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Fitness for purpose? project-based, collaborative learning in engineering undergraduate education.

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Overview

- Why Project Based Learning?
- The Case Study*
- Disciplinary learning: Findings
- Analysis and Conclusions

*UCL, Institute of Education ‘seed-corn’ funded project: *Fitness for purpose: developing the pedagogy of project-based, collaborative learning in engineering.*

Purpose ? What purpose?

Higher Education to Employment Transition
Work readiness; 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.

Engineering working practice
Working in (interdisciplinary) project teams
- the concept of the project team informs the division of labour
- focus is collaborative problem-solving and solution finding
- Workplace Learning (as a social practice)

Project-based learning

Two essential components

Not just administrative framework***

lting series of artefacts,
oducts, addressing the
driving question *

Process-led activity

Criteria for PjBL **

Central to
curriculu

Focused on
principles of a
discipline

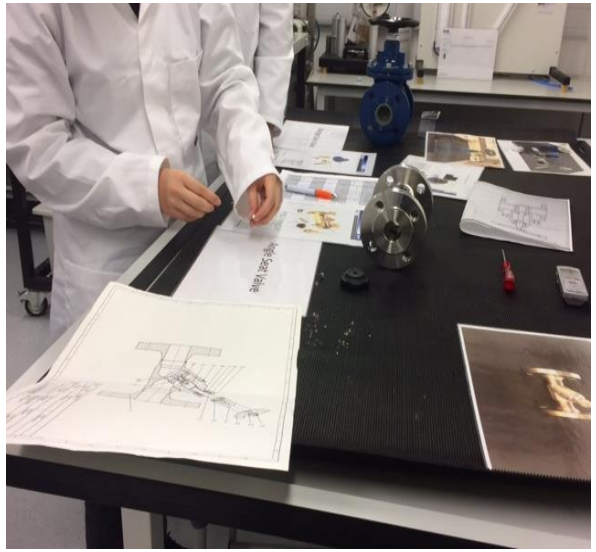
Investigation

Student-
work time and
responsibility

What is learned and how

*Blumenfeld et al. 1991, p. 371
**Thomas 2000, p. 3
*** Hammell and Savin-Baden, 2013

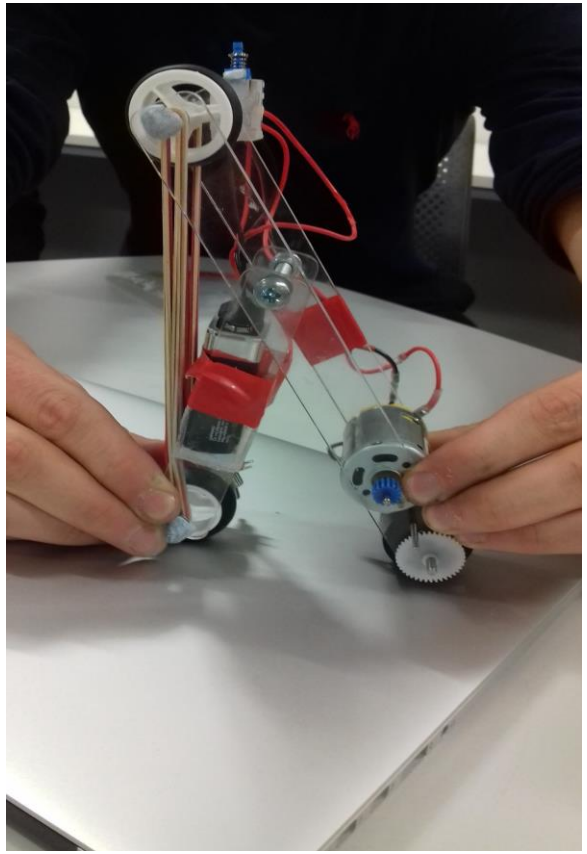
The Case Study



Inter-disciplinary Challenge

Year One
Electronic and Electrical Engineering paired with Computer Science

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



Fitness for Purpose? Disciplinary scenarios

What is being learned in disciplinary PjBL ?

Higher Education to Employment Transition
Work readiness; 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.

Engineering working practice
collaborative problem-solving and solution finding; Nature of learning at work.

Analytic themes….

'Non-technical' aspects ..
Communication
Team working etc.

Turning theoretical work into:
- **'real solutions'**
- **problem solving**
- **solution finding**
- **starting with the minimum**

Collaborative Learning
- learning expectations

Extracts from Biochemical and Biomedical Engineering, year 2…..

Communication….and budgeting

"I think definitely communication, because it's OK that everyone does anything but if they're not communicating what they're doing it's hard for you to know what they're doing […]. It's also difficult to know what they're thinking, if they're confused, communication is like a key thing because if you don't understand, if you wait until the last day to say it it's incredibly difficult for everyone else." [Biomedical]

"We looked at what we were given [budget/resources] because we needed to do something that was viable. So we looked at the sensors we were given and what flex sensors and pressure sensors […] We'd used flex sensors and pressure sensors in previous labs so we…[…] knew how they worked…" [Biomedical]

Team working…..

Identified differences in disciplines/interdisciplinary [BioChem]

"A: I think that people would think differently especially if they are from different disciplines, but probably we think similarly because we are from the same discipline..[we get on better]"

"B: [In interdisciplinary] it was like two different disciplines, like you're with people you've never spoken to before and just be…they have a really different personality!

C: It was harder to co-operate.

Turning theoretical work into real solutions

"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..** [Biochemical]

[…] Although it's like still theoretical, we haven't done [anything in] the real world! …but it's better than like sitting in a room, a lecture room, listening to pure theory things. **Because you work through it and you learn better**…" [Biochemical]

Linking to wider curriculum

"Yeah, we were inspired as well by a lecture we had on another course [anatomy and physiology] talking about wheelchair users and the [shoulder] problems that they often suffer as a result of [pushing chair]…" [Bio Medical]

Problem solving/solution-finding [Bio Med]

B "We worked out all of the electronics first, we thought that would be the most challenging phase, and so we had a working circuit, and after we knew that it was working and we tested it a few times ..we decided to go ahead and put it [together]"

D "We actually changed what we wanted to do. […]. So we were planning to give a response as soon as you were moving your arms, but we thought that [might] not be ideal, because it's very hard for the LED to detect the movement of a sensor [….] because there can be a lot of delay. So we went onto something different, calculating an average. So the person sitting in the wheelchair is doing some pressures and then after a certain amount of time it recalls the data and then averages the data out […]. So it won't give you an immediate response but after a certain amount of time has passed […]"

Starting with the minimum of information/resources

"I wish they'd given us a bit more of a brief though. They've given us a bit of stuff but it's still a bit unclear I feel like what exactly we have to do. But we're just doing the best of it that we can…." [Biochem : day 1]

Q: "So how has it gone since Monday?

B It's good. I actually feel better..[…] I did a lot more stuff than I expect[ed] I would do…

A Yeah we didn't expect that […] because we've done quite a lot of the work and so we're only halfway through the week. So yeah, it just feels like we've accomplished stuff…."

Learning through collaboration

"So basically we're kind of like splitting it up […] So each of us are doing different parts of the entire production team. And then we combine it to see how we're going to like basically optimise the entire process. So like for example they're doing […] environmental sustainability of the entire process, he's doing […] feed stocks and so on" [Biochem A]

"[Everyone] pitches the idea and like everyone comes in …So it's very collaborative […] everyone's working on different things so we all have different ways of seeing the same issue. […] it's like a very collaborative process in the sense that there's a lot of inputs coming in…we **try to shape the idea together** to basically get something that fits rather than like really opposing each other's ideas, because I think that's not very constructive" [Biochem B]

Insight into learning expectations…

"I think what [the lecturer] is interested in is more **how we think** [….], like how we present our information, how we express our information, and how we think. Not so much how everything is calculated. Because everything can be done by [computer]…"

PjBL : Fit For Purpose?…

Key Aspects Identified

- Developing of non-technical aspects of engineering solutions
- Using knowledge to create ‘real solutions’
- Operationalising a set of (disciplinary) investigative processes collaboratively
- Developing collaborative practice

Depends on

- Type/complexity of Project; degree of autonomy expected; scaffolding.

“The ubiquitous presence of and interaction with technological objects … frames the learning process” (Nerland, 2008)

- Cross curricula expectations, induction.
- Active mediation of learning through **feedback and questioning** (with peers, PGTAs, lecturers and external experts)

PjBL : Fit For Purpose?…

Requires

- an understanding of **learning** as a *social practice.*
- project groups feature **'distributed cognition**'.
- *A* **series of interactions between students over time** (de Graff and Kolmos, 2007; Illeris, 2009
- Not simply 'applying' what has already been learned
- Recognition that knowledge 'becomes a lens' through which problems, situations and practices specific to the domain are being scrutinised (Damşa & Nerland 2016).

And its fun!

“I’m actually really excited to tell people what we’ve done. Because we’re getting questions like ‘oh what are you guys working on’ and you have to explain it every single time. And once you put it out there and everyone knows what you did during the week it’s just pleasing, you’ve accomplished something.” [BioMedical]

Thank You

Questions and Discussion

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