Board 271: Engineering Instruction Action Team (E-IAT): Improving Teaching Methods in Engineering

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Project Background

The University of Georgia Department and Leadership Teams for Action, or DeLTA, is an NSF project to help students develop STEM knowledge and skills. The project brought together more than 50 University of Georgia faculty members in science, technology, engineering, and math to collaborate on a comprehensive research project that seeks to transform STEM education on campus and at research universities nationwide. To facilitate this process, seven faculty level Instructional Action Teams (IATs) were created, and Engineering was one of such teams. This paper presents the key activities and findings conducted under the three projects by the engineering IAT.

The three projects done by the Engineering Instructional Action Team E-IAT were:

1. Self-Assessment to Enhance Student Engagement.
2. Faculty Peer Observation to Enhance Teaching
3. Enhancing Assessment Through the use of Test Blueprints

Organization of the paper

The three projects done under this research were conducted as unique projects. Each project lasted a period of one year. Individual faculty involvement changed from project to project. While some were involved in only one of the projects, some were involved in more than one. This paper is presented in three sections with each section focusing on one project. Each project is presented with its background information, the primary project objectives and activities, methods used, discussion of the results and a conclusion. The following is a summary report of the three projects.

Project 1: Self-Assessment to Enhance Student Engagement

Introduction

Self-assessment as in using students to assess their own work is one of the most interesting assessment topics in literature both in secondary and in higher education. The complexity of the topics ranging from what constitutes self-assessment, why do self-assessment and how to use self-assessment results are some of the reasons why this topic is interesting and getting attention in the literature. The interest in self-assessment is due to many reasons. Boud [1], Dochy, Segers and Sluijsmans [2], and Sluijsmans, Dochy and Moerkerke [3] suggested that the reason for this greater interest may include the desire to increase greater involvement of students in the learning process by making the process more democratic.

As implicit as they may, Andrade [4] points out some of the key missing elements of the two definitions above by suggesting that the purpose and rationale for conducting self-assessment needs to be well articulated in the definitions. Andrade [4], then suggested that “self-assessment is feedback, and that the purpose of feedback is to inform adjustments to processes and products that deepen learning and enhance performance; hence the purpose of self-assessment is to

generate feedback that promotes learning and improvements in performance" (p. 2). Andrade's [4] suggestion is heeded by several authors including Paris and Cunningham [5], Paris and Paris [6], Black and William [7], and Taras [8] who argue that self-assessment helps students in such areas as monitoring and regulating learning activities towards knowledge acquisition. For a class that uses activity-based learning including class room team work and faculty led discussions to engage students to improve student performance. Andrade's [7] rationale for incorporating self-assessment to promote learning and potentially improve student performance was adopted for this study.

Project Objective: The second project evaluated student self-assessment as a tool to enhance students learning experience.

Activities performed: Specifically, the following activities were performed under this project:

- Reviewed the literature to understand the concept of self- assessment.
- Created a unified self- assessment feedback questionnaire.
- Implemented self-assessment in some of the courses.
- Administered the self-assessment questionnaire to the students.
- Analysis the self-assessment
- Presented the results of the project as a poster session on campus.

Faculty involved: Nine (9)

Results and Discussion: Across the six courses, one graduate and five undergraduates, the results of student perception on self- assessment are consistent. Figure 1 presents the result of the students' self-assessment survey. The items with the highest ranked means include doing self-assessment to improve on future assignments (5.52/7), using self-assessment to avoid mistakes made in previous assignments (5.91/7) and understanding the connection between course materials (5.97/7). The least ranked item is the willingness to do self-assessment without any incentive (3.81/7). The results show that self-assessment helps the students engaged in the course, but they will only do that with an incentive.

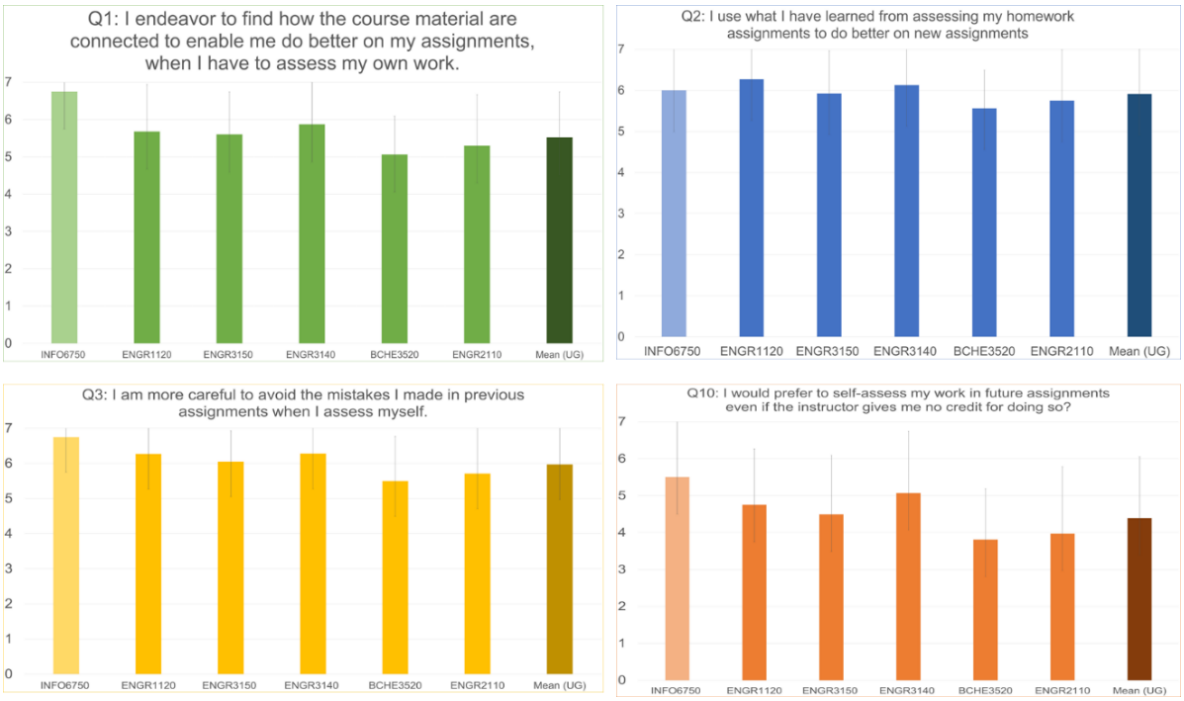

Figure 1: Students Self-assessment survey results

Conclusion:

Results from this study clearly demonstrate students' ability to grade their own works. It also shows that letting students grade their own work has some academic benefits such as enhancing course engagement as perceived by students. However, an essential aspect that emerged from the study is the role of reward in promoting student participation in self-grading activities. The results indicate that without proper rewards or recognition, students may be less inclined to engage in self-assessment. Instructors should consider implementing strategies to incentivize self-assessment, such as offering extra credit or incorporating self-assessment results into the overall grading scheme as used in this study.

Project 2: Faculty Peer Observation to Enhance Teaching

Introduction

The practice of using student evaluations to assess instructors in higher education is faced with numerous difficulties Wieman [9]. These evaluations are often biased for several reasons. One is that the students conducting the evaluations are not equipped with knowledge of teaching techniques, leading to inadequate or incorrect evaluations of instructional methods Wieman et al [10]. Additionally, students have a tendency to rate courses higher that have lenient grading systems, which leads to the inflation of grades. Moreover, student evaluations are widely recognized as being inadequate measures of successful learning outcomes Uttl et al [11].

To address these difficulties, this project proposes the implementation of faculty peer observation. Peer evaluation or observation is a well-established method and may serve as an important alternative to student evaluations Dillon et al [12]. This approach involves evaluating the performance and contributions of instructors by their colleagues in teaching domain. Such evaluations can offer useful feedback to instructors, aid in their professional development, and contribute to the growth of the academic community.

Project Objective: The objective of the third project was to incorporate faculty peer observation as a feedback tool to improve the quality of the instructor teaching method.

Activities performed: Specifically, the following activities were performed under this project:

- Reviewed Several Faculty Peer Evaluation Forms
- Partition the Evaluation Process into two focus areas:
    - Lecture-based classes
    - Flipped Classroom classes.
- Developed Separate evaluation instrument for each focus area.
- Conducted several evaluations site visits.

Faculty involved: Seven (7)

Results

In this project, faculty peer observation was conducted in two groups, with one group focusing on the flipped classroom model and the other on lecture-based teaching method. Both groups started by developing a peer observation instrument that was specific to their teaching modality. The main content for these two instruments is shown below in table 1. This instrument was used to gather feedback from peers on various aspects of teaching, including course design, classroom management, and student engagement. The results of the evaluation showed that the peer observation process encouraged instructors to reflect on their own teaching practices and made them more aware of their strengths and areas for improvement. In addition, this project demonstrated the effectiveness of using faculty peer observation as a tool for improving the quality of teaching and learning in higher education and highlight the importance of considering different teaching modalities when conducting peer observation.

Table 1: Peer observation Instruments main content

Flipped Classroom Instrument	Lecture-Based Instrument
Section A: Prior to classroom observations: The observer reviews the course material on the course LMS, meet with the instructor to discuss the approach to the course, student	Section A: Prior to classroom observations: The observer reviews the course material on the course LMS, meet with the instructor to discuss the approach to the course, student challenges and issues and plan for observed lessons.

challenges and issues and plan for observed lessons.	
Section B: Flipped Classroom Observation Tool This tool includes observation items in areas related to instructor-student interactions and collaborative learning activities.	Section B: Classroom Observation Tool This tool includes observation items in eight major areas: Lesson Organization, Content Knowledge & Relevance, Presentation, Instructor-Student Interactions, Collaborative Learning Activities, Lesson Implementation, Instructional Materials, and Student Responses.
Section C: After classroom observations: The observer meets with the instructor to hear their reflections, discuss new ideas or questions, and provide constructive feedback with a focus on highlighting strengths over areas for improvement (at least three times as many strengths as areas with room for improvement).	Section C: After classroom observations: The observer meets with the instructor to hear their reflections, discuss new ideas or questions, and provide constructive feedback with a focus on highlighting strengths over areas for improvement.

Conclusion

This study demonstrates the effectiveness of using peer observation as a feedback tool in higher education and highlights the potential for ongoing growth and development of instructors through this process. The faculty peer observation process was successful in promoting reflection and self-awareness among instructors, leading to an improvement in the quality of their teaching. The use of specifically tailored observation instruments for the flipped classroom and lecture-based teaching methods emphasized the importance of considering different teaching approaches when conducting peer observation.

Project 3: Enhancing Assessment Through the use of Test Blueprints.

Introduction

In all academic works, course assessment plays a major role by providing the instructor a way to monitor student progress and performance toward the learning outcomes designed for the courses. M. R. Raymond and J. P. Grande [13] suggest that the "primary goal of assessment is to allow an instructor to make a claim or inference about what students know and can do. As suggested by Mislevy and Riconscente [14], a test is one of such assessment tools that creates the opportunity to obtain evidence to support such claims.

Instructors generally develop their tests without following any formal and structured approach. Without a structured plan to guide the preparation of assessment tools, the chances of missing out on key outcomes that need to be tested are high. Like a building

plan that serves as a guide to follow and construct the building, a well-thought-out assessment plan is to ensure that assessments are consistent with course objectives and address truly important learning outcomes in a balanced manner Raymond et al [13]. These plans are typically called Test Blueprints, although they are also known as test plans, tables of specifications, and test specifications Millman [15]. A test blueprint describes the key properties of a test including such properties as the amount of emphasis allocated to each content area, the cognitive demand of the assessment tasks, the assessment format, and other important features [15], [16].

Project Objective: The purpose of this project was to investigate how Test Blueprints enhance assessment for different engineering courses.

Activities Performed. Specifically, the following activities were performed under this project:

- Reviewed different Test Blueprint Models.
- Each faculty developed a suitable Test Blueprint for their course.
- Analyzed previous assessment materials (exam, etc.) using the newly developed Test Blueprint
- Use the new Test Blueprint as the basis for new assessment design.
- Presented the results of the project as a poster session on campus.

Faculty involved: Five (5)

Results and Discussion:

Figure 2 shows a sample Test Blueprint prepared for an engineering course. The figure compares to tables. One table was created using an older assessment prepared without a Test Blueprint. The second table, however, was created using Test Blueprint. As seen from the two tables, without the guidance of a Test Blueprint, critical learning outcomes can go without being assessed. Additionally, without a Test Blueprint, distributing the assessment questions to reflect key concepts to be assessed may be difficult. For example, without using a Test Blueprint, 31% of the entire assessment in Fall 2019 exams was based on a lower cognitive level as compared to 17% when test Blueprint was used as the guide in the Spring of 2020.

TEST BLUEPRINT – EXAM I – FALL 2019
ENGR 2110: ENGINEERING DECISION MAKING

No.	Course learning Objectives	Cognitive levels			TOTAL	
		K*	U*	A*	#	%
1	Understanding basic concepts of engineering decision making	4	0	0	4	22%
2	Apply the Engineering Economics Decision making process	1	0	0	1	6%
3	Understand Cost types	0	0	0	0	0%
4	Develop Project cost and profit equations to estimate cost and profits	0.5	1	1	2	11%
5	Understand cash flow and their representations	0	0	0	0.5	3%
6	Understand time value of money and equivalence	0	7	1	8	44%
7	Solve problems using compound interest formulas		0	2.5	2.5	14%
	TOTAL	5.5	8	4.5	18	100%
	Percent	31%	44%	25%	100%	

REVISED TEST BLUEPRINT SHOWING PREVIOUSLY UNTESTED AREAS (5 AND 8)
EXAM I - SPRING 2020

No.	Course learning Objectives	Cognitive levels			TOTAL	
		K*	U*	A*	#	%
1	Understanding basic concepts of engineering decision making	1	0	0	1	5%
2	Apply the Engineering Economics Decision making process	1	0	0	1	5%
3	Understand Cost types	0	0	0	0	0%
4	Develop Project cost and profit equations to estimate cost and profits	0	1	1	2	10%
5	Understand and apply various cost models	1	2		3	14%
6	Understand cash flow and their representations	0	1	0	1	5%
7	Understand time value pof money and equivalemce	1	4	0	5	24%
8	Understand and solve problems involving different compounding effects and effective interest rates	0	5	2	7	33%
9	Solve problems using compound interest formulas	0	1	0	1	5%
	TOTAL	4	14	3	21	100%
	Percent	19%	67%	14%	100%	

Figure 2: Sample Test Blueprints

Conclusion: The study of Test Blueprints provided a guided way of properly preparing assessment material to capture the intended learning outcomes of the course. Test Blueprints clearly showed across all courses that faculty were missing some important learning outcomes when their assessments were not guided by a Test Blueprint. It was also evident that Test Blueprints varied significantly depending on the nature and the delivery mode of the course.

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