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University Student Use of Dynamic Textbooks: An Exploratory Analysis

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Within the array of resources for teaching and learning, the textbook continues to be the most prevalent one for instructors and students. Textbook formats have been changing from paper to digital, open source formats, including sophisticated tools such as computing cells, annotation tools, and powerful search engines, easing access at relatively low cost. Importantly, open source textbooks never expire or go out of print and can be distributed at no cost to students, making them practically fully accessible. The main study seeks to describe how instructors and students use two open-source, technologically enhanced textbooks (linear algebra and abstract algebra for math majors). We use Rezat and Strässer's (2012) didactical tetrahedron to investigate how resources support instruction (Cohen, Raudenbush, & Ball, 2003). The tetrahedron suggests a relationship between textbooks, students, instructors, and the content at stake and suggests that instructors, and the nature of linear algebra, can influence the interactions between the students and their textbooks. We investigate the use of the textbook by the students (student-textbook interaction, arrow *a* in Figure 1) and how linear algebra chapters of the textbook and instructor planning influence such use of the textbook by the students (arrows *b* and *c*, respectively, in Figure 1.)

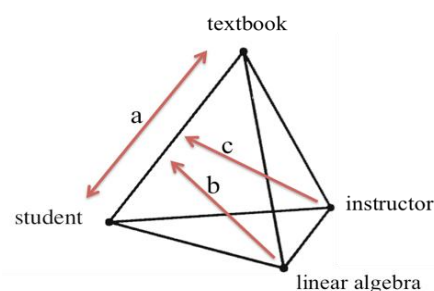


Figure 1: Relationships studied in the didactical tetrahedron (adapted from Rezat & Strässer, 2012, p. 241)

We analyzed bi-weekly log¹ data from 102 students from four instructors in four different states who were using a dynamic linear algebra textbook (Beezer, 2017). The textbook can be accessed on any device with any commonly available browser. It is online, free, open-source, enhanced with computational cells.² It includes standard linear algebra chapters (e.g., systems of linear equations, matrices, vector spaces, etc.) and is written in a definition-theorem-proof format, with exercises and some solutions towards the end of each chapter. The textbooks used in the project have a tracking system that allows to identify which sections of the textbook are being viewed and for how long.

¹ A log was an online survey that contained between four and seven questions about the use of the textbook during the past two weeks. We used thematic analysis to group log responses regarding student use of the textbooks.

² Students did not use the open-source feature, and infrequently used computational cells.

The analysis of the viewing data revealed, unsurprisingly, that viewing tended to occur during the days when the classes were offered (mostly during class sessions), close to exams days, or when homework was due. The students mainly used solutions of exercises—in 17,405 viewings, 81% of the viewing time was for solutions of exercises, 15% for examples, and 5% for all the other elements. In the log responses students reported that they checked the textbook the day before class or the last day of their break; they also used it to study for the upcoming class, or when they were stuck, missed class, or had not understood their instructor's explanation. Students reported using mainly problems, exercises, and examples as they were preparing for class. When asked about their use of theorems, definitions, and examples, students said those were mainly used when producing notes for later use because they wanted to make sure they were connecting ideas and knew the basic definitions. In addition, students created class notes, homework documents or solutions, and textbook notes in order to improve their understanding, for practice, and reminders or memorization, and used many other resources (classmates, Internet, Google, YouTube, Chegg, Khan Academy, and class lecture videos).

We have been tracing how the various uses students reported relate to the specific content covered in the courses and to decisions instructors had made about the course. We noticed that students did not use features that were not required by their instructors; in general, the students (and their instructors) seemed reluctant to take full advantage of novel features (such as the programming cells). We speculated that by itself, the design of the textbooks was insufficient for pushing users into adopting different ways of using these textbooks in teaching and learning linear algebra. Instructors might need training, perhaps in the form of conversations with designers and authors or in authorship that takes advantage of the open nature of the textbooks, so that they can envision new ways in which these textbooks can be used for teaching and learning. Textbook production is expensive, and thus, research that documents how open access textbooks can be made widely available is important. Yet, without knowing how to best take advantage of the new technologies, we might not realize their potential within mathematics classrooms.

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