Inquiry-based cell culture course improves student conceptual and practical understanding of biomedical research

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**Introduction**

**Course goals**
- Develop strong scientific thinking abilities in the context of cell biology experimentation
- Train students in cell culture methods through inquiry-based activities
- Engage students in a research-like experience

**Course modules**
- Cell Proliferation
  - NIH 3T3 cells used to examine the contribution of sera and substrates to the rate of cell proliferation
- Cell Viability
  - NIH 3T3 cells used to test the cytotoxic potential of various additives
- Cell Differentiation
  - Adipose derived mesenchymal stem cells (AD-MSCs) used to examine their multipotent differentiation capacities: adipogenesis, osteogenesis, chondrogenesis

**Lab intensive course implementation**
- Flipped classroom model
  - Content delivery via textbook and course materials posted to Blackboard
  - In class activities are mainly development of culture skills and experimentation (groups of 2-4 students)
- Testing
  - On-line: pre-class quizzes, illustration of protocols and experimental designs
  - In class: three written examinations and one laboratory practicum

**Course assessment**
- Pre- and post-course self-efficacy and career aspirations surveys
- Experimental Design Ability Test (EDAT)

**Examples of Student Experimental Data**

<table>
<thead>
<tr>
<th>Cell Differentiation</th>
<th>Cell Viability-Live/Dead</th>
<th>Cell Viability-Alamar Blue</th>
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<tbody>
<tr>
<td><img src="image4.png" alt="Figure 4" /></td>
<td><img src="image2.png" alt="Figure 2" /></td>
<td><img src="image3.png" alt="Figure 3" /></td>
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**Discussion**

- Self-efficacy and career aspirations surveys show a positive effect on the students’ confidence
- Students indicate a better understanding of biomedical and cell culture research and a slight increase in their interest in these areas
- Post-course evaluation of experimental design ability did not demonstrate significant improvement.

**Future Directions**

- Assessment of experimental design ability in the specific context of cell biology
- Development and assessment of new modules to teach
  - flow cytometry
  - gene expression analysis
  - primary explant culture

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