Imparting Future Workforce Skills using Virtualized Active Learning: A Case Study in an Engineering Core Course

Ronald F. DeMara[1], Shea Silvermann[2], Francisca Yonekura[2], Meghana Reddy-Vangala[1], and Mousam Hossain[1]
[1]Department of Electrical and Computer Engineering
[2]Center for Distributed Learning
University of Central Florida, Orlando, FL 32816-2362
ronald.demara@ucf.edu

***Abstract*—A technology-enabled approach to advancing collaboration-based skills in STEM curricula is developed. It integrates virtual collaboration tools into the Canvas Learning Management System allowing laptops with Wi-Fi connections to facilitate team-based activities within any classroom space. Problem-based learning advancing teamwork becomes traceable, observable, and auto-graded, while sustaining the learner's engagement.**

***Keywords*—Technology-Mediated Instruction, Computer-Supported Collaborative Learning (CSCL), Team Skills Development, Active Learning.**

The ability to function effectively on multi-disciplinary teams has been recognized as a professional skill of increasing importance to the future workforce in Science, Technology, Engineering, and Mathematics (STEM) career fields [1]. However, an open challenge remains how to integrate such teamwork experiences into the curriculum. Generally, the inclusion of more active learning exercises with student teams can provide one such option. This becomes especially feasible when lecture content is made available online or with video capture in a "flipped classroom", also known as mixed-mode or hybrid online/live delivery [2]. In such cases, more of the in-person Face-to-Face instructional seat time can be available to conduct learning activities which impart teamwork skills than curricula of the past where teamwork was constrained mostly to occur within capstone Senior Design courses [3][4].

In addition to allocating time for team-based active learning, an appropriate classroom environment is essential to conduct such activities. While offering features beyond traditional fixed stadium-seating classrooms, such recently-developed Collaborative Learning Spaces (CLSs) may unfortunately impart new scalability, cost, and scheduling demands. CLSs require dedicated rooms and furniture so that students can physically co-locate. Meanwhile, the instructor has difficulty to observe more than one team at a time and traceability of student participation is lost. Also, each teams' submission requires manual grading which limits the scalability of delivery. Without technological assistance, the instructor's capability to moderate, guide, and remediate learning activities in real-time can remain restricted [5].

To address these challenges, a *Virtualized Active Learning (VAL)* approach was developed for synchronous team-based problem solving. Specifically, a templating tool was created for the Canvas Learning Management System (LMS) called *EtherMaker*. *EtherMaker* creates distinct URLs to Etherpad links within a Canvas quiz which are accessed by the student *Groups* menu option. This realizes automated team formation / disbursement / coordination, and real-time auto-grading. Meanwhile, Mozilla's Etherpad realizes an interface for team members to discuss solutions with traceability of student participation via color-coded text highlighting and timeline-based playback features. The instructor can view each student's participation by accessing the Etherpad of each team to provide real-time feedback as necessary. *EtherMaker* is programmed in Python and uses the LTI standard that is built into the LMS for authentication. It also makes use of the Open Source project CanvasAPI [6] to automate the link and page creations for each student group. Prior to *EtherMaker*, links to each Etherpad session were created manually and balanced team formation was infeasible via Canvas-based delivery. Thus, *EtherMaker* improves online team-based learning activities from both instructor-facing and student-facing perspectives.

A pilot study during the Fall 2019 semester in a Computer Organization course with 69 students enrolled indicated positive results from VAL mechanisms. Specifically, this team-based active learning method provided worthwhile incentives for all learners to participate more fully, including peer teaching to assist others, as compared to conventional team activities. Due to traceability provided by VAL, teammates indicated that they were able to accurately and fairly crowdsource the most significant contributor while quickly reaching consensus on their technical design solution.

REFERENCES

[1] R. F. DeMara, L. O. Campbell, R. Hartshorne, S. Spiegel, and J. G. Katz, "Community Report on Digitally-Mediated Team Learning," National Science Foundation (NSF) Center for Innovative Research in Cyberlearning (CIRCL) *Rapid Community Report*, August 1, 2019. Available at: https://circlcenter.org/wp-content/uploads/2019/08/DeMara-DMTL-Whitepaper.pdf

[2] R. F. DeMara, S. Salehi, R. Hartshorne, and B. Chen, "GLASS: Group Learning At Significant Scale via WiFi-Enabled Learner Design Teams in

an ECE Flipped Classroom," *in American Association for Engineering Education National Conference*, Columbus, OH, June 25-28, 2017.

[3] M. A. Kazemitabar, S. Bodnar, P. Hogaboam, Y. Chen, J. P. Sarmiento, S. P. Lajoie, C.. Hmelo-Silver, R. Goldman, J. Wiseman, and L. Chan, "Creating instructor dashboards to foster collaborative learning in on-line medical problem-based learning situations." *in International Conference on Learning and Collaboration Technologies*, pp. 36-47. Springer, 2016.

[4] M. L. Loughry, M. W. Ohland, and D. J. Woehr, "Assessing teamwork skills for assurance of learning using CATME team tools." *Journal of Marketing Education*, 36, no. 1 (2014): 5-19.

[5] R. F. DeMara, J. E. Beck, L. O. Campbell, R. Hartshorne, S. Spiegel, Z. Chen, M. Dagley, E. Hernandez, T. Tian, T. Gibson, S. Sheikhfaal, A. Tatulian, H. Pourmeidani, and H. Esteves, "Methods and Outcomes of the NSF Project on Synthesizing Environments for Digitally-Mediated Team Learning," in *Proceedings of American Society for Engineering Education Annual Conference (ASEE-2019)*, Tampa, FL, USA, June 16 – 19, 2019.

[6] M. Emond, "Python API wrapper for Instructure's Canvas LMS," Available at: https://github.com/ucfopen/canvasapi/releases/tag/v0.14.0