Contaminant Fate Modeling

Differential Equations Series

Instructor's Guide

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Developed by the Teaching and Learning Laboratory at MIT
for the Singapore University of Technology and Design

Introduction

When to Use this Video

- In Soph 301, at home, or in recitation, before Lecture 4: Applications to Differential Equations.
- Prior knowledge: conservation of mass, control volumes

Key Information

Duration: 10:03
Narrator: David Griffith, Ph.D.
Materials Needed:
• paper
• pencil

Learning Objectives

After watching this video students will be able to:

- Construct a differential equation to estimate the concentration of a chemical in the environment.
- Appreciate how informed estimates can help simplify and solve differential equations.

Motivation

The changing concentrations of species in a physical system provides a nice context for students to practice writing differential equations. Even though students may not be able to solve the differential equations, understanding how to describe processes with differential equations is an important skill.

Student Experience

It is highly recommended that the video is paused when prompted so that students are able to attempt the activities on their own and then check their solutions against the video.

During the video, students will brainstorm chemical and physical processes that might remove estrogens from Massachusetts Bay.

Video Highlights

This table outlines a collection of activities and important ideas from the video.

Time	Feature	Comments
0:00	The idea of estrogens as a contaminant in the environment is introduced.	
0:58	Prerequisite knowledge and Learning objectives	
1:24	Chapter 1: Modeling Contaminant Concentrations	Use of differential equations in modeling contaminant concentrations is discussed.
2:44	Chapter 2: Modeling Estrogen Concentrations	
3:23	David discusses his research on the fate of estrogens discharged into Massachusetts Bay	
4:35	Student activity	Students are asked to brainstorm processes that might remove estrogens from Massachusetts Bay.
5:02	Processes that may be considered negligible in the model are discussed.	
5:56	Two additional simplifying assumptions are discussed.	
6:28	Chapter 3: Using the Model	
8:00	Chapter 4: Next Steps	David discusses how he has used the model and next steps that can be taken to refine the model.
9:18	To Review	

Video Summary

This video combines the concepts of modeling, conservation of mass, and differential equations to estimate the concentration of estrogen in Massachusetts Bay. Students consider what the dominant inputs and outputs may be and see how simplifying assumptions make the differential equation easier to solve.

Soph 301 Materials

Pre-Video Materials

When appropriate, this guide is accompanied by additional materials to aid in the delivery of some of the following activities and discussions.

1. Conservation of mass and control volumes

If students need to review the law of conservation of mass and need practice in selecting control volumes, the STEM Concept Video, Conservation of Mass can be useful. This video can be found in the MIT OCW STEM Concept Video collection: http://ocw.mit.edu/resources/res-tll-004-stem-concept-videos-fall-2013/index.htm

Post-Video Materials

1. Model assumptions

In small groups, and then as a whole class, discuss the validity of the assumption that the concentration of estrogens in Massachusetts Bay is constant in time. What other factors does this assumption depend upon?

Additional Resources

References

Learn more about David Griffith's research in an article he wrote for general audiences.

- Griffith, D. (2011, Winter). From Sewers to the Seafloor. *Oceanus Magazine*, 30-33.

The following educational articles describe approaches to teaching differential equations to address common student difficulties.

- Davis, P. (1994). Asking good questions about differential equations. *The Coll. Math. J.*, *25*(5), 394–400.
- Pennell, S., Avitabile, P., & White, J. (2009). An engineering-oriented approach to the introductory differential equations course. *PRIMUS*, *19*(1), 88–99.

RES.TLL.004 STEM Concept Videos

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