Annotations and Discussions of Textbooks and Papers Using a Web-based System (Work in Progress)

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WIP: Annotations and discussions of textbooks and papers using a web-based platform

Abstract

Textbook reading over many decades for higher education students is commonly reported at 30% or less. The objective of this paper is to integrate an existing static textbook with modern web tools to increase student interaction. Using a web-based platform called Perusall (perusall.com), students in a graduate course in fluid mechanics annotated a traditional textbook and journal papers. Students' questions about or comments on the readings were awarded a fraction of the total grade for the course. Features used to engage students in textbook readings will be discussed as well as example responses, scoring, inter-student discussions, faculty intervention, and end of semester survey. The quantity and quality of comments were graded using machine-learning algorithms built into the platform. Each comment was auto-graded on a 0, 1, or 2-point scale, the machine scoring agree very well with the professional judgment of the instructor. The spacing of comments across each assignment was accounted for also, which helps insure reading of the entire assignment.

Introduction

Textbooks became a standard tool for higher education and engineering education in the 20th century. However, the amount that college textbooks are or have been read is not well studied. Some survey and reading quiz data provide a depressing snapshot [1-6]. A 2016 survey of over 280,000 college and university students found the likelihood that students came to class without reading was more than 70% (for students responding sometimes, often, or very often) [2]. A more formal study of over 900 students quantified reading using an unannounced reading quiz and found a decreasing amount of reading compliance from 80% in the early 1980s to about 20% between 1993 and 1997, which precedes the availability of handheld electronic devices [5].

While a textbook's size and weight limits a student's ability to carry around multiple textbooks, the ubiquity of smart phones, tablets, and laptops has led to multimedia course resources, including electronic textbooks, interactive web textbooks, and online homework systems [7-19]. While many of these tools are an extension of familiar paper textbooks, interactive alternatives are starting to become available in engineering. Interactivity, which creates learning by doing situations, is a feature of many electronic resources. For example, interactive web-based content led to statistically significant learning gains compared to static web-based content [8, 10]. In addition, students have also shown preference for the diverse set of resources on the Internet compared to a single, text-heavy textbook [15, 20].

When methods use interactive components, these methods should be considered active learning, which defines the set of techniques that continue to show in single studies and meta-analyses that students learn more through doing [12, 21-23]. In addition to the benefits of active learning, interactive technologies leverage the strengths of the digital native [24, 25]. Student engagement with new technologies does not seems to be a detractor; recent surveys found a majority of current engineering students, sometimes called digital natives, prefer interactive and/or electronic textbooks [26, 27]. However, many faculty authors of educational materials are not natives of the digital age, so creation and adoption of interactive materials may be slow.

Overall, fully interactive tools are becoming available for core chemical engineering courses, e.g., material and energy balances zyBook [28]; however, the market size for chemical engineering is much smaller than foundational math or science courses (e.g., General Chemistry), so investment by major publishers is relatively small. Therefore, integrating existing static textbooks with modern web tools has potential to increase student interaction and learning without building new materials from scratch. Perusall offers on methods to take static textbooks and scientific papers and create an active learning experience for students.

What is Perusall?

Perusall is a web-based tool that allows commenting on static text [29]. In brief, student contribute notes that are automatically graded using machine learning algorithms [30]. Therefore, the amount of student reading can be inferred from the comments, the quality of the comments, and the location of the comments. Examples of Perusall's operation, interface, and example comments with scoring will be presented first and followed by analysis of one semester's data as well as survey responses.

Perusall is primarily an asynchronous response system with comments in line with the text. Student engagement is quantified by machine scoring comments regularly (about every hour), so students know when they have earned their grade and could lead to more students being prepared for class. Perusall can send reminders to students who are not keeping pace with the readings. The asynchronous system allows students to get questions answered in between classes and potentially faster than waiting for office hours or the next class. Perusall offers an automated confusion report to the instructors, which could be used as a just-in-time teaching technique [31-33]. A confusion report identifies the parts of the text, based on the content of scored comments, that seem to be unclear to multiple students. However, these reports were not used in this study as the sample size of 10 students was too small to generate confusion reports. Other features include FERPA compliance, no advertising of outside products, and the ability to integrate into different learning management systems.

Example comments frame the discussion of auto-graded scoring (Figure 1). All of the comments were graded using the machine learning algorithms on a scale of 0, 1, or 2 points. Every comment was read by the instructor, and the assigned score seemed appropriate in almost all cases. With over 1000 comments entered across the semester, the instructor changed or considered changing a comments scores less than 10 times (~1%). The instructor and students found longer comments – more than two sentences - usually received 2 points, while even well formulated questions or queries of one sentence usually scored 1 point.

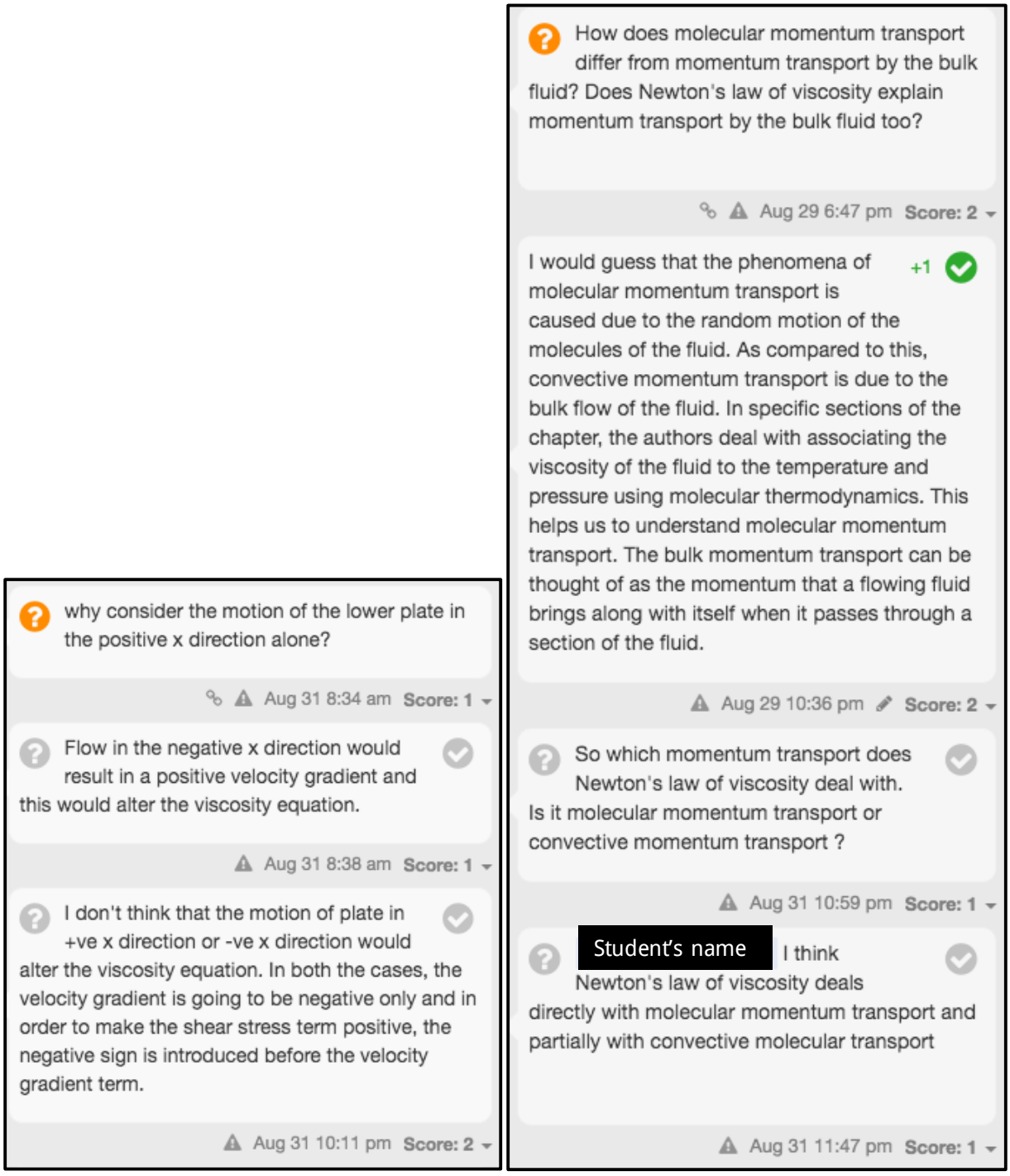

Figure 1. Two sets of student comments and scoring of 1 or 2 points. Green check indicates one student found another student's comment helpful.

One semester's data and student response

The class using Perusall was a graduate level transport phenomena class focusing on fluid mechanics at the University of Toledo during the Fall 2016 semester. The course consisted of 10 graduate students (both M.S. and Ph.D.) with 80% male and 20% female students. The course met on Tuesdays and Thursdays with a total of 12 assignments completed in Perusall over the course of the semester (Table 1). Neither the institution or students directly pay for Perusall. In this case, the primary textbook was Transport Phenomena, Revised 2nd edition by Bird, Stewart, and Lightfoot [34]. While the course only covered about one-third of this textbook, little discount was offered for an abbreviated book. Thus, the price to purchase and keep the full electronic book via Perusall was $52 per student, which is measurably cheaper than rental prices or purchase price for the hardcover book from at least one large online retailer. The textbook was supplemented by the instructor with five papers from scholarly journals.

Table 1. Assignments using Perusall during one semester.

Assignment(s)	Length (pages)	Required comments
Chapter from textbook (7)	Varies	7
Active learning paper from Proceedings of the National Academy of Science	6	5
Non-Newtonian flow paper from Transactions of the Society of Rheology	16	3
Intermolecular potential paper from Journal of the American Chemical Society	9	3
Polymer drag reduction paper from Experiments in Fluids	15	5
Physics of baseball from American Journal of Physics	6	5

Since the length and depth of each reading assignment varied, the number of required comments was also adjusted (Table 1). Seven comments per chapter was suggested by Perusall and was used for all of the textbook chapters. The total score for individual assignments can be set by the instructor (e.g., 100 points), holds for all assignments, and is independent of the number of required comments. After some experimentation after the first few assignments by the author, each assignment was graded out of 10 points in this case. Therefore, an instructor could weigh each assignment based on the number of comments, but these calculations would be done outside of Perusall.

The positioning of the comments can be used as a criterion to determine each assignment's grade. In this case, 10% of each assignment was based on the comments' distribution across the reading. An analogy to this idea would be that only commenting on the action on 30% of a football or soccer field would not lead to a full understanding of the game's action. The effects of changing the distribution from 10 to 50% will be discussed in the talk for the semester averages.

As the semester progressed, comments appeared to be more randomly placed and less dialogue between students was occurring. For the last few assignments, comments were given four more distinct designations to encourage more interaction. The categories were: 1. "Q" If you are confused, ask your classmates a question; 2. "C" If you are not sure if you understand a concept, try to state your understanding; 3. "H" If you can help a classmate, response to C and Q comments. Research shows that "teaching teaches the teacher."; and 4. "R" If you think that you can explain a concept better than the text, rephrase in a way that you think will be useful to your classmates.

At least one comment from each category was required in these assignments. The added letter to each comment did not seem to alter the machine learning algorithms grading the comments.

Faculty-student interactions can be initiated in two ways using Perusall. Difficult, possibly conceptual, questions can be posed by the instructor to seed discussions by the students during their reading. This technique would probably be useful in a larger class than discussed here. Alternatively, the faculty member could directly answer a student's question during the next class period. For example, a student asked: 'The textbook says, "for liquids the viscosity usually decreases with increasing temperature." What would be some examples of fluids that become more viscous with increasing temperature? Are they primarily Newtonian, non-Newtonian, or both?' The instructor responded during the next class with a one slide presentation of interesting data from the literature [35], which emphasized the important difference in properties between Newtonian (where experience and intuition is usually grounded) and non-Newtonian fluids.

Finally, an end of semester survey was administered and comments related to Perusall and other components of the course. Several Perusall-related questions received generally positive responses (Table 2), which will be further detailed in the talk.

Table 2. End of semester survey results related to using Perusall.

Statement	**% of students responding strongly agree or agree**
I learned new material by responding to other students comments in Perusall.	90
I learned new material by composing questions in Perusall.	90
I found Perusall a useful tool for the course.	80

The applicability and limitations of Perusall are added here to provide points of discussion for faculty considering adoption of this tool. Since Perusall negotiates competitive price with many, if not all, major publishers and places the textbook in your class to purchase, faculty do not need to interact with their local bookstore. The author believes that eliminating resellers provides direct revenue to the publisher and saves students' money. The platform is set up for classes of all sizes and sub-groups can be set up to avoid overwhelming students with hundreds of comments. Correlating comments with student learning is a challenge to be tackled in the coming years. One possible path of qualitative research would incorporate coding the comments, similar to interviews. Creating very large data sets from comments on popular textbooks should also be possible, especially in lower level science courses.

Conclusion

In summary, a web-based platform called Perusall was implemented in a graduate course in fluid mechanics. Students' annotations and questions were awarded a fraction of the total course grade. Example responses, scoring, faculty intervention, and survey showed a generally useful tool to increase the amount students read beyond the 30% of less commonly cited in the literature. The spacing of student comments was accounted for, which encourages reading of the entire assignment, and the results will be analyzed in the talk.

Disclaimer

The author is not associated with the sale, promotion, or development of Perusall or the materials used in the course discussed in this paper.

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