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Highlighting the learning in project-based undergraduate engineering education: pedagogical and methodological considerations

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UCL Centre for Engineering Education

UK and Ireland Engineering Education Research Network

6th Annual Symposium, November 2018

The Context

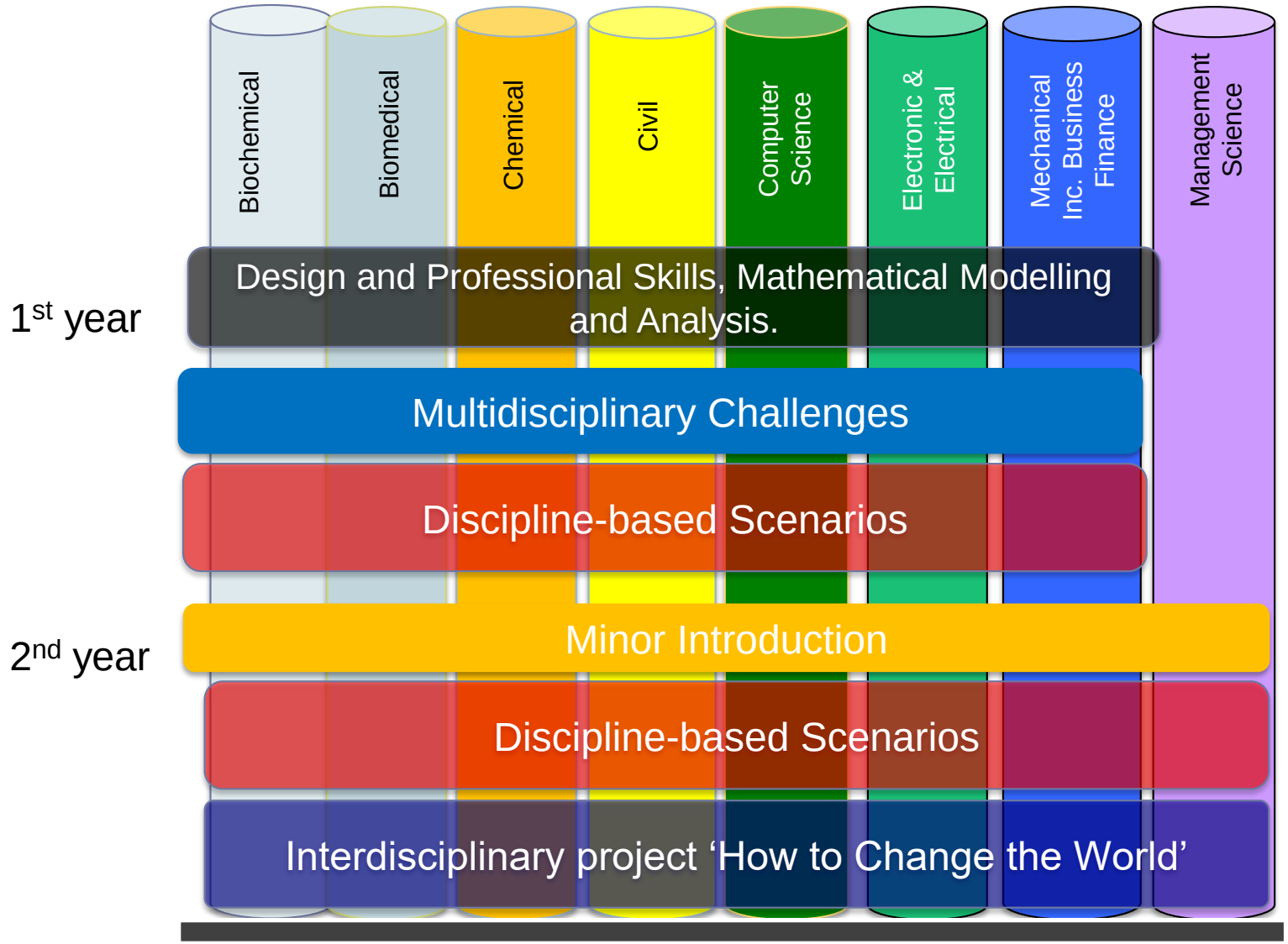
Higher Education to Employment Transition
Employability; competencies, capabilities, attributes, graduate 'skills and attributes'…

Engineering Employers/ RAE
… innovative problem-solving skills ; balance between scientific and technical understanding and application to problem solving.

UCL response
The Integrated Engineering Programme

"a common curriculum structure,…..
all undergraduate programs across UCL Engineering, built around a series of authentic engineering projects;
Shared multidisciplinary team projects and Minors, bringing students together from across UCL Engineering." Graham (2018:91)

Integrated Engineering Programme: Years 1 and 2



Project-based learning

Two essential components

Not just administrative framework***

organised

ng series of products [or] addressing the driving question *

Process-led activity

What is learned? How learning happens

Criteria for PjBL

Central to the

"drive" students to

involve in

autonomy, choice,

Realistic-feeling of

QUERY: *application* of knowledge as opposed to the *acquisition* of knowledge?

*** Hammell and Savin-Baden, 2013

Methodology

Observations and Interviews *in situ.*
Data collected in 'live' settings....on the ground, in real time, as it happens.

- "unobtrusive observer" role (Robson, 2002:309).
- development of descriptive narrative of settings.

Observers
Project team members
Post Graduate Teaching Assistants (PGTAs) Faculty Engineering
PGCE students (full-time, FE route)

Disciplinary Scenarios	Year
Biomedical Engineering	Two
Biochemical Engineering	Two
Chemical Engineering	Two
Computer Science	Two
Civil Engineering	One
Electrical and Electronic Engineering (EEE)	One
Mechanical Engineering (Parts 1 & 2)	One

Inter-disciplinary Challenge
Year One **Electronic and Electrical Engineering paired with Computer Science**

What is being learned?

All students across all scenarios spoke of:

- **Non-technical aspects of engineering** (communications; team working; problem-solving); the impact of authentic 'real' experiences on their learning; the challenges and possibilities of collaborative working.
- Differences of learning in disciplinary, as opposed to interdisciplinary groups. In disciplinary, students ***"spoke the same language"*** : they shared not only technical knowledge but also a discourse and understanding of the ways of working in the discipline.
- Challenges and opportunities presented in collaborative working

What, if any, technical knowledge was being learned?....

Developing knowledge and understanding

"I guess it's familiarisation with the material that we learn in class. Because I guess in lectures you kind of absorb it but when you actually apply it and you kind of think of all the assumptions [….] **and I think that's probably the most valuable input you kind of get from this particular scenario..[…] Because you work through it and you learn better** [Biochemical]

Q to Biomedical student group: So it sounds like you were sort of drawing on your previous knowledge from last year?

"Well we knew we needed to get the concept sorted out fairly quickly because there was going to be a lot of things to figure out."

Computer Science:

"Well…a lot of the stuff that we're doing **is new**, so it's connecting to new systems that we **haven't seen before** and providing sort of features that we **haven't tried before**. So, both in own areas of expertise and in other areas we've sort of learnt new things."

Bio Medical

.. "a lot of the stuff **is new** and **you're putting that into a newer context**, so you needed to do research on that **to make everything work**."

Computer Science:

Q: So would you share [what you've learned] with the other members of the group?

C Yes…especially in the integration part, because you cannot integrate with the others, you have to understand what he has done. You have to understand everything. You cannot just integrate some part without understanding the work.

Bio Medical

A. This is Arduino [coding] and we're given it. [Its] daunting, but **we actually learn a lot because we make mistakes….**

B. Yeah, but actually I think it's quite good because my kind of learning is we make mistakes and you learn from it. So this is a way of making a lot of mistakes and you're like 'oh why, why' and you're **finding it out yourselves and you tend to remember it more** than someone teaching you.

Mechanical

"With the design process we found there's been an ongoing [problem] situation for us because every time we thought we'd completed a design we had another flaw came in our way. And yeah just multiple problems that came up **and we had to find a way** of solving them."

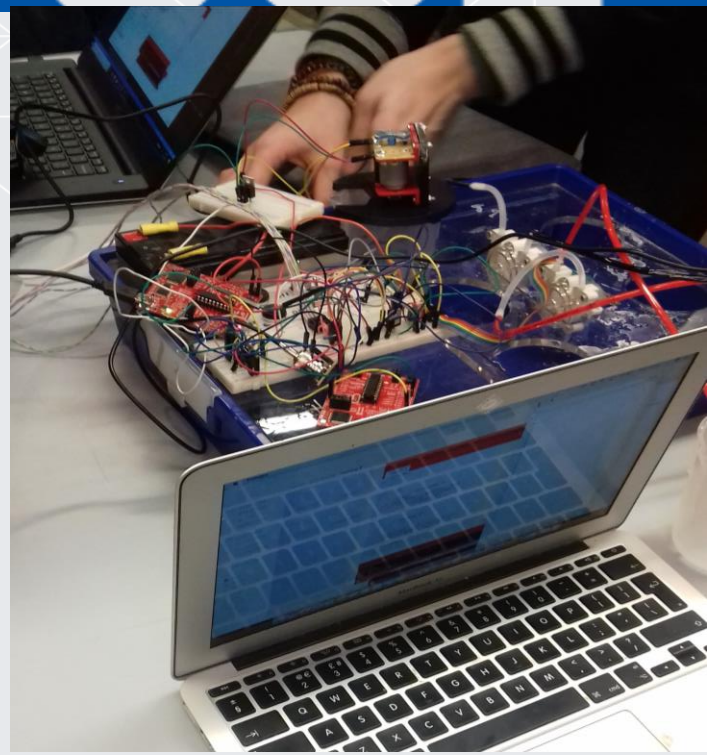
EEE student: “I got an insight in programming……[another student] Yes same here!”

“Well, to be fair, I didn’t know how to use any of this kit that we’re using, so yeah I think it’s been a really good experience because….Yeah…I think what the CS do is learn a bit about electronics, and the electronics learn a bit about the CS.”

EEE student: “And it’s a bit more interesting to work with people from different like courses. Although it’s not really different, they do they same thing but **they also can do like circuits and we can’t,** so….”

[So they’re useful!!]

Student: “Yeah! But yeah on the like IE meetings we had to discuss stuff with people from like civil engineering, biochem, and they like **bring some stuff up that you don’t even like know** but you just like discuss it, so it’s interesting.”



EEE/CS [Interdisciplinary] Scenario, year 1.

Implications…

Pedagogy

Seeing ***learning as a social practice*** at the centre of PjB**L**

- students not simply 'applying' what has already been learned.
- developing knowledge and understanding through process of **engagement**
- **Knowledge is 'put to use'** in new ways.
- Knowledge 'becomes a lens' through which problems, situations and practices specific to the domain are being scrutinised (Damşa & Nerland 2016).
- project groups embed **'distributed cognition**'.

Methodology (for Engineering Education Research)

- Development of in-depth, qualitative approaches to 'document' learning as it happens
- Accept the impact of observation practice *on observers* and development of practice.

Thank You

Questions and Discussion

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