# Collaborative Learning Journal Clubs in Biomedical Engineering Education

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## Abstract

A challenge of teaching undergraduate biomechanics is providing content depth to students from diverse academic backgrounds, including a mix of engineers and scientists. One collaborative learning activity that is accessible to students from diverse scientific backgrounds is a Journal Club. Journal Clubs are popular educational tools in medical education.[2-3, 5] In an extensive literature review, 80% of 101 studies reported that journal club discussions improved knowledge and critical appraisal skills.[1] The present study examines results from a structured Journal Club that has been implemented for three years in a biomechanics course of approximately 31 students per year. Typically 36% were Chemical Engineering majors, 45% were Mechanical Engineering majors, and 19% were other engineering/science majors. On average, 6% were graduate students. Each group of students chose and read an article from the peer-reviewed biomechanics literature and evaluated its scientific merit and interpretation of results in a guided discussion. This process was repeated approximately weekly. Students consistently recognized Journal Club as a significant learning experience, with annual averages of 3.8, 3.3, and 3.7 on a 5-point Likert scale (with 5 = "strongly agree") over a three year period. An additional survey of the third cohort of students showed that students increased their proficiency in reading scientific articles (4.0), found Journal Club helpful to the successful completion of their literature review assignment (4.2), and recommended that Journal Club be kept as a part of the course (3.7). Furthermore, topics taught in the course lecture were perceived as relevant to Journal Club discussions (3.5) and the discussions themselves were enjoyable to students (3.5). These results indicate that students perceived significant educational benefit from the collaborative learning experience in Journal Club.

## Introduction

Courses in biomechanics appeal to students from diverse academic backgrounds, especially in engineering and science. As a professional elective, engineering students often expect a computationally-intensive, technically-oriented course, whereas other scientists may not have a strong background in engineering mechanics. It is challenging to design course activities that offer depth of education while allowing all students to succeed with even a basic mechanics background. One approach is to focus on the critical evaluation of published scientific studies and the research processes that led to their findings. An effective collaborative learning activity for this is a Journal Club, in which students read and discuss articles from scientific literature. Within the medical community, Journal Clubs have a longstanding tradition. They originated a cost-saving measure in the face of rising periodical costs[4] and have evolved as a means for medical professionals to learn about cutting edge research being performed around the world. More research on the optimal design of Journal Clubs[1-2] is essential to improving their implementation. Journal Clubs in medical education have been highly successful.[2-3, 5] Participation in a Journal Club increases medical knowledge in 88% of medical residents[2] and bridges the gap between research and clinical practice.[4] A literature review reported that 80% of published reports claimed that Journal Club discussions improved knowledge and critical

appraisal skills.[1] In a small subset of this literature review, there were 12 articles in the experimental/comparative paper category. Of these, 10 articles noted a significant impact of an outcome measure (from a Journal Club) compared to a control activity (such as a lecture).[1] Journal Clubs allow participants to discuss a peer reviewed journal article in a friendly setting while educating one another on the techniques described in that article. The knowledge obtained from a Journal Club can be transferred to a variety of daily work and personal activities.

As an educational tool for undergraduates, students can improve individual reading and synthesis skills. The format of Journal Club is flexible and no strong preference in structure has emerged in the literature. The success of the Journal Club does depend on the goals set prior to the discussion.[2] An avenue yet to be quantified is the longevity of evidence uptake or application of Journal Clubs.[1] The student requirements to effectively participate in a Journal Club discussion include basic reading skills, discussion skills, and knowledge of the scientific method, but do not rely on depth of technical knowledge. The student must be able to read an article and think critically about its methods, results, and conclusions. In discussion, different perspectives (i.e. engineer vs. biologist) are appreciated. The present work describes a structured Journal Club that has been implemented in a biomechanics course for three years and presents results from student surveys.

**Comprehensive Description of Work**

The course described in this study was a biomechanics course at a primarily undergraduate private university. The average enrollment was 31 students per year. Graduate students could complete additional work to earn graduate credit. On average, 6% were graduate students and 38% were women. By discipline, students were typically 45% Mechanical Engineering majors, 36% Chemical Engineering majors, and 19% other Engineering/Science majors. This diversity was mirrored in the students' self-selected discussion groups: in the third cohort, 80% of the student groups contained students from at least two different majors. Throughout the semester, students worked in self-selected groups of 3-4 for the guided Journal Club discussions. Approximately weekly, each group was tasked to choose and read an article from the peer-reviewed biomechanics literature, discuss its scientific merit, and evaluate the interpretation of its results. This process was repeated on Fridays throughout the semester.

The overall learning objective for the Journal Club was for students to demonstrate proficiency in locating, reading, analyzing, and discussing current biomechanics research literature. Proficiency in these skills is critical to student success in the literature review, which is the capstone assignment of the course. This is a skill that students who continue on to graduate school will be expected to perform. The structure of the Journal Club discussions and evaluation has evolved over the three-year period to promote active student discussions and accurate assessment.

To ensure students were prepared to effectively participate in Journal Club, the university's Reference Librarian gave a guest lecture within the first week of class and demonstrated how to search for articles and access them via local resources or Interlibrary Loan. An associated homework assignment required students to find articles both in hardcopy and electronic format using the resources described by the Reference Librarian. To help students evaluate research

studies within the context of the scientific research process, the course instructor gave a brief primer on the peer-reviewed publication process early in the semester. This included a discussion of authorship standards within the field of biomechanics.

*Student Roles*

To ensure active participation and student preparation, each student was assigned a role. Students rotated among the roles approximately equally throughout the semester in a self-selected order. To promote effective preparation, an article had to be chosen each week and students needed to read the article prior to the in-class discussion.

The *Gatherer* student chose the article and posted it to Moodle (course management software) by the established deadline of 3 days prior to the in-class discussion. S/he also posted an 8-12 sentence summary of the article prior to the in-class discussion. The choice of the article was left solely up to the student, so long as it came from a peer-reviewed journal and was relevant to biomechanics. Students were especially encouraged to choose articles on topics of personal interest or on their chosen topic for the literature review assignment. The *Questioner* posted at least two questions about the article to Moodle prior to the in-class discussion. These were to be used as a starting point for the group's discussion. The *Answerer* posted answers to these questions following the in-class discussion. For groups with 4 students, the *Historian* investigated the authors of the article with a focus on their collaboration and publishing history and posted a summary of relevant information prior to the in-class discussion. This formal preparation structure allowed for individual assessment, and helped foster a starting point for the in-class discussions. If the *Gatherer* failed to post the article by the deadline, the teaching assistant assigned an article to the group. If the *Questioner* failed to post questions, the group was tasked with identifying both questions and answers during their in-class discussion. Posts to Moodle were accessible to all students in the course.

*In-Class Discussions*

During the in-class discussions, 20-25 minutes were devoted to Journal Club. Students were each required have either a hard- or electronic-copy of their group's article present during the discussion. An instructor (professor or teaching assistant) also read each article in advance and joined each group for 4-5 minutes during the discussion time period. During this time, students were encouraged to ask clarifying questions of the instructor related to the article, especially regarding technical details that were unclear. The instructors qualitatively assessed student preparation by asking targeted questions to the students, such as asking students to define scientific terms used in the article that may be new to the students. To give the students a sense of the breadth of biomechanics research being conducted, at the conclusion of the discussion time one student from each group was randomly selected to provide a brief (30-second) summary of their article.

*Student Assessment*

Students were assessed individually via posts to Moodle and documented participation in each group discussion. Table 1 below summarizes the point-accruing scheme based on student

role. A student earned two additional points each time s/he was randomly selected to summarize the group's article for the class. In the third year, Journal Club performance was worth 15% of the course grade, with 12 points earned per week over the 8-weeks of Journal Club. All students had this opportunity at least twice to ensure that each student could earn up to 100 points total.

*Research Data Collected*

Student perceptions about Journal Club were surveyed as part of the normal course evaluation process. An additional voluntary survey of the third cohort of students was conducted. All questions asked students to answer on a 5-point Likert Scale (with 5 = "strongly agree").

**Table 1: Journal Club Student Roles and Point Values**

<table>
<tr>
<td>Gatherer (weekly task)<br>• Article less than 10 years old (3 points)<br>• Article posted to Moodle on time (3 points)<br>• Summary posted to Moodle before discussion (3 points)<br>• Attend discussion with a copy of the article (3 points)</td>
<td>Questioner (weekly task)<br>• Post questions to Moodle before discussion (6 points)<br>• Attend discussion with a copy of the article (6 points)</td>
</tr>
<tr>
<td>Answerer (weekly task)<br>• Post answers to Moodle after class discussion (6 points)<br>• Attend discussion with a copy of the article (6 points)</td>
<td>Historian(weekly task)<br>• Post historian summary to Moodle before discussion (6 points)<br>• Attend discussion with a copy of the article (6 points)</td>
</tr>
<tr>
<td colspan="2">All Students – End of discussion summary to class (2 points) (twice per semester per student)</td>
</tr>
</table>

## Results and Conclusions

Over three years, students consistently identified Journal Club as a significant learning experience. Sixty nine percent of the students in the third cohort volunteered to complete the additional survey. These students reported markedly increased proficiency in reading scientific articles and found Journal Club helpful in the completion of their literature review assignment. Furthermore, topics taught in the course lecture were perceived as relevant to Journal Club discussions. The discussions themselves were enjoyable to students and most students recommended that Journal Club be kept as a part of the biomechanics course. A summary of the Likert scale ratings is in Table 2. Overall, these results indicate that students perceived significant educational benefit from the collaborative learning experience in Journal Club.

**Table 2: Journal Club Survey Likert Ratings**

| Journal Club Trait | Likert Rating |
|---|---|
| Significant Learning Experience | 3.8, 3.3, 3.7 (over a three year period) |
| Proficiency in reading scientific articles | 4.0 |
| Completion of their literature review | 4.2 |
| To keep Journal Club as part of the course | 3.7 |
| Course topics relevant to Journal Club | 3.5 |
| Enjoyable Discussions | 3.5 |

Key educational benefits to this collaborative learning exercise include increased content depth compared to a traditional lecture - in a traditional lecture, the technical depth would be limited to ensure the success of students from different technical backgrounds. With the team-centered approach, students work collaboratively to self-educate on the relevant principles. It is interesting to note that throughout the course, 79% of articles chosen for Journal Club were directly related to the course topics (Figure 1). This suggests that students actively sought out relevant scientific studies to gain deeper knowledge of lecture topics. Interestingly, the proportions of student-selected articles were not the same as the proportions of topics lectured (Figure 1 compared to Figure 2). Furthermore, a semester-long literature review assignment, as previously mentioned, also required synthesis of scientific literature. The data suggest that most students used the Journal Club discussions to discuss articles relevant to their self-chosen literature review topic: in the third cohort, 22 out of 35 students did this. Interestingly, 42% of students in the third cohort reported discussing topics they learned about in Journal Club with their peers outside of the classroom, indicating good student engagement both in and outside of the classroom.

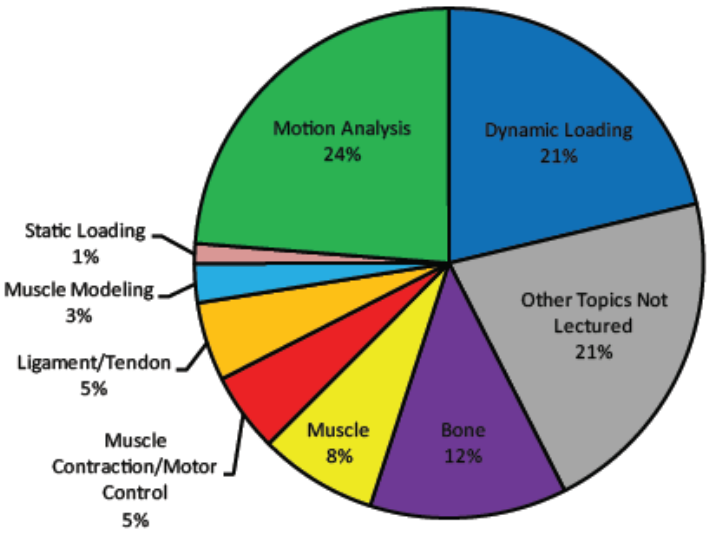


**Figure 1: Topics of Student-Selected Articles.**

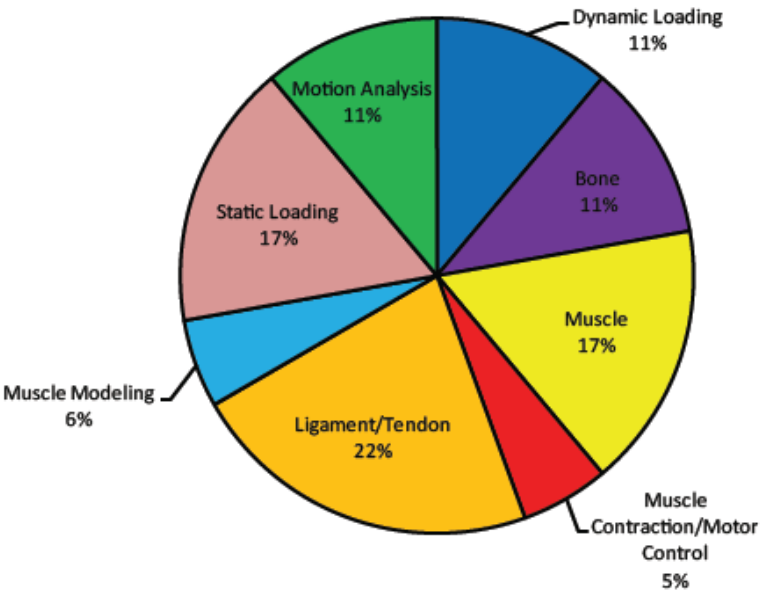


**Figure 2: Course Lecture Topics.**

Instructors can also benefit from structured Journal Club discussions. Participating in the discussions gives regular feedback regarding student interest, which can influence the future selection of topics covered in the course. Journal Club also offers a unique opportunity to engage in discussions with students and share content knowledge with students who are most interested, and at a level appropriate to the student's background. Furthermore, faculty members may reap the same benefits that health care professionals experience from Journal Club: namely, increased knowledge of contemporary scientific literature.[1]

Future work will include objective assessments of learning as a result of the Journal Club discussions. This technique could be applied to other technical elective courses. Additional extensions of this work may include surveys of course alumni to assess the relevance of the skills developed in Journal Club to their careers and lives.

In summary, Journal Club discussions are an effective way to engage students in biomechanics. Students gain an introduction to scientific literature and the research process, and learn customized content in what would otherwise be an introductory course. Anecdotally, students have reported using their literature search skills to research topics of personal interest, particularly with regard to health. Students generally enjoyed the activity: as one student said: "… Journal Club broke things up and was a lot of fun…"

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