Prototyping a transdisciplinary bioengineering curriculum development project

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Abstract

- Biomedical engineering is transdisciplinary
- Students must be able to integrate concepts across domains to tackle biomedical problems
- Traditional curricula do not reflect this: students tend to over-compartmentalise concepts & engage in surface learning
- Applied design-based research framework to redevelop curriculum around collaborative student-led design of a bionic limb
- Implementation in 2 subjects to date has garnered positive student feedback

Methods

- **Framework:** Design Based Research (DBR)
  - Continuous iterations of design, deployment, reflection, and redesign
- **Approach:** Re-develop curriculum around a bionic limb design project
  - Inspired by work done in a previous subject exploring the integrated learning of mechanics & programming concepts

Progress

- Formed curriculum design team aligned with core subjects & bionic limb sub-systems

<table>
<thead>
<tr>
<th>Subject</th>
<th>Focus Area</th>
<th>Relevant bionic limb sub-systems</th>
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<tbody>
<tr>
<td>BMEN2003</td>
<td>Applied Computation in Bioengineering</td>
<td>User-bionic limb interfacing, programming &amp; simulation</td>
</tr>
<tr>
<td>BMEN30006 Circuits and Systems</td>
<td>Actuation &amp; control of limb motion</td>
<td>Electronics &amp; circuitry</td>
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<tr>
<td>BMEN30010 Mechanics for Bioengineering</td>
<td>Material design &amp; fabrication, mechanics of limb motion</td>
<td>Physical structure of bionic limb</td>
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<tr>
<td>BMEN30008 Biosystems Design</td>
<td>Engineering design &amp; analysis principles</td>
<td>Feasibility studies, safety &amp; risk analyses, assembly</td>
</tr>
</tbody>
</table>

- **Staging of information is important**
  - Students encounter BMEN2003 first, then BMEN30006 & BMEN30010 concurrently, and finally BMEN30008
  - Subject assessments designed to account for this & to foreshadow connections to future concepts
- **Prototyping of bionic limb by tech designers**
  - Revealed challenges likely to be faced by students
  - Inform design of accompanying scaffolded learning activities

Conclusion

- Positive preliminary student feedback
  - “It is a fantastic concept and I love the idea that unit coordinators are working together as a specialisation rather than isolated units. I think it’s great our coordinators are working together to integrate content. Overall, I think the collaboration is fantastic and something that we should do throughout our degree to bring skills together.”

- **Reflections**
  - COVID-19 restrictions adversely affected student interactions & collaborations
  - Difficult to alter students’ approaches to learning due to length of semester (12 weeks) – likely to observe changes in longer term
  - Formal evaluations (surveys & focus groups) planned for upcoming semesters
  - Ecology of resources to be expanded (ePortfolios)

Background

- **Biomedical engineering is transdisciplinary**
  - “Integration of multiple disciplines in a way that transcends their traditional boundaries” (Khoo, Haapakoski, Helistén, & Malone, 2019)

- Previous curriculum did not reflect this (little to no cross-subject references/connections)
  - Students tend to over-compartmentalise concepts
  - Students tend to engage in surface learning
- **Aims/Objectives:**
  - Help students make connections between concepts & across subjects
  - Promote deep learning through hands-on collaborative design work
  - Enhance the overall learning experience

- **Framework**
  - Design Based Research (DBR)
    - Continuous iterations of design, deployment, reflection, and redesign

- **Approach**
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- **Bionic limb-related learning activities launched in 2 subjects to date**
  - BMEN2003
    - Biomech simulation (Figure 3) adapted for delivery
    - Subject altered to incorporate concepts drawn from a diversity of bioengineering-related fields (e.g. electromagnetism, systems biology)
  - BMEN30010
    - Activities modified to promote recall of knowledge covered in BMEN2003
    - Established project-based task assignments requiring synthesis of mechanics & computation (along with scaffolded accompanying tasks)

References