

Tools for the 3Cs of Entrepreneurially Minded Learning (EML)

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Abstract—Entrepreneurially Minded Learning is a pedagogical technique that seeks to equip students to be more curious about trends in the changing world, make connections from disparate sources of information to gain insight, and identify unexpected opportunities to create extraordinary value for themselves and their communities. The core of the entrepreneurial mindset can be summarized succinctly by the three Cs: Curiosity, Connections, and Creating value. This interactive workshop will introduce participants to these three Cs using three specific tools that facilitators have successfully used in their engineering classrooms. The workshop is targeted towards a total of 40 participants and will require only projection capabilities for audio-visual equipment.

Keywords—*Entrepreneurially Minded Learning (EML), curiosity, connections, creating value, Question Formulation Technique (QFT), analogies, NABC framework*

I. INTRODUCTION

Entrepreneurially Minded Learning (EML) is an emergent pedagogy that emphasizes discovery, opportunity identification, and value creation. It can be applied to all areas of study and is being developed by hundreds of faculty across the country [1]. EML focuses on three core components (3Cs): Curiosity, Connections and Creating Value.

This workshop focuses on the use of three tools, one for each of the 3Cs:

The **Question Formulation Technique (QFT)**, developed by the Right Question Institute, is a step-by-step process that helps students learn how to produce, improve, and use their own questions. A fundamental assumption of the QFT is that students learn better and take ownership of the learning process when, fueled by curiosity, they ask their own questions, and use them to drive their learning [2].

Analogies across disciplines or from everyday experience engage students and encourage them to make connections. This tool helps students see the relevance of the current topic under discussion, learn it, and apply the core principles to new situations [3].

The **Need-Approach-Benefit/Cost-Competition (NABC) Framework**, developed by SRI International, is a well-defined yet flexible framework for developing stakeholder specific value

propositions [4]. We will present the NABC framework, show how it can be combined with story to create compelling value propositions, and discuss how it can instill a value creation mindset in students.

II. GOALS

This pre-conference workshop will introduce participants to the important aspects of Entrepreneurially Minded Learning (EML) principles and provide three concrete tools - Question Formulation Technique (QFT), analogies, and Need-Approach-Benefit/Cost-Competition (NABC) value propositions - that participants can use to integrate EML in the classroom.

The specific objectives of this pre-conference workshop are to provide participants with:

1. An understanding of the EML pedagogical approach.
2. An introduction to the EngineeringUnleashed.com digital platform which is freely available to instructors at institutions of higher education, and contains EML classroom content across a growing number of subjects covered in engineering and computer science curricula.
3. An understanding of the Question Formulation Technique (QFT) framework and how it can be used to engage student curiosity and improve question formulation ability.
4. An experience of applying the QFT from the student's perspective.
5. Takeaway examples of QFT applied in engineering courses (hopefully including an example developed by the participant for one of the participant's courses).
6. An understanding of the importance of using analogies to improve student learning to help students make connections between different courses, fields, and experiences.
7. Takeaway examples of analogies applied in engineering courses (hopefully including an example developed by the participant for one of the participant's courses).
8. An understanding of the Need-Approach-Benefit/Cost-Competition (NABC) framework and how it can be

used to craft a compelling value proposition to different stakeholders.

9. An experience of applying NABC framework from the student's perspective.
10. Takeaway examples of NABC applied in engineering courses (hopefully including an example developed by the participant for one of the participant's courses).

The objectives of this workshop adhere to the Frontiers in Education (FIE) vision statement to "*promote and advance engineering and computing education to ensure that all students receive the best possible education*". This workshop is designed to provide participants with an engaging experience to emphasize the importance of balancing the student's technical skillset with an appropriate mindset. A mindset that balances the 3Cs of curiosity, connections, and creating value will enable students to be better prepared for future technical challenges we might not be able to imagine yet. This falls in line with the FIE mission statement to "*bring together a multidisciplinary global community committed to developing the future of engineering and computing education*."

III. WORKSHOP AGENDA

20 mins - Introduction and EngineeringUnleashed.com

- 5 mins: Overview of the workshop and Introduction to the 3Cs of the Entrepreneurial Mindset.
- 15 mins: EngineeringUnleashed.com profile setup, introduction to the features of the website and how to upload new content.

60 mins - Question Formulation Technique (QFT)

- 10 mins: Introduction to the QFT Framework.
- 15 mins: Question Focus (QFocus) Guidelines and Examples used in Electric Circuits and Digital Signal Processing courses.
- 25 mins: Participants try out QFT on a generic STEM example.
 - 4 mins: Participants respond to QFocus statements with their own questions.
 - 8 mins: Participants improve questions.
 - 3 mins: Participants prioritize questions.
 - 5 mins: Explore next steps and Reflect on the Process.
 - 5 mins: Examples of next steps from our Electric Circuits Course.
- 10 mins - Participants work on QFT QFocus ideas for their courses.

60 mins -The NABC Framework

- 10 mins: Participants discuss personal research or scholarship with a partner.
 - 4 mins: Think about way to describe research/scholarship to the partner in 2 mins.
 - 3 mins: Partner A describes research to Partner B
 - 3 mins: Partner B describes research to Partner A.
- 10 mins: Introduction to value propositions and NABC Framework.

- 10 mins: Introduce a framework for creating NABC value propositions and types of assignments to which NABC may be applied.
- 15 mins: How to use the NABC framework in class (with examples).
- 15 mins: Participants work on NABC assignment ideas for their courses.

30 mins - Analogies

- 5 mins: What does the science of learning say about analogies?
- 10 mins: Examples of analogies from multivariate calculus, electric circuits, electromagnetics and control systems.
- 15 mins: Participants develop (or refine) an analogy for one of their courses.

5 mins - Workshop wrap-up

IV. TAKE-AWAY SKILLS, KNOWLEDGE AND MATERIALS

The take-away skills, knowledge, and material for attendees will be:

1. An understanding of the Entrepreneurially Minded Learning (EML) pedagogical approach.
2. Knowledge of the EngineeringUnleashed.com platform and examples of exemplar content available on the platform.
3. A user profile on the EngineeringUnleashed.com platform with access to the workshop content and follow up discussions through the available forums.
4. An understanding of the Question Formulation Technique (QFT) framework and how it can be used to engage student curiosity and improve question formulation ability.
5. An experience of applying the QFT from the student's perspective.
6. Takeaway examples of QFT applied in engineering courses (hopefully including an example developed by the participant for one of the participant's courses).
7. A summarizing handout of the QFT framework.
8. A worksheet to be used in class to help engage students to understand the QFT process.
9. An understanding of the importance of using analogies to improve student learning to help students make connections between different courses, fields or experiences.
10. A summarizing handout emphasizing the importance of analogies.
11. Takeaway examples of analogies applied in engineering courses (hopefully including an example developed by the participant for one of the participant's courses).
12. An understanding of the Need-Approach-Benefit/Cost-Competition (NABC) framework and how it can be used to craft a compelling value proposition to different stakeholders.
13. An experience of applying NABC framework from the student's perspective.

14. Takeaway examples of NABC applied in engineering courses (hopefully including an example developed by the participant for one of the participant's courses).
15. A summarizing handout of the NABC framework.
16. A worksheet to be used in class to help students develop a compelling value proposition using the NABC framework.

V. ANTICIPATED AUDIENCE

The workshop topics are applicable across the STEM disciplines and many of the examples used only assume a STEM background. There are a few examples that are specific to electrical and computer engineering, but we do not believe this will discourage participants from other disciplines, as the main examples used in the active exercises are more generic.

The maximum number of attendees should be 40.

VI. FACILITATOR QUALIFICATIONS

This pre-conference workshop will be led by four faculty members from three institutions. The facilitators have presented a 90-minute version of this workshop at the 2018 KEEN national conference in Dallas, TX in January 2018.

A. Heath LeBlanc

Heath LeBlanc has been awarded the Professor Henry Horlitz Outstanding Teacher Award for the 2015-2016 academic year from Ohio Northern University (ONU), is highly involved with the Kern Entrepreneurial Engineering Network (KEEN) as Co-PI of ONU's institutional grant, and regularly publishes engineering education papers at FIE and ASEE conferences.

B. Greg Mowry

Greg Mowry has taken the lead in integrating Entrepreneurially Minded Learning techniques in the analog electronics portions of the Electrical & Computer Engineering at the University of St Thomas (MN) where he serves as Professor and the Program Director of the Graduate Electrical

Engineering program. He has published engineering education papers both at FIE and ASEE conferences.

C. Kundan Nepal

Kundan Nepal has been highly involved with the Kern Entrepreneurial Engineering Network (KEEN) as Co-PI of University of St Thomas's institutional grant. He serves as the Chair of the Electrical & Computer Engineering Department and has taken the lead in integrating the Entrepreneurially Minded Learning techniques in the digital portions of the Electrical & Computer Engineering curriculum. He is also heavily involved in the Center for Engineering Education and has published engineering education papers at both FIE and ASEE conferences.

D. Alan Cheville

Alan Cheville has served as a program director for the Engineering Education Program at the National Science Foundation where he received the NSF Director's Award for Program Management Excellence in 2012. He facilitates student learning at Bucknell University, where he serves as Professor and Department Chair of the Electrical Engineering Department. He has published numerous papers on engineering education.

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