Teaching Biomechanics with Just-in-Time Teaching (JiTT)

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INTRODUCTION

Biomechanics and movement science are rapidly growing fields in academia and industry. However, research suggests that many biomechanics and exercise science graduates are not prepared [1,2]. A key approach to improving the learning outcomes in these fields may reside in improving the classroom educational practices. Therefore, the purpose of this study was to evaluate how different teaching models affect undergraduate student learning in biomechanics.

THEORETICAL FRAMEWORK

In educational settings, action-based research is a method for evaluating how the investigator’s teaching activities affect student learning. It acknowledges biases exist because the researcher and instructor are coupled. Thus, action-based research is a systematic, iterative method for planning, acting, observing, evaluating and reflecting on student learning and teaching effectiveness [3].

The goals of action-based research are to test new learning approaches and implement change in a structured, dynamic manner that provides the instructor/research the opportunity to evaluate how the teaching method influences student learning [4]. In short, action-based research is a means for understanding how instruction affects learning [5].

With an action-based research paradigm, the teaching framework centered on Just-in-Time Teaching (JiTT). JiTT structures student learning as an active, iterative and synergistic process with web- and classroom-based activities. When teaching with JiTT, students respond electronically to conceptual web-based questions just prior to the start of the class. This allows the instructor to review, assess and address the students’ understanding “just-in-time" to adapt the ensuing classroom lesson to their knowledge level.

This encourages students to come to class prepared and engaged with material, while providing an opportunity for the instructor to develop relevant, meaningful lectures to assist in correcting students' misconceptions and misunderstanding in the material. JiTT has been well-received by students in other disciplines [e.g. 6] and encompasses several factors that enhance student learning [7,8]:

- student study outside of the classroom,
- low-risk, high-challenge environments that promote student conceptualization,
- increased student assessment, and
- quality student-faculty interaction.

The fundamental tenet of JiTT is the nearly real-time feedback to rectify students’ conceptual understanding. From this perspective, the instructor directs the classroom activities to the students’ needs. JiTT can be thought of as a steward of knowledge, fostering learning and cultivating comprehension by foregoing factual, static information (e.g., knowing basic equations) in light of greater conceptual understanding.

METHODS

This study occurred over two years in a senior-level undergraduate biomechanics course. Participating students were kinesiology students who were required to pass the course for graduation. Students had a kinesiology concentration of either exercise science or physical education. Participants signed a university-approved consent form.

The same instructor taught two biomechanics courses per semester. Students who took the course in the first year were taught without using web-based questions or JiTT (No JiTT). During the study’s second year, courses used web-based
questions. One course each semester had conceptual web-based questions (JiTT), while the other used simple, factual web-based questions as a modified JiTT (Mod-JiTT) framework (Table 1).

### Table 1: Teaching model by semester.

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Year 2</th>
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<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Morning Course</td>
<td>No JiTT</td>
</tr>
<tr>
<td>Evening Course</td>
<td>No JiTT</td>
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</tbody>
</table>

Student biomechanics understanding was assessed using the Biomechanics Concept Inventory (BCI) [2] at the start and conclusion of the course. BCI scores were calculated into percentage of maximum possible (POMP) scores for statistical analysis [9]. General linear model with a Tukey post-hoc analysis was used to assess teaching style in the different student populations (e.g. Hispanic, primary English speaker). Alpha was set at $p = 0.05$.

### RESULTS AND DISCUSSION

There were no significant demographic (Table 1) or pre-BCI score differences between groups.

### Table 2: Student demographics.

<table>
<thead>
<tr>
<th></th>
<th>No JiTT (N=127)</th>
<th>Mod JiTT (N=69)</th>
<th>JTT (N=57)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female (%)</td>
<td>56 (44)</td>
<td>34 (49)</td>
<td>24 (42)</td>
</tr>
<tr>
<td>Hispanic (%)</td>
<td>99 (78)</td>
<td>54 (78)</td>
<td>47 (82)</td>
</tr>
<tr>
<td>English Primary Language (%)</td>
<td>50 (39)</td>
<td>25 (36)</td>
<td>17 (30)</td>
</tr>
</tbody>
</table>

Post-BCI scores were significantly higher in the Mod-JiTT ($p=0.023$) and JiTT ($p=0.012$) courses compared to the No JiTT courses (Figure 1). Comparing between Mod-JiTT and JiTT, students in the JiTT courses had significantly ($p = 0.035$) higher post-BCI scores than students in Mod-JiTT courses. Further, non-English primary language speakers had greater learning gains in the JiTT courses compared to the No JiTT ($p=0.010$) and Mod-JiTT courses ($p=0.043$). This work suggests that frequent web-based conceptual questions can improve student biomechanics learning; however, the long-term learning gains of JiTT are unknown.

### REFERENCES


### ACKNOWLEDGEMENTS

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![Figure 1: Student pre- and post-scores on the Biomechanics Concept Inventory (BCI).](image)