Pre-Class Preparation for Flipped Classroom

Autar Kaw, Renee Clark, Eleonora Delgado
University of South Florida / University of Pittsburgh / University of South Florida

Abstract

In a prior three-year study that compared blended and flipped modalities for a typical STEM course in numerical methods, small effect sizes were observed in learning and affective domains. While mentioning the high demands of the flipped classroom, students also pointed out its benefits of enhanced learning and engagement. To enhance the benefits and reduce the workload associated with a flipped classroom in this study, we designed the pre-class preparation to occur through adaptive lessons. A commercial adaptive platform that combined video lectures, text, and assessment via multiple-choice and algorithmic questions was used. Preliminary results of the effects of these adaptive lessons on cognitive gains, measured via a final examination and a concept inventory, will be available at conference time.

Keywords

Numerical Methods, Adaptive Learning, Flipped Learning, Blended Learning.

Background

In a classic meta-study conducted by Freeman, et. al. [1], active learning has been established to increase student performance in STEM courses. On an average, student performance on examinations was 0.47 SDs higher under active learning, and students were 1.5 times more likely to fail in a traditional lecture than an active learning course. One learning model that incorporates active learning is the flipped classroom.

As per flippedlearning.org [2], "Flipped Learning is a pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter."

One of the more challenging aspects of flipped learning is having the students come prepared to the classroom (group space). Currently, most teachers assign lecture videos or reading assignments that are followed by a quiz that is taken online or at the beginning of the class meeting. However, this is a one-size-fits-all approach to pre-class preparation. What if the pre-class preparation was adaptive, where depending on how students are responding to assessments, they are taken along appropriate paths. We hypothesize that adaptive lessons would be more effective and efficient in the pre-class preparation.

Methods and Results

To improve the pre-class activities of the flipped classroom for a course in Numerical Methods, the instructional and assessment modules from prior NSF support were augmented and revised to develop lessons that conform to an adaptive platform [3]. These lessons include a combination of lecture videos, text, simulations, and multiple-choice and algorithmic questions. Depending on how the student answers the assessment questions, personalized paths of completing the lesson are created.

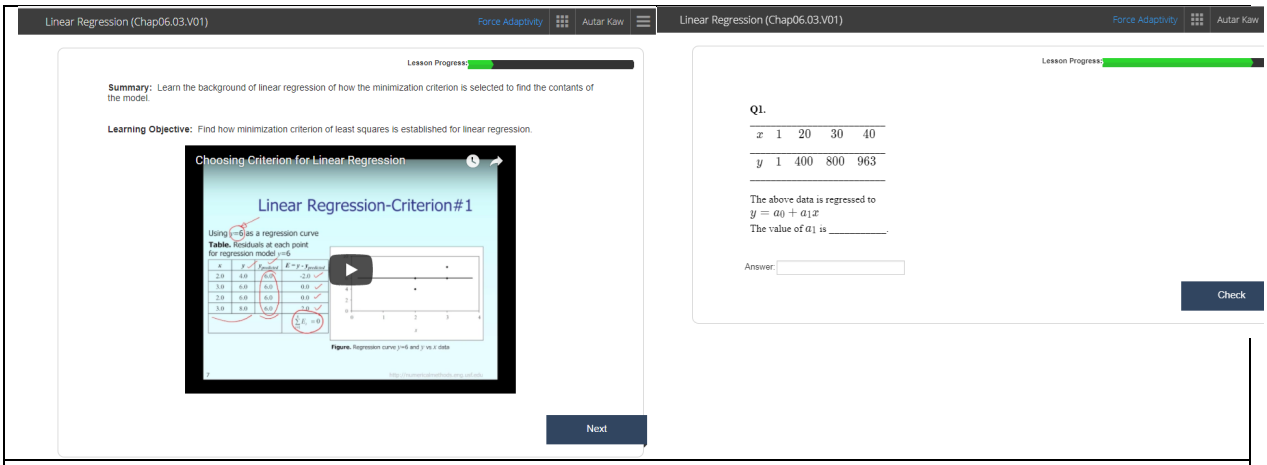

Figure 1. A sample of adaptive learning lesson

The adaptive lessons were implemented in the fall 2017 semester. About 109 mechanical engineering students were enrolled in the course, with 90 of them participating in the study. We will have the initial evaluation results available at the conference, where we will compare the effectiveness of a flipped classroom with adaptive learning and a flipped classroom without adaptive learning. The comparisons will be made based on students' conceptual and procedural knowledge and higher-order problem-solving skills, via a combination of a final examination and a concept inventory.

References

1 Freeman, S., S. L. Eddy, M. McDonough, M. K. Smith, N. Okoroafor, H. Jordt, and M.P. Wenderoth, Active Learning Increases Student Performance in Science, Engineering, and Mathematics, Proceedings of the National Academy of Sciences, 201319030, 2014.

2 Flipped Learning, http://flippedlearning.org , Last Accessed November 4, 2017.

3 Create Learning Experiences as Unique as Your Students, http://www.smartsparrow.com, Last Accessed November 4, 2017.

Acknowledgment

This material is based upon work supported partially by the National Science Foundation under Grant Number 1609637, and the Research for Undergraduates Program in the College of Engineering at University of South Florida (USF). Any opinions, findings, and conclusions or

recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

Autar Kaw

Autar Kaw has been a professor of mechanical engineering at the University of South Florida since 1987. Professor Kaw's current scholarly interests are in education research methods, adaptive learning, flipped learning, open courseware development, and the state and future of higher education. He is a recipient of the 2012 U.S. Professor of the Year Award. His work on engineering education has been funded continuously by NSF since 2001 and has resulted in multiple resources in Numerical Methods such as OCWs (MathForCollege.com) with 1,000,000+ page views/year, and YouTube lectures with 1,800,000+ views/year.

Renee Clark

Renee Clark serves as research assistant professor focusing on assessment and evaluation within the University of Pittsburgh's Swanson School of Engineering and its Engineering Education Research Center (EERC), where her interests center on active and experiential learning. She has 25 years of experience as an engineer and analyst, having worked most recently for Walgreens and General Motors/Delphi Automotive in the areas of data analysis, IT, and manufacturing. She received her PhD in Industrial Engineering from the University of Pittsburgh and her MS in Mechanical Engineering from Case Western while working for Delphi. She completed her postdoctoral studies in engineering education at the University of Pittsburgh.

Eleonora Delgado

Eleonora Delgado is a master's student in the department of mechanical engineering at the University of South Florida. She graduated *magna cum laude* from the University of South Florida with a B.S. in Mechanical Engineering. Her areas of interest include education research, vibrations and machine design.