



# Biologists and Mathematicians tell very different stories of the definite integral.

## On Narratives of the Definite Integral in Biocalculus

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**Goal:** Explore variation in the presentation of the definite integral in calculus texts written by mathematicians and those written by biologists.

**Corpus:** (biology-oriented texts are classified by authorship teams + preface materials).

- **[Mathematician's Calculus,]** James Stewart. (2016). *Calculus: Early transcendentals* (8th Ed.). Cengage Learning.
- **[Mathematicians' Biocalculus,]** James Stewart & Troy Day. (2015). *Biocalculus: Calculus for Life Sciences*. Cengage Learning.
- **[Biomathematicians' Biocalculus (Example 1),]** Claudia Neuhauser & Marcus L. Roper. (2018). *Calculus for biology and medicine*. Upper Saddle River: Pearson.
- **[Biomathematicians' Biocalculus (Example 2),]** Erin N. Bodine, Suzanne Lenhart, & Louis J. Gross. (2014). *Mathematics for the life sciences*. Princeton University Press.
- **[Biologists' Biocalculus,]** Alan Garfinkel, Jane Shevtsov, & Yina Guo. (2017). *Modeling life: the mathematics of biological systems*. Springer International Publishing AG.

**Framework:** Analysis via literary tradition of narrative.

- Established use in studying mathematics curriculum (e.g. see Dietiker, 2013; Dietiker, 2015; and MicZys 2023).
- I'm following Netz (2005) - mathematics texts tell a story:  
"Some passages - descriptive - add detail to the fictional world, constructing its underpinning of reality; other passages - narrative - unfold the plot that takes place in that fictional world" (2005, p. 262).
- Final product of analysis - a set of chronological diagrams that position the mathematical concepts (descriptions) along a story arc to convey how narrative relates these topics.

**How to interpret diagrams:**

**General features.**

- Upward slope (rising action) indicates a concept building on another concept.
- Horizontal lines (a climax or false-climax) are concepts that were separated from the general text as important (e.g. by a box.)
- Downward slope (denouement) indicates a closing thought.

**Notable combinations of general features.**

- A horizontal line that ends without a decent immediately following it indicates a split narrative, where the reader is to keep this train of ideas in mind, but we start again at height zero to build up another sequence of concepts.
- A horizontal line appearing at a height greater than zero without an upward sloping line preceding it indicates a *deus ex machina*, or the abrupt introduction of a concept in a climactic role without narrative connection to preceding concepts.

### (Surprising) Finding 1:

No narratives used a *deus ex machina* to reach the definite integral.

**Note.** The *deus ex machina* is a popular narrative device in stories of the derivative, e.g., to introduce the derivative function in Biomathematicians' Biocalculus (Example 1).

### (Surprising) Finding 2:

In some narratives, the definite integral was not a climax.

**Future Directions.**

- [1] Explore the scope and rigidity of student's structural expectations and how this impacts learning.
- [2] Explore other fruitful constructs from literature, e.g., the analytic tool of implied reader inspired implied student (Ulriksen, 2009).

**References**

- Dietiker, L. (2013). Mathematical texts as narrative: Rethinking curriculum. *For the Learning of Mathematics* 33(3), 14-19.
- Dietiker, L. (2015). Mathematical story: A metaphor for mathematics curriculum. *Educational Studies in Mathematics*, 90, 285-302.
- MicZys, V. (2023). Cheap plot tricks and plot holes in mathematical stories. *Educational Studies in Mathematics*, 113, 1-15.
- Netz, R. (2005). The aesthetics of mathematics: a study. In Mancosu, P., Jorgensen, K. F. & Pedersen, S. A. (Eds.) *Visualization, Explanation and Reasoning Styles in Mathematics*, pp. 251-293. Springer.
- Ulriksen, L. (2009). The implied student. *Studies in Higher Education*, 34(5), 517-532.