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Collaborative Learning for High Voltage Engineering Education

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Introduction

Project Goal: To evaluate the applicability and efficacy of a collaborative learning environment for high voltage (HV) engineering education. This environment is based on the interaction of two pedagogical approaches: computer simulation and experimental/laboratory work. Two courses on HV engineering were offered in parallel in the Fall 2018 semester – one taught at Western Michigan University (WMU) focusing on computer simulation and the other one taught at Mississippi State University (MSU) focusing on experimental/laboratory work.

Rationale: Comprehensive and effective HV engineering education requires exposure to HV laboratory paired with state-of-the-art simulation tools. However, availability of HV facilities for education is rare on a global scale. Numerous universities may offer degrees in electrical engineering but only a select few have facilities to support HV experimental activities.

Methods

Both HV Engineering courses at WMU and MSU adopted the student learning outcomes required by ABET's Engineering Accreditation Commission (EAC) **[1]**:

Outcome 3.1: "An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics."

Outcome 3.6: "An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions."

In Fall 2018, MSU students used rubrics designed by the PIs of this project to rate the simulation reports of WMU students to assess student outcome 3.1, and WMU students used the rubrics to rate the experimental/laboratory reports of MSU students to assess student outcome 3.6.

WMU and MSU students also reported reflections on their learning experience on High Voltage Engineering by combining experimental/laboratory work with computer simulations.

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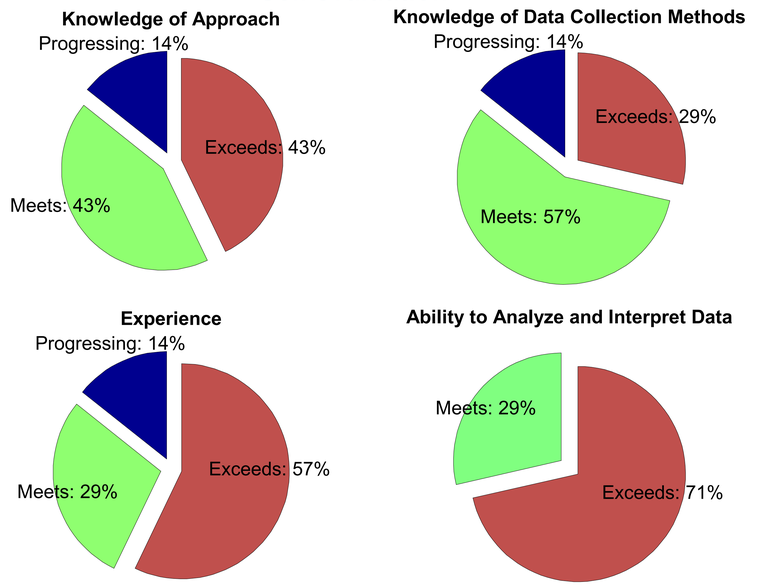
Activities and Results

The following assessment activities are implemented in Spring 2019 to evaluate the interaction of the computer simulation pedagogical approach and the experimental/laboratory pedagogical approach:

Activity 1. Student reflections on their learning of HV engineering by combining computer simulation with experimental work have been recorded. Student responses are analyzed -- quantitatively and qualitatively -- to assess if and how the two pedagogical approaches interact and their impact.

Activity 2. WMU and MSU instructors (content experts) select a subset of student reports and rate them using the proposed rubrics. The faculty ratings are then compared with the student ratings. The faculty ratings of reports validate student learning of HV engineering, as well as the use of rubrics for assessing student outcomes.

Self evaluation



Sample comments to the following question: Please explain how the experimental report enhanced your understanding of the corresponding topic.

"It has been helpful to relate the course concepts to the real electric equipment. It helps me to keep the concept in my mind for a long time."

"The visuals provided in the report enhanced my understanding of this project overall. Seeing the breakdown in the plexiglass was very impressive. You don't see that kind of visual information within simulations."

"Without the report from MSU I would not have known which components to use while conducting an experiment. Additionally, their discussion about meeting lightning impulse standards leads me to believe that I could reproduce this experiment without errors."

"Comparing this report to our own, I was able to confirm how flashovers and breakdowns worked for the insulator string. This report helped me understand this topic better."

Report	Rating by WMU peers	Rating by MSU instructor	|Diff.|
Bundled conductors	9.0	8.0	1
Corona rings	9.0	9.0	0
Insulation string	9.0	8.0	1
Solid insulation	7.0	8.0	1

Report	Rating by MSU peers	Rating by WMU instructor	|Diff.|
Bundled conductors	9.0	9.0	0
Corona rings	9.5	9.3	0.2
Insulation string	10.0	9.3	0.7
Solid insulation	8.5	9.0	0.5

Conclusions

The students' response to the collaborative use of pedagogical approaches (computational and experimental) in HV engineering was very positive. According to their feedback, WMU's students found that this approach enhanced their understanding of concepts, helped them relate their simulated results with real equipment tests, and gave them confidence to perform experimental work without being directly exposed to it.

Both WMU and MSU students were able to rate their peers' reports within 1 point difference or less (in a scale of 1 to 10) compared to the evaluation from the content experts.

Lessons Learned

The students at WMU observed that the parameters considered for the experimental tests (materials, dimensions, etc.) did not exactly match those used in simulations in some cases, resulting in deviations in the results and precluding a better comparison between reports from both institutions.

The students also suggested to have a more direct and constant communication between institutions throughout the course to improve the understanding of arrangements studied.

References

[1] Accreditation Board for Engineering and Technology, Criteria for Accrediting Engineering Programs 2019 – 2020, Criterion 3: Student Outcomes, https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2019-2020/#GC3 [Accessed February 28, 2019]