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# *Technology in Mathematics Teacher Preparation Courses*



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# Teacher Preparation

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- **Teacher Preparation and Enhancement courses need to model what is expected in the future classrooms of prospective and experienced teachers.**
  - **Common themes include**
    - **Mathematical modeling**
    - **Problem solving**
    - **Effective use of technology**
    - **Communicating mathematics**
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**The Methods for Teaching Mathematics  
in Middle and High School course  
includes information and demonstrations  
of a variety of calculator and computer  
uses and require student use of  
calculators and computers in peer  
teaching.**

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# **Hand-held Computer Algebra System**

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**Hand-held devices such as the Texas Instruments TI-89, TI-92 Plus, or Voyage 200 have**

- a computer algebra system**
  - graphing capability for 2-D and 3-D**
  - geometry software**
  - statistics software**
  - many other applications software**
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**Using calculators and computers as "laboratory" tools has been effective in developing mathematical concepts in classroom demonstration, exploration, experimentation and calculation.**

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# **Student Project Presentations**

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- **We assign projects to provide the opportunity for students to communicate mathematics.**
  - **We require that students work in teams of two or three.**
  - **We require each team to make a formal presentation of their project to the entire class.**
  - **Many students use Power Point and access web sites for their presentation.**
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- **Projects provide an extra dimension in the learning process.**
  - **Students work together on a problem that is not completely laid out for them.**
  - **In some cases, they have a broad choice in topic selection and, therefore, they acquire a sense of ownership.**
  - **They are required to analyze the problem, do research, if necessary, make decisions, and find results.**
  - **Sometimes they are asked to make recommendations based on their findings. This provides an opportunity for them to interpret their results as it relates to real life.**
  - **They are encouraged to criticize their work and, in some cases, are asked what else they would have done if they had more time or more resources.**
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- **Students often comment that projects helped them to understand better and also to recognize the importance and relevance of the mathematics studied in the course.**
  - **Some report a sense of accomplishment and personal pride.**
  - **Most importantly, they are doing mathematics and that is the best way to learn mathematics!**
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# **Some Topics**

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- **Population models**
  - **Models of social choice**
  - **Economic models**
  - **Models of the epidemiology and the immunology of AIDS**
  - **Simulation models in planning and development**
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# Illustration

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**The struggle for existence among species has been studied for centuries. According to the theory of Charles Darwin, the average number of a species of prey depends on how many of the species are consumed by their predators. In the 1920's and 1930's Vito Volterra and Alfred Lotka, independently reduced Darwin's predator-prey interactions to mathematical models.**

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# Lotka-Volterra Predator-Prey Model

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$$x' = (-a + by)x = -ax + bxy \text{ and}$$

$$y' = (c - dx)y = cy - dxy, \text{ where}$$

$a, b, c, \text{ and } d$  are positive constants and

$x = x(t), y = y(t)$  are populations at time  $t$  of a predator and a prey, respectively.

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# A Specific Case of Volterra's Model

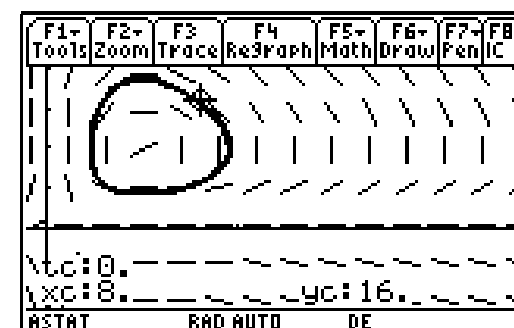
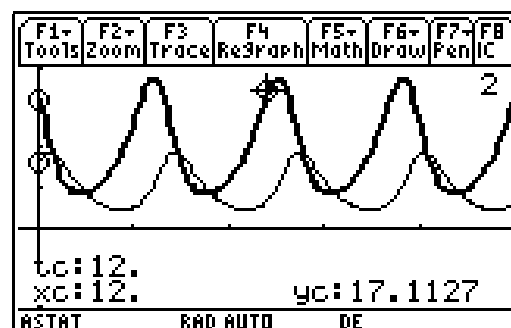
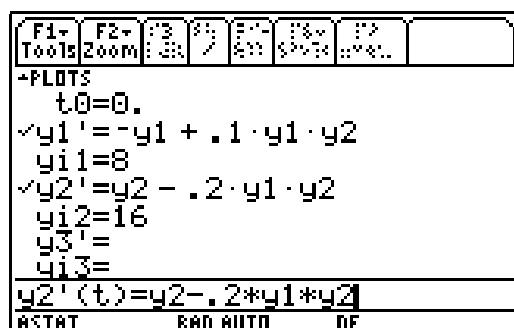
- We choose  $a = 1$ ,  $b = 0.1$ ,  $c = 1$ , and  $d = 0.2$ .
- This predator-prey model is represented by a system of two first order differential equations with constant coefficients:
  - $x' = -x + 0.1 xy$  and
  - $y' = y - 0.2 xy$ , where

$x = x(t)$  represents the amount of selachians (predators) and

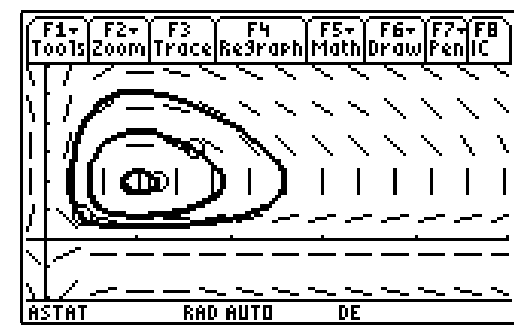
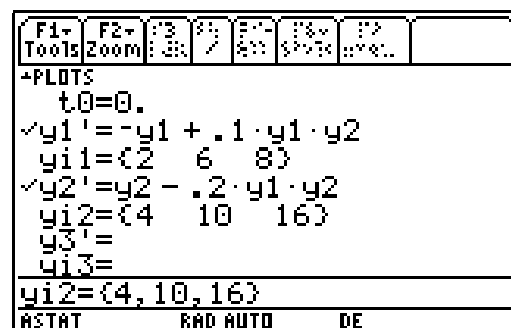
$y = y(t)$  represents the amount of food fish (prey) at time  $t$ .
- Let the initial populations be represented by  $x(0) = 8$  and  $y(0) = 16$ .
- Note: In this setting, it is more realistic to use units of pounds or tons rather than the number of fish i.e. biomass. So “8” might be 8 tons etc.

# The TI-89/Voyage 200

To enter the differential equations in the equation editor of the TI-89 Calculator, the built in variables  $y_1$  and  $y_2$  are used for  $x$  and  $y$ , respectively.



F1-Tools	F2-Setup	F3-Edit	F4-Delete	F5-Insert	F6-Undo	F7-Redo	F8-IC
t	y1	y2					
0.	8.	16.					
.20944	8.8711	13.841					
.41888	9.3904	11.627					
.62832	9.5088	9.6387					
.83776	9.2709	8.0134					
t=0.							
ASTAT	RAD AUTO	DE					



# The Volterra Model With Fishing

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The Volterra model with fishing is

$$x' = -ax + bxy - ex = -(a + e)x + bxy \text{ and}$$

$$y' = cy - dxy - fy = (c - f)y - dxy ,$$

where  $a, b, c, d, e$ , and  $f$  are positive constants.

Here  $e$  is a constant that represents the effect of fishing on the predator and  $f$  represents the effect of fishing on the prey.

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**The Lotka-Volterra model can be employed in a wide variety of different scenarios. One of the points we stress in our teaching of mathematical modelling is this very principle; namely that the same model can be employed in very different settings. A good project is to have the students investigate other applications of the Lotka-Volterra model.**

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# Research

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**There is evidence that appropriate use of technology does help students to learn mathematics better.**

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# Some Studies

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**Results of the achievement study at the University of Connecticut at Storrs indicated that students in the computer-integrated calculus course performed significantly better on the common final exam and suggested that female students in the computer-integrated course benefited more than any other subgroup(Connors ,1995).**

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# West Point Research Project

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- **Purpose:** To investigate the impact of the integration of the TI-89 handheld CAS on student achievement and attitude.
  - **Site:** U.S. Military Academy, West Point, NY
  - **Date:** 1999-2000 Academic Year
  - **Subjects:** Over 900 students in required first year core courses with 20 instructors
  - **Courses:**
    - Discrete Dynamical Systems and Introduction to Calculus
    - Calculus and Differential Equations
  - **Calculator:** TI-89 adopted at USMA commencing Fall Semester 1999 after ten years of using HP models
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# Results - Achievement

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- **Results support assertion that use of a hand-held CAS can enhance teaching and learning to achieve improved procedural, conceptual and application performance.**
  - **Of significance is the achievement on application problems where students must have a grasp of both the concepts and the procedures.**
  - **This study showed no degradation of conceptual or procedural understanding – students performed at or above previous levels. (Connors & Snook, 2001)**
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## Other Reports

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- **Dunham, P., 1998, "What does research tell us about the most commonly used technology in today's mathematics classrooms, the hand-held calculator?", *Standards 2000 and Technology Conference Proceedings*, Reston, VA: NCTM.**
  - **Hurley, J, Koehn, U., and Ganter, S., 1999, "Effects of calculus reform: Local and national", *The American Mathematical Monthly*, 106, 800-811.**
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# Conclusion

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- **Educators need to learn more about the impact of computers and calculators on what and how we teach and learn mathematics.**
  - **It is exciting to anticipate future developments in technology and their impact on mathematics education.**
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# QUESTIONS?

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