Not Just Physics: Applications from the Partner Disciplines in Calculus: A SUMMIT-P Project

MAA Contributed Paper Session on Integrating Math Modeling and Interdisciplinarity into Your Classroom

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SUMMIT-P NSF I-USE Grant:

Synergistic Undergraduate Mathematics via Multi-institutional Interdisciplinary Teaching Partnerships

Inspired by the MAA's Curriculum Foundations Project

Augsburg and Our Project:

Our Team: three mathematicians (Pavel Bělík, Su Dorée, and Jody Sorensen), an economist (Stella Hofrenning), and a chemist (Joan Kunz)

Goal: Renovating our Calculus sequence to meet the needs of our students and the partner disciplines

More **active** and more **applied**

Our team led ‘fishbowl’ meetings with these partner disciplines:

- Biology
- Business
- Chemistry
- Computer Science
- Economics
- Mathematics
- Physics

Every 70 minute MWF class includes three 20 minute sections:

- An exploratory activity, usually applied, done in small groups at tables

Every 70 minute MWF class includes three 20 minute sections:

- A ‘barely enough’ lecture/discussion introducing the day’s big ideas

Every 70 minute MWF class includes three 20 minute sections:

- Practice problems with randomly selected student pairs at the whiteboards

In addition, our Calc 1 and 2 courses have a weekly lab period, which we elected to use to work on **transferrence**

We created activities and examples using a variety of resources

- Conversations and collaborations with Augsburg partner discipline faculty
- Gathering textbooks from partner discipline courses
- Selecting and expanding problems from our text, Briggs/Cochran et. al.
- Keeping eyes open for interesting contexts

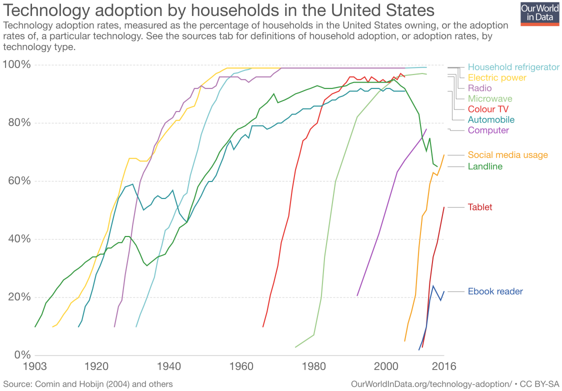
The exploratory activity on the first day of Calculus I asks students to calculate and interpret rates of change using this chart showing Blood Alcohol Content based on body weight and number of drinks.

NUMBER OF DRINKS

BODY WEIGHT	1	2	3	4	5	6	7	8	9	10	11	12
100 lb.	.038	.075	.113	.150	.188	.225	.263	.300	.338	.375	.413	.450
110 lb.	.034	.066	.103	.137	.172	.207	.241	.275	.309	.344	.379	.412
120 lb.	.031	.063	.094	.125	.156	.188	.219	.250	.281	.313	.344	.375
130 lb.	.029	.058	.087	.116	.145	.174	.203	.232	.261	.290	.320	.348
140 lb.	.027	.054	.080	.107	.134	.161	.188	.214	.241	.268	.295	.321
150 lb.	.025	.050	.075	.100	.125	.151	.176	.201	.226	.251	.276	.301
160 lb.	.023	.047	.070	.094	.117	.141	.164	.188	.211	.234	.258	.281
170 lb.	.022	.045	.066	.088	.110	.132	.155	.178	.200	.221	.244	.265
180 lb.	.021	.042	.063	.083	.104	.125	.146	.167	.188	.208	.229	.250
190 lb.	.020	.040	.059	.079	.099	.119	.138	.158	.179	.198	.217	.237
200 lb	.019	.038	.056	.075	.094	.113	.131	.150	.169	.188	.206	.225
210 lb.	.018	.036	.053	.071	.090	.107	.125	.143	.161	.179	.197	.215
220 lb.	.017	.034	.051	.068	.085	.102	.119	.136	.153	.170	.188	.205
230 lb.	.016	.032	.049	.065	.081	.098	.115	.130	.147	.163	.180	.196
240 lb.	.016	.031	.047	.063	.078	.094	.109	.125	.141	.156	.172	.188

https://awareawakealive.org/educate/blood-alcohol-content

A lab later in Calculus I is based on the logistic growth in the adoption of trends. We use the data represented in this graphic. Students approximate rates of change, discuss various models, and practice derivative rules.



https://ourworldindata.org/technology-adoption

We collaborated with Environmental Science faculty to create a lab activity modeling the famous Lynx-Hare populations. Students calculate growth rates and equilibrium solutions, and read a short article from an academic journal.

INTRODUCTION

The snowshoe hare cycle

As any ecology student can readily relate, cyclic fluctuations in population density of the "snowshoe," or "varying," hare (*Lepus americanus*) and its mammalian predators in Canada's north woods have been the subject of continuing inquiry and debate since the days of Elton and his collaborators (1924, 1927). The importance of this phenomenon, arguably ecology's most celebrated oscillation, is accentuated both by its magnitude and inherent romance: since colonial times at a minimum, hares, lynx, martens, and other fur-bearing creatures of the spruce–fir forest have fluctuated in abundance, attaining maximal densities every 8–11 yr (Fig. 1). By ecological, if not celestial, standards, it is an extraordinarily precise metronome which, over the years, has attracted the attention of ecologists (Elton and Nicholson 1942*a, b,* MacLulich 1957), field biologists (Wolff 1980, Keith 1990, Boutin et al. 1995, Poole 1995, Slough and Mowat 1996, and references therein), statisticians (Bulmer 1974, Finerty 1980, Royama 1992, Stenseth et al. 1997), and theorists (Leigh 1968, Fox and Bryant 1984, Trostel et al. 1987, Akcakaya 1992, Blasius et al. 1999).

The most important features of these oscillations are as follows (Norrdahl 1995):

1. *Regularity*.—Although the cycles are by no means perfectly periodic, hare population peaks and those of their predators succeed one another at fairly regular intervals. The most famous evidence of this regularity, as seen in the lynx fur harvest, was gathered by Elton and Nicholson (1942*b*). The lynx is strongly, if not obligately, dependent on the hare (Brand et al. 1976), and changes in its abundance are generally believed to reflect changes in the availability of its preferred food species. As is well known, Elton and Nicholson (1942*b*) found that most peaks in most localities occurred at intervals of 8–11 yr. Not surprisingly, there is a strong and statistically significant peak in the power spectrum at a frequency of $\sim 0.1\ yr^{-1}$ (Finerty 1980). Reviews of more recent fur statistics point to a similar conclusion, suggesting that the cycle continues to this

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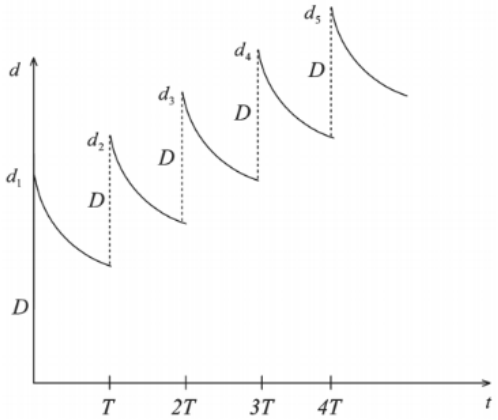
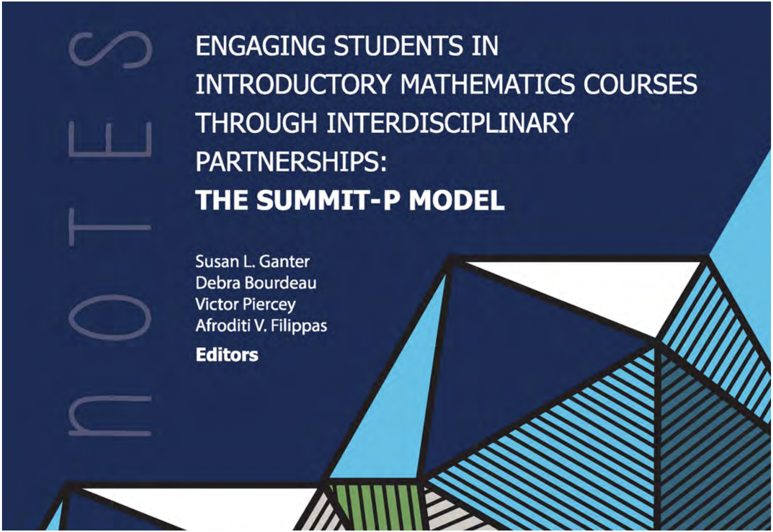
King and Schaffer, *Ecology*, 2001.

A Calculus II activity developed from the text models periodic drug dosing as an application of series




notes
ENGAGING STUDENTS IN
INTRODUCTORY MATHEMATICS COURSES
THROUGH INTERDISCIPLINARY
PARTNERSHIPS:
THE SUMMIT-P MODEL
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Debra Bourdeau
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