Review of *Active Calculus, 2016 Edition*,
by Matthew Boelkins, David Austin, Steven Schlicker

Comprehensiveness

*Active Calculus* (Boelkins, M., et al, 2016) provides a conceptual approach to calculus, and fits solidly in the category of reform calculus. The text pushes students to understand what a limit is, what a continuous function is, what differentiability means, and what a definite integral computes. Each section offers four reform calculus homework questions. These challenging exercises are often set in a real-world context and require students to approach the topic using the ‘Rule of Four’ (symbolic, graphical, verbal and table-based reasoning).

The choice of using the reform perspective sometimes leads to material being presented in an intuitive way at the expense of mathematical precision. For example, the definition of a limit is written out in words successfully and informally, rather than through formal analytic statements. However correct completion of homework problems requires students to understand the nuances of what it means for a function to be continuous. Limit laws are not given explicitly in the text’s expository sections in Chapter 1, but some appear in homework problems such as showing that the derivative of the sine function is the cosine function.

The theoretical arc of single variable calculus is not fully presented in this text. The Intermediate Value Theorem, Rolle’s Theorem, and the Mean Value Theorem are not included.

Otherwise the text covers the usual topics of single-variable differential and integral calculus. The sections may seem light on an initial reading as they succinctly introduce each topic and provide a few key examples. Depth in the material is gained through careful working of homework problems. For example, the inclusion of the chapter on differential equations before the chapter on series allows a wonderful culminating homework problem seeking real analytic solutions to Airy’s differential equation. Examples and homework exercises include applications in physics, chemistry, biology and simple economics. Marginal cost and marginal revenue are not included in this text.

Content Accuracy

The reviewer did not notice any problems with accuracy in the exposition, examples and exercises of *Active Calculus*. The examples and exercises in fact provide a helpful source of well-written reform style problems. Although largely helpful and well-rendered, occasionally figures pose opportunities for reader confusion. For example, the increasing segments of the function graphed in Figure 1.26 are so close to linear that it is not clear whether or not there is an instant of zero concavity in these segments, or an entire interval of zero concavity. This can lead to a wide variety of reasonable answers to Preview Activity 1.6 when a single answer would be more helpful pedagogically.
Relevance/Longevity

Although the reform calculus movement has been around for several decades, recent reports (President’s Council of Advisors on Science and Technology, 2012; Tanner J.D. et al, 2016) have put the spotlight on the need to make undergraduate mathematics education more student-centered (Najmabadi, S., 2017). In light of this Active Calculus offers a timely and useful contribution to undergraduate calculus education. Should the calculus concept inventory initiated by Epstein (Epstein, J., 2013) be completed, it would be interesting to see how the Active Calculus curriculum performs relative to other active-learning, as well as more traditional, pedagogical approaches to calculus.

Clarity

Active Calculus appears to be written with the student audience in mind. Overall this is successful. The sections introducing global and local extrema, and the first and second derivative tests were not as clear as I had hoped.

Organization Structure Flow

The Active Calculus text is carefully structured with Preview Activities to build student intuition, text-based explanation to set up important ideas, in-class Activities to practice those ideas, and homework problems do develop them more deeply. The numbering of text elements including Sections, Preview Activities, in-class Activities, homework Exercises and Definitions may lead to confusion. Each of these elements appears to have its own separate counter, and that counter may or may not be explicitly tied to a section number. As a result its not clear which text element belongs in which section. Students might also confuse “Preview Activity 1.5” with “homework Exercise 5 in Section 1.”

Interface

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How well it worked at LC, in my department

I used Active Calculus once at LC in a differential calculus course. The reform approach to calculus offered by Active Calculus raises implementation challenges. Students are unaccustomed to the complex and open-ended nature of the assigned problems. This included the homework grader (themselves a very strong student), who needed significant mentoring in how to grade homework for the course.

In addition working in groups both in and outside of class is not something that necessarily comes naturally to students. For example students reported great difficulty in setting up group homework meetings outside of class hours. One solution to this could
be setting up a required weekly 90 minute ‘lab section’ to the course. Group homework could be completed at this time.

From the instructor’s perspective, finding a balance between class lecture and in-class problem solving is tricky. I suspect this balance would be found by the third implementation of the course. In addition a separate source of more routine homework problems would be a useful addition to the course. Webwork would be one possible source that would not increase the burden on the homework grader. Pairing the Active Calculus curriculum with a more formal textbook would provide a nice balance between detailed, formal exposition, and context-based, more intuitive exposition.

Works Cited


