Workshop: STEAMing Ahead! A Paradigm Shift in Research & Rhetoric: [Enhancing the student experience through Active Learning & Educational Research]

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ABSTRACT

This workshop addresses the somewhat controversial question of whether teaching in engineering and applied science should be informed by research. It will provide an interactive experience in which colleagues will firstly participate in an active learning exercise before going on to consider how they might critically evaluate the learning processes and outcomes of such an exercise. The final part of the workshop will comprise a facilitated discussion in which the challenges and benefits of three different methodological tools used in engineering education will be discussed (surveys, observations, semi-structured interviews). It is anticipated that colleagues will be able to apply the learning taken from the workshop to their own practice and, as a consequence, be encouraged to undertake future Engineering Education Research (EER).

1. INTRODUCTION

Starting with the research question '**Why should teaching in engineering and applied be informed by research?**' this workshop aims to build on previous work in Engineering Education Research (EER)[1,2]. To achieve this, the workshop will start by considering the wider context, looking at how and why EER represents an important pedagogical tool. A reflexive approach will be adopted in which colleagues will be encouraged to reflect upon their own practice and in doing so identify any learning &

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teaching related problems they are frequently required to deal with. This will involve considering in some depth how to test potential solutions to such problems through the adoption of an Action Research Approach[3].

The following paragraphs provide a detailed overview of the format and content of the workshop with timings for each different segment depicted.

1.1 BACKGROUND (Workshop Introduction: 5 Mins)

The underpinning ethos to this workshop reflects the facilitators' belief that the role played by high quality, empirically grounded Engineering Education in preparing tomorrow's Engineering Graduates to tackle the challenges of contemporary society has never been so important,[4,5,6]. Despite this, there exists a degree of reluctance amongst much of the Engineering Academic Community when it comes to providing 'evidence-based' teaching. The reason for this is somewhat difficult to pin down, but may be indicative of the fact that many colleagues find it difficult to make the conceptual leap from scientifically ground Engineering Research, to the 'softer' Social Science Research field in which Pedagogy and Engineering Education Research sit. The result of this is that much of the innovative learning and teaching practice which takes place in the engineering classroom remains unevaluated and not disseminated.

Practically speaking, one of the main difficulties encountered by engineers wishing to conduct a piece of EER reflects a lack of tangibility when it comes to 'sampling'[5] in that on the whole, engineering students make far more complex 'research subjects' than do engineering or scientific based variables. Additionally, many colleagues find the language and culture of Social Science Research Methodology difficult to penetrate[6,7]; indicative of the fact that the impact of a new teaching approach can be much more problematic to measure and test than the results of a traditional engineering experiment.

In seeking to tackle this issue head-on, workshop participants will begin with a simple 'Active Learning' experience which may be used to engage students of any discipline, providing the means by which they can visually map key linkages between and across theories and threshold concepts[8].

Following this and supported by three different handouts (Figures 1,2,3), colleagues will consider the validity and academic viability of using three different methodological tools to evaluate the active learning experience they have participated in. The final activity will involve a facilitated discussion looking at the challenges and benefits of each of the methodological tools discussed, with colleagues passing on advice and guidance, based on their own experiences, to each other.

2. METHODOLOGY: The Workshop Format (50 Mins in total).

Based upon an Action Research Methodology[3] and starting with the research question '**Why should teaching in engineering be informed by research?**' this interactive workshop will provide colleagues with the opportunity to look closely at some of the underpinning methodological tools used in Engineering Education Research. Using Concept Mapping as an exemplar pedagogy and adopting a reflexive approach to research and teaching in which colleagues will be encouraged to reflect upon their own practice, the workshop will comprise three distinctive, but interconnected parts, each

one of which will be facilitated in such a way so as to maximise interaction and debate. The three segments of the workshop will be:

Part 1: Group Work in Engineering Education:

Part 2: Turning Practice into Research.

Part 3: Next Steps: A framework for future research:

Each of these segments is now described in some detail.

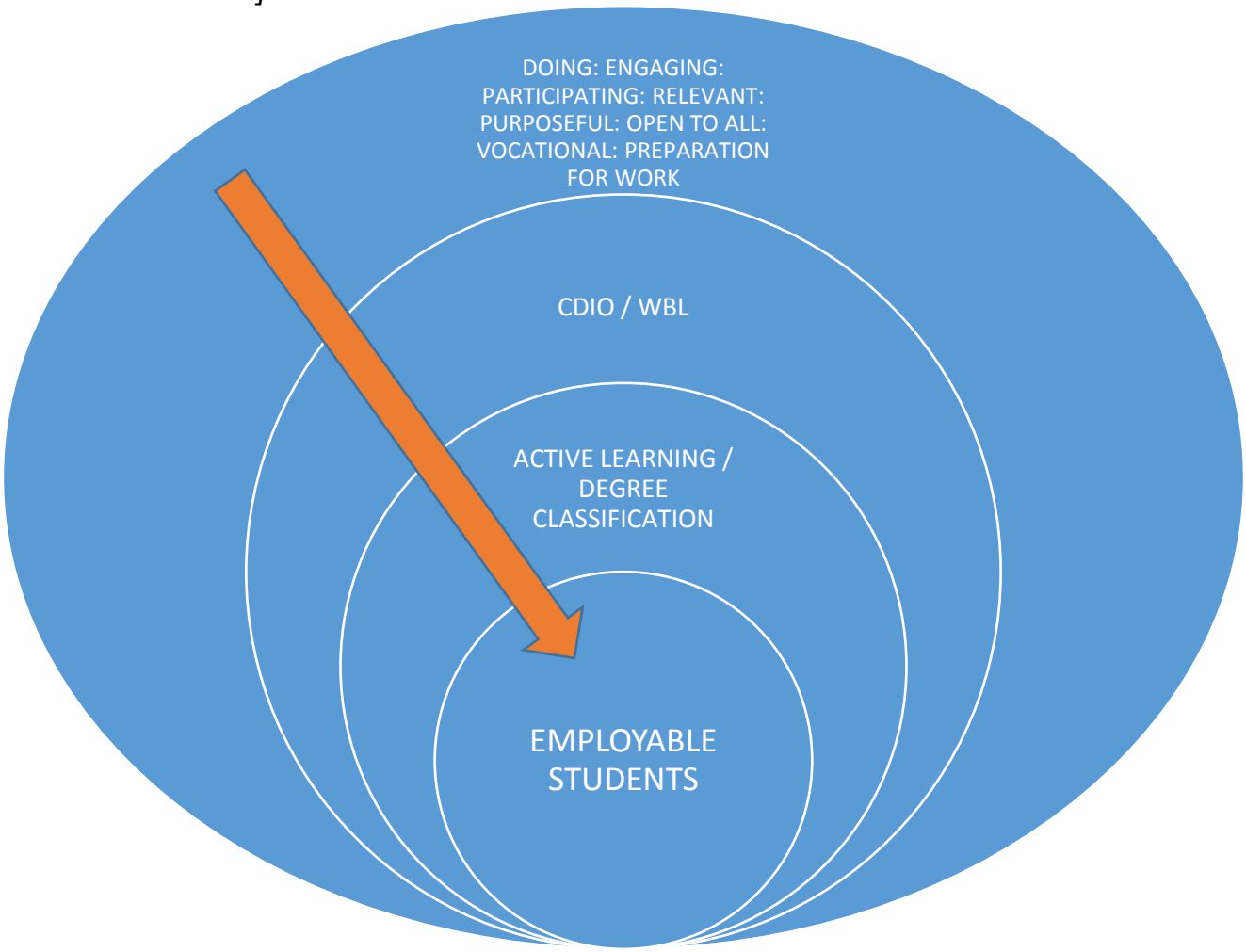
2.1 **Part 1: Group Work in Engineering Education: Concept Mapping:** *(15 minutes).*

Concept Mapping provides an ideal learning and teaching tool which can be used in any discipline area to promote group-working. It enables students to think about, and depict, how theories and concepts are interlinked. The first two stages of the Concept Mapping process involve listing and classifying the various concepts, theories and other terms related to the body of knowledge being mapped. For the purposes of the workshop these two stages will be completed in advance of the activity itself. Following an explanation by the workshop facilitators, colleagues will be given the following handouts (Figures 1,2,3) which will be used to guide and inform the group exercise.

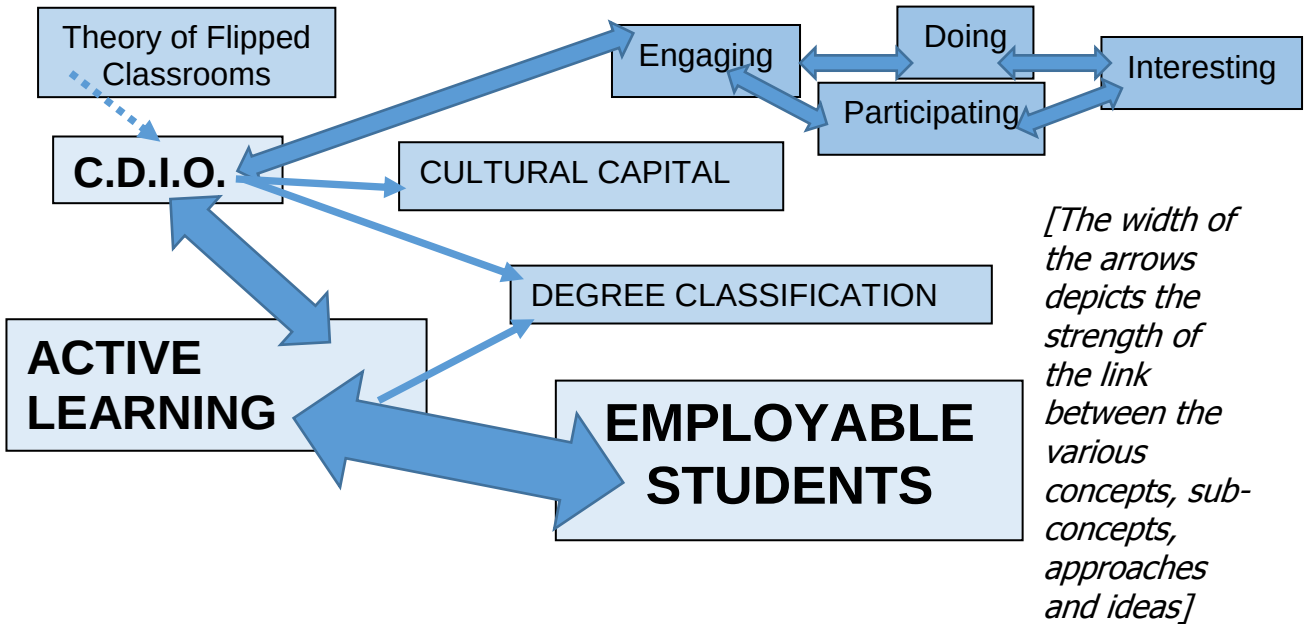
FIG 1: Active Learning Concept Mapping: Classification of Terms, Theories & Concepts (Handout 1)

EDUCATIONAL CONCEPTS	EDUCATION SUB-CONCEPTS	EDUCATION THEORIES / ACTIVITIES	[Initial Features / Terms] University is[about]
UNIVERSITY AWARDS CLASSIFICATION LEARNING EMPLOYABLE INNOVATION KNOWLEDGE SKILLS COMPETENCIES CAPABILITIES KNOW-HOW PROFESSIONALISM STANDARDS REWARDS LEARNERS LECTURERS TEACHING	DISCIPLINES (engineering / computer science etc) ACTIVE LEARNING PASSIVE LEARNING DEEP LEARNING FEEDBACK DEGREE LEVEL	CDIO WBL PBL PjBL 'Flipped Classrooms' Pedagogy Andragogy Scaffolding Cultural Capital Concept Mapping	Doing: Engaging : Participating: Elitist: Interesting: Boring: Hard: Easy: Relevant: Technology: Pointless: Purposeful: Students Teachers: Leaders: Accessible: For all: Opportunity: Self-improvement: Equity: A privilege: Equality: Self Betterment: Being taught: Self learning: Adult learning: Meritocracy: Costly: Multicultural: International: A mixing pot: Life-Long education: Preparation for work: Training: Vocational : Testing: Assessment

FIG 2: A Stacked Concept Map: (Handout 2) *[One feature / theory / concept naturally leads into the other]*



G 3: A Relational Concept Map (Handout 3)



[The width of the arrows depicts the strength of the link between the various concepts, sub-concepts, approaches and ideas]

- **WORKSHOP ACTIVITY 1:** *(15 minutes)*

Using the list of terms, theories and concepts depicted in Figure 1, and working in small groups, colleagues will develop a 'Prototype Concept Map' in one of the following areas:

- Promoting Student **Competencies** in Engineering Education
- Maintaining **Standards** in Engineering Education
- Enhancing **Learning** in Engineering Education

[The Concept Map may follow one of the formats depicted in Figure 2 or 3, or it can be unique to the group. However, participants need to bear in mind the schedule!]

2.2 Part 2: Turning Practice Into Research

- **WORKSHOP ACTIVITY 2:** *(20 minutes)*

Having developed the Concept Maps, colleagues will participate in guided small group discussions whereupon they will reflect upon the process of Concept Mapping as a learning approach. In doing so, colleagues will be asked to considering how they could go about conducting research to measure, identify and critique the validity of Concept Mapping by:

- Developing a research question / hypothesis
- Identifying research aim(s)
- Articulating the key learning variables to be measured or evaluated
- Considering to what extent the following methodological tools could provide the means by which the process of Concept Mapping could be evaluated:
    - Survey research (To measure the student perspective of learning)
    - Observational study (To record the lecturer's perspective of student engagement)
    - Semi—structured interviews (To evaluate the student perspective of the experience).

2.3 Part 3: A Framework for Future Research

- **WORKSHOP ACTIVITY 3:** *(Facilitated Discussion: 15 mins)*

The final discussion will comprise an 'interactive plenary' which will bring together the findings of the workshop activities to answer the initial research question of ***"Why should teaching in engineering be informed by research?".*** In reflecting upon the outcomes of the workshop activities the discussion will consider:

- Why is Engineering Education Research important?
- What should Engineering Education Researchers be focusing on?
- Is one methodological tool preferable for use in Engineering Education Research?
- What challenges are likely to be encountered when undertaking Engineering Education Research?

3. CONCLUSION *(Workshop 'Round-Up': 5 Mins)*

The workshop will conclude by bringing together all of the discussions in such a way so as to provide a clear answer to the original research question.

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