Using Model Mysteries in the Classroom

by Rachel Molenaar
Innovation Academy Charter School

Several years ago, I was teaching a new accelerated precalculus class and looking for ways to incorporate systems thinking lessons into the curriculum and build on what the students learned in the previous year. The previous year's teacher suggested I look at *Model Mysteries*, and I was sold immediately. Each lesson introduces a different type of model with engaging topics like zombies and social media contagion. Then, a selection of related "stories" are offered, each of which can be modeled by modifying the basic model for that chapter. For example, the first unit focuses on modeling exponential growth and decay, using a scenario in which zombie chickens from outer space invade the Earth and begin multiplying explosively (literally). The stories include the demise of the dodos, saving money for college, and the growth of the national debt, as well as a "make up your own" prompt.

The lessons in *Model Mysteries* are designed to be used with Stella Online. Each lesson includes a detailed diagram of the basic model that corresponds directly to what students will build in Stella. Once students are familiar with the conventions of these diagrams, they can quickly build the basic model and begin experimenting with different variables and analyzing the results with Stella's graphing tools. The lesson encourages students to play with variables and modify the model to answer provocative questions.

I've used the *Model Mysteries* lessons in my precalculus class every year, and I'd like to share my plans and supporting documents so that other teachers can more easily implement these powerful and entertaining lessons in their own classrooms.

General Plan and Timing

When I first started teaching with *Model Mysteries*, I planned two 80-minute blocks for each lesson. However, I've found that one block is sufficient time for most students to build the basic model and make a good start on their chosen story. However, if your class does not have previous experience with Stella, you should budget extra time to allow students to come up to speed with the application.

I use the first part of each lesson as a learning tool. I give the students paper copies of the lesson, and encourage them to take notes, answer questions, sketch graphs, and take screenshots of their work in Stella. The first year, I collected and graded this work; however, I found that all students were turning in complete and correct work, so I stopped collecting this initial work on the main scenario.

I use the stories at the end of each lesson as an assessment tool. After they have completed the main scenario, each student selects the story that most interests them. The story scenarios require students to do some research as well as make estimates and assumptions about values for different variables. They use this information to modify the basic model from the main scenario to match the scenario in their story and answer related questions. Each student documents their work and writes a short report, which they publish to their digital portfolio.

I've created a one-page "Model Mysteries Directions and Checklist" to guide students as they work through each lesson and write their story reports, as well as a rubric for grading the reports and providing feedback. These documents, as well as links to exemplar reports, are provided at the end of this article.

Tools and Materials

- For the teacher: projector and laptop
- For the class: 10-15 copies of each story
- For each student:
    - laptop (or similar) with internet connection (need full screens and keyboards)
    - Stella account
    - main scenario packet ("Put Together the Pieces" and "Dare to Dig Deeper")
    - Model Mysteries Directions and Checklist
    - Grading Rubric

Teacher Prep Before Lesson:

The best preparation for teaching a *Model Mysteries* lesson is to "play student" and work through the main scenario and all stories. Creating the models and experimenting with variables will build familiarity with Stella, and give the teacher an opportunity to experience and appreciate the pitfalls and common errors. Teachers who are newer to modeling should also review the "Getting Started" chapter, especially the basic building blocks of modeling and the explanation of how instructions are set up.

Student Prep Before Lesson (Optional)

If students are new to Stella and/or modeling, plan on spending 15-20 minutes having each student create their own Stella account and giving them a brief tour of the interface.

Lesson Plan:

Introduction. Distribute packets and ask for a volunteer to read out the scenario description on the cover page. Explain that students will be modeling and exploring this scenario in Stella to better understand this type of model. Describe the type of model in basic terms. (For example, "Growing, Growing, Gone" uses an exponential model. In exponential models, the rate of change is proportional to the amount of stuff present. That means that the more stuff you have, the faster it grows (or decays.)

Outline Plan. Distribute directions and rubrics. Preview the schedule for the lesson, and explain the work expected. Emphasize that students should use the main scenario to develop their understanding of the type of model featured in the lesson, so that they can adapt the model to their story of choice. Draw their attention to the report requirements for the stories, as well as the grading rubric so they are aware of how their work will be evaluated.

Main Scenario. Ask students to log into Stella and begin building the first model as outlined in the packet. Depending on student experience with Stella, you might project the first model from the lesson and walk through the conventions used in *Model Mysteries* as outlined in the "Getting Started" chapter. If necessary, lead the class through building the first model in the packet. Encourage students to help each other and ask for help as needed while working through the packet. Circulate to monitor progress, answer questions, and troubleshoot any problems.

Stories. As students finish the packet, direct them to the selection of stories. Remind them to keep good records while working on the story, so that they can more easily write the report afterwards. Encourage students to search online for real-world data to help them decide on variable values, but also guide them towards using "good enough" numbers. A model need not be perfect to provide valuable insights!

Wrap-up. About 5-10 minutes before the end of class, ask students to find a stopping point for the day. At the board, draw a generic version of the type of model featured in the lesson. For example, see the diagram of a generic exponential model below, with non-specific (yet descriptive) labels for each element. Highlight the feedback loops present in the model, as well as any other unique features.

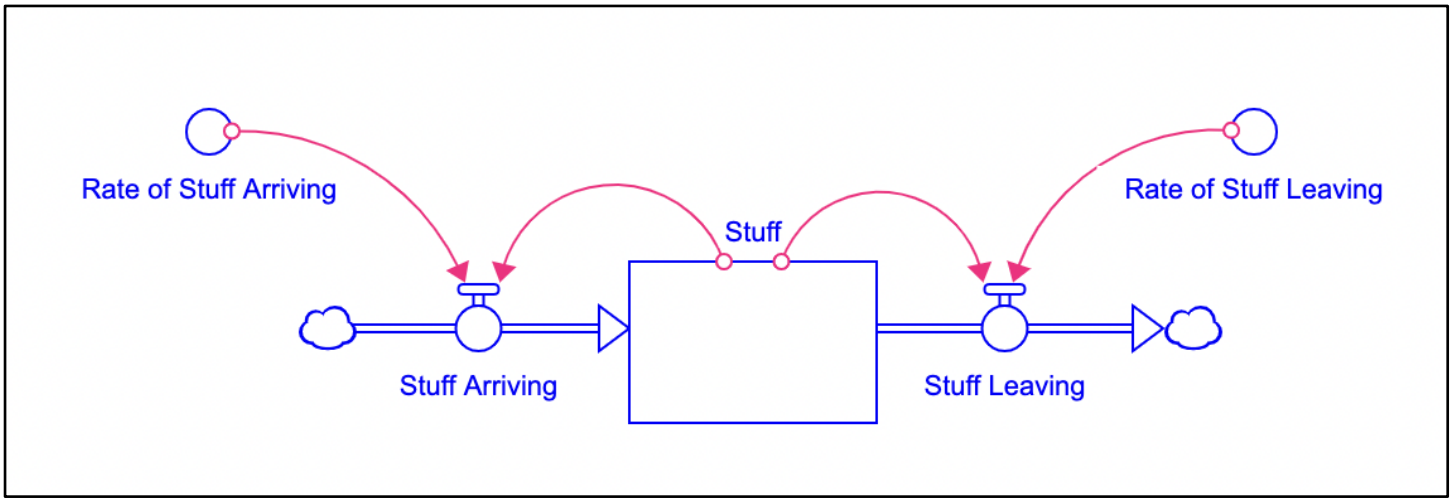

Figure: Generic Exponential Model

Parting Thoughts

Each year as my precalculus students make their way through the lessons in *Model Mysteries*, I am impressed by their perceptiveness and ability to quickly understand and apply each type of model to novel situations. The lessons have complete instructions that students can follow to be successful, but also have open-ended questions that provoke curiosity and ambitious learning.

Exemplar "Story" Reports

Interested in Interest
Dodo Disappearance

Model Mysteries Directions and Checklist

Main Scenario:
Your work on the main scenario is meant to help you learn about a particular type of model. In *Put Together the Pieces*, you will follow the directions to build and explore the basic model. In *Dare to Dig Deeper*, you will follow the directions to develop a better understanding of how this model works and how it might be adapted. You are encouraged to take notes and use the provided packet to further your understanding, but you do not need to turn in your packet.

Stories:
After you have created and experimented with the basic model, you will choose **ONE** of the stories, and follow the directions to apply this model to a new problem. You may need to do research on your story, and make educated estimates for the values of some variables. Make sure to take screenshots of your models and your graphs as you go; it's important to take notes and make sketches, either on paper or in an online document. You will write a succinct but complete report on your adaptations of the basic model to your story. Publish your report in your digital portfolio, and share the link with me.

Report Requirements

Done	Item
	Intro Paragraph: ● Explain, in your own words, the type of problem modeled in this assignment. ● Make sure to say which additional "story" you selected.
	Story Model: ● Explain the story you chose, and how you adapted this model to answer questions. ● Show a picture of your adapted model. ● Explain using words and graphs how your adapted model works. ● Answer questions from your story.
	Reflection Paragraph: ● Reflect on your learning for this assignment. Some questions you might consider: ○ What did you learn about this type of model? ○ What connections did you make to other classes? ○ What questions do you still have?
	Report is Published on Digital Portfolio

Rubric: Model Mysteries

Name: _____ Story: _____

Application: *Student applies learning to real-world, authentic problems beyond the classroom walls.*	**Points Possible**	**Points Earned**
Intro Paragraph	**5**	
Story & Worksheet	**20**	
Reflection Paragraph	**5**	
Self Direction: *Meets deadlines and submits all elements of the task on time.*	**Points Possible**	**Points Earned**
The project is submitted on time Projects will not be accepted after 14 calendar days	**14**	
Work is clear, polished and organized; work is published on DP.	**6**	
Totals		
Total Points for Application Strand	**/30**	
Total Points for Self Direction Strand	**/20**	

Feedback: