REFLECTION AND REFLEXIVITY IN REVIEWING AND EVALUATING CDIO: AN EMPIRICAL APPROACH TO EVALUATION.

Dr Robin Clark

School of Engineering & Applied Science,
Aston University. Birmingham. B4 7ET. UK.

r.p.clark@aston.ac.uk
0121 204 3567

Dr Jane Andrews

School of Engineering & Applied Science,
Aston University. Birmingham. B4 7ET. UK.

j.e.andrews@aston.ac.uk
0121 204 3363

ADVANCED WORKSHOP

ABSTRACT

Facilitated by an Engineer and a Social Scientist, both of whom have expertise in Engineering Education Research and Evaluation (EERE), this interactive workshop is divided into three main sections, each one focusing on a different area of evaluation. It will build on research conducted at Aston University School of Engineering and Applied Science to explore and critique the value of introducing CDIO across the first year undergraduate curriculum. Participants will be invited to consider the pedagogical and engineering related challenges of evaluating the academic and practical value of CDIO as a strategy for learning and teaching in the discipline. An empirical approach to evaluation developed by the researchers to provide empirically grounded evidence of the pedagogical and vocational value of CDIO will form the theoretical and conceptual basis of the workshop. This approach is distinctive in that it encapsulates both engineering and social science methods of evaluation. It is also contemporaneous in nature, with the researchers acting as a 'fly on the wall' capturing data as the programme unfolds.

Through facilitated discussion and participation, the workshop will provide colleagues with the opportunity to develop a cross-disciplinary, empirically grounded research proposal specifically for the purposes of critically evaluating CDIO. It is anticipated that during the workshop, colleagues will work together in small groups. Suitable pedagogical approaches and tools will be suggested and a purposefully developed Engineering Education Research Guide, written by the workshop facilitators, will be given to all participants to inform and support the Workshop approach.

KEYWORDS: Evaluation, Evidence, CDIO, Engineering Education Research

BACKGROUND

The importance of Engineering in addressing some of Society's most pressing problems has recently come to the fore with issues such as the Japanese Earthquake and Tsunami, the Mexican Gulf Oil Spillage, the Icelandic Volcano and the continued problems caused by Global Warming making the headlines across the Globe. Furthermore, the need for the Engineering Profession to provide innovative and practical solutions to a range of high profile modern-day environmental, geographic, socio-political, economic and other problems is reflected in the academic, vocational and policy related literature [1] [2] [3]. Conversely, whilst much Engineering Practice may be conceptualised as being 'reactionary' in nature, proactive innovation and invention represent the most exciting aspect of the Profession. Manifested by practical and highly visible projects such Large Hadron Collider [4], the Virgin Galactic spaceflight [5], and the Apple i-pad [6], such innovation and invention act to spark the public's imagination, bringing engineering and science to life in an applied yet accessible manner.

Given the complexity of contemporary Engineering-related challenges, the demand for Universities to provide a ready supply of suitably qualified Engineering graduates, equipped with high level employability skills, and are able to make innovative decisions and think 'outside of the box' is at unprecedented levels [7] [8]. Yet whilst innovation is often perceived to be one of the most exciting and crucial aspects of Engineering as a discipline, young peoples' misconceptions regarding exactly what the discipline constitutes represents a significant barrier both to Universities in attracting new applicants and to the Profession as a whole.

The situation is worsened by problems associated with high levels of attrition, with retention being a major issue in Engineering Education [9] [2] [10]. One of the main outcomes of this is that there is a severe shortage of young people entering the Profession at graduate level. Furthermore, whilst the current situation is undoubtedly troubling, unless urgent action is taken to remedy the situation, matters will deteriorate markedly over the next two decades. Indeed, in the UK, there is a likelihood that predicted shortfalls in the numbers of students expected to enrol on undergraduate engineering programmes over the next 10 to 20 years, will seriously test future governments' ability to retain and sustain local, national and global infrastructures and communities [2].

CDIO AS A SOLUTION

Questions of how to attract more young people onto University level Engineering Programmes are set within the context of high drop-out rates and failure – particularly in the first year of study. From a Higher Educational perspective, whilst many undergraduate Engineering Programmes have been transformed and updated to meet the changing needs of engineering students [11] [12], learning and teaching approaches to engineering remain a significant issue - with the subject generally perceived to be difficult and academically challenging. In addressing this issue, Aston University has introduced CDIO across its undergraduate curriculum for all first year students studying Mechanical Engineering and Design [13]. Introduced in October 2010, the new curriculum is intended to provide students with an exciting, practical, high quality and academically relevant learning experience. From its induction, Engineering Education researchers have 'shadowed' the staff responsible for

developing and introducing the new curriculum. It should be noted that emergent findings suggest that CDIO is generally perceived, by students and staff, to be a success.

EVALUATING CDIO: THE WORKSHOP APPROACH

Utilising an Action Research Design [13], and adopting qualitative research techniques, the researchers have worked closely with the teaching team to critically reflect upon the processes involved in introducing CDIO into the curriculum. Concurrently, research has been conducted to capture students' and lecturers perspectives of CDIO [14]. In evaluating the introduction of CDIO at Aston, the researchers have developed a distinctive research strategy with which future CDIO programmes may be evaluated. It is this research strategy that forms the basis of this interactive workshop.

By offering a series of interactive and facilitated activities, the workshop will provide participants with the opportunity to work through the epistemological, ontological and methodological steps taken by the research team in constructing a suitable research design with which to critically evaluate the CDIO programme.

The workshop will provide the opportunity for participants to begin developing their own approach to evaluating CDIO. It will commence with a group activity aimed at identifying and articulating the particular research related issues meriting evaluation within CDIO. By discussing underpinning theoretical and conceptual pedagogical epistemology and ontology the workshop participants will be encouraged to take a critical look at how they, and others, approach CDIO evaluation.

Having looked at the issues associated with identifying and refining suitable research questions, the 2nd part of the workshop will focus upon the selection of methodological tools and approaches. The strengths and weaknesses of different approaches will be briefly discussed and participants encouraged to reflect upon their own experiences in this area.

The final part of the workshop will bring the first two stages together allowing the participants to consider how they might approach future evaluation. The researchers will facilitate an exercise in which potential research areas and future collaborative partners will be identified and brought together.

Table 1, below gives a diagrammatic outline of the proposed schedule for the workshop. Participants are encouraged to sign up for the workshop in advance.

Table 1: Workshop Focus: Content & Context

Workshop Focus	Time schedule	Programme Content and Context
Introduction to workshop	5 Mins	
Theoretical and Conceptual Frameworks: Epistemology and Ontology	20 Mins	- **Identifying research areas** - **Articulating research questions** - **Identifying suitable theoretical approaches** - **Developing theoretical frameworks** - **Identifying and critiquing conceptual and contextual variables** - **Refining research question**
Selection of Tools: Quantitative, Qualitative or Mixed?	20 Mins	- **Quantitative approaches in EERE** - **Qualitative approaches in EERE** - **Validation, reliability and transferability** - **Measurement and Evidence**
Discussion and future collaboration	15 Mins	- **Ideas for future evaluation of CDIO** - **Identifying suitable collaborative partners**

BUILDING FUTURE PRACTICE

The workshop itself will be used as a research exercise. Following a phenemonographic approach the researchers will record the activities and interactions of the participants [15]. Participants will be asked, in advance, to sign a consent form in respect of their participation. All participant's individual and organisational details will remain fully confidential.

Following the workshop, the researchers will undertake a phenomenographic [15] analysis of the workshop findings. All of the data will be critiqued and used to further develop the original evaluative framework upon which this workshop is based. This will then be disseminated directly to the workshop participants. It will also be made available to the wider conference.

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Robin Clark is a Programme Director and Senior Lecturer in the School of Engineering and Applied Science, Aston University. A Professional Engineer, Robin now focuses his research interests on Engineering Education. He is currently the Primary Investigator in a large HEFCE sponsored pedagogical research project, and is also leading / managing several other sponsored research projects. He currently teaches Engineering Management at Undergraduate and Postgraduate levels and is supervising five PhD students.

Jane Andrews is a Social Research Fellow in the School of Engineering & Applied Science, Aston University. Jane's main area of research is pedagogy and educational management, focusing specifically on engineering education. She is currently involved in, or leading, several research projects across a range of different areas in engineering education. Jane also contributes to teaching in the School. She is currently supervising three PhD students.