Using Phenomena to Drive Student Learning in a Unit of Instruction for Middle School Students

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Figuring out Phenomena

How does phenomena help us support a classroom culture of figuring out for all students?

Anchoring and Investigative Phenomena

We will show how we use an Anchoring Phenomenon to drive learning of a complex idea in a Middle School Unit

We will show how we use Investigative Phenomena to support a culture of "figuring out" - so all students participate in knowledge building while explaining the complex idea

Using the Middle School Storyline Example

We will familiarize ourselves with the Performance Expectations we are building toward in the Middle school Matter and Energy example unit "Fog"

We will examine the anchoring phenomenon in this unit

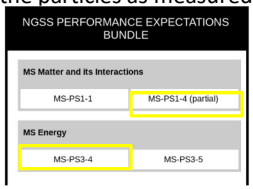
We will figure out the key characteristics that make the anchor and investigative phenomena effective

What do we want students to be able to explain?

The first part of this unit gets students to explain matter and energy:

MS-PS1.4 Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

MS-PS3.4 Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

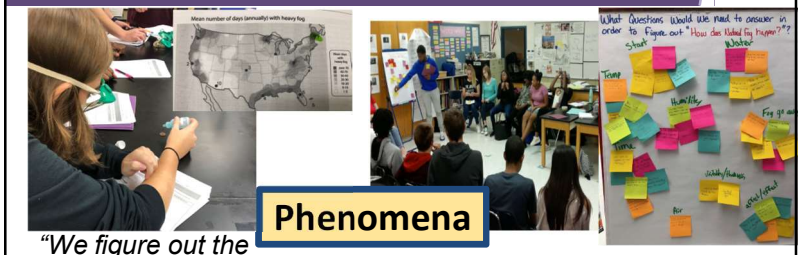


Why is the use of phenomena important to get to these performance expectations?

To explain the phenomena students will use:

Science and Engineering Practices	Disciplinary Core Ideas	Cross Cutting Concepts
Asking Questions and Defining Problems **Developing and Using Models** **Planning and Carrying Out Investigations** **Engaging in Argument from Evidence**	**PS1.A Structure and Properties of Matter** **PS3.A Definitions of Energy** **PS3.B Conservation of Energy and Energy Transfer**	**Energy and Matter** **Cause and Effect** **Scale, Proportion, and Quantity**

Students as partners in knowledge building



Phenomena

"We figure out the science ideas."

"We figure out where we are going each step."

"We put the pieces of the science ideas together over time."

Thinking about the Matter and Energy Storyline and how to employ phenomena

- How can we use an anchoring phenomenon to motivate developing a complex model of matter and energy.
- Can we use student questions to motivate investigations that look at new phenomenon that will be helpful in developing our ideas about matter and energy?
- Can students construct a model of fog step by step by building up from their explanations of their investigations of phenomenon?

Middle School Matter and Energy Unit Target PEs

MS-PS1-1 (partial) Develop models to describe the atomic composition of simple molecules and extended structures.

MS-PS1-4 Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

MS-PS3-4 Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

MS-PS3-5 Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

What key elements are necessary to ensure the anchoring phenomenon can carry the unit?

Students Explore the Anchoring Phenomenon - *What do we notice?*

Students attempt to make sense of the Phenomenon - *How can we explain this? Do our explanations agree?*

Students Identify Related Phenomena - *Where else does something like this happen?*

Develop Questions & Next Steps - *What do we need to figure out?*

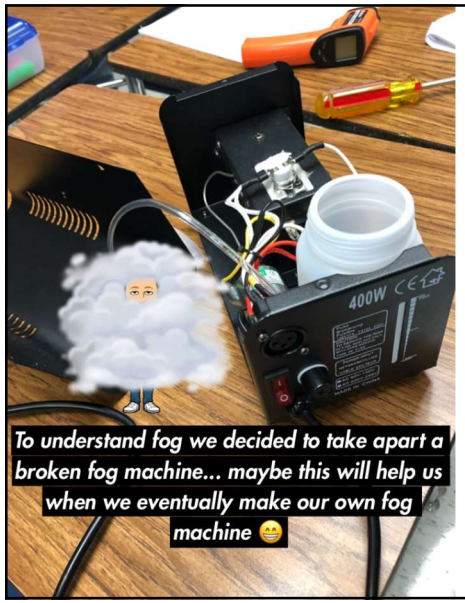
What makes a scene spooky?

The teacher introduces unit by asking a question: What makes a scene spooky?

we watch a bunch of spooky clips and students agree in a spooky scene we need fog… but we're not sure what fog is…

Effective Anchoring Phenomena...

- Are immediately (or progressively) interesting to explore



Students notice that there is a container for liquid...there is some tube that goes to an element that gets hot... students then model how they think it works.

Students explore some information about fog and uncover related phenomena

Students wonder is natural fog made the same way as our broken fog machine?we then watch a series of clips of natural fog in different locations.

Students attempt to explain the phenomenon.

What do our models have in common? How are they different?

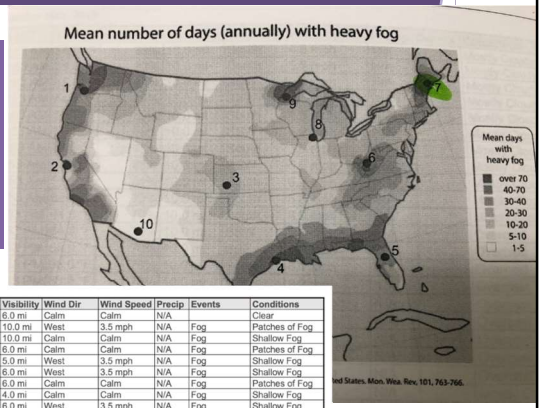
Similarities	Differences
- Particles - Condensation - humidity getting thicker (visibility)	- Some had % - Some called it fog others Water vapor. - Some had the humidifier played in - Keys - Close together & Far apart (particles) - Other particles involved

Effective Anchoring Phenomena...

- Are immediately (or progressively) interesting to explore
- Lead us to wonder
- Generate controversy (competing explanations)

Students explore some information about fog

Students wonder is natural fog found everywhere? Are some places more foggy than others? what is the weather like at these places?



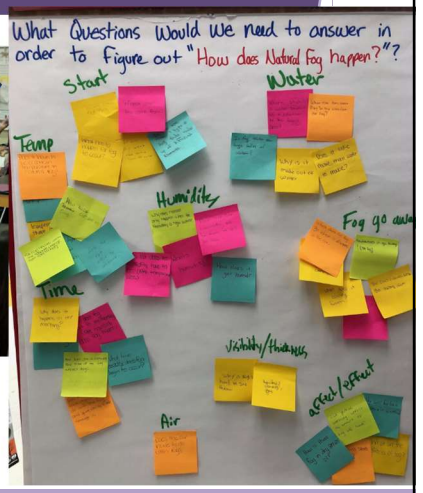
Portland, OR: October 5th, 2013

Time (PDT)	Temp.	Humidity	Visibility	Wind Dir	Wind Speed	Precip	Events	Conditions
12:53 AM	48.9 °F	93%	6.0 mi	Calm	Calm	N/A		Clear
1:53 AM	46.9 °F	97%	10.0 mi	West	3.5 mph	N/A	Fog	Patches of Fog
2:53 AM	46.9 °F	93%	10.0 mi	Calm	Calm	N/A	Fog	Shallow Fog
3:36 AM	44.6 °F	100%	6.0 mi	Calm	Calm	N/A	Fog	Patches of Fog
3:53 AM	45.0 °F	97%	5.0 mi	West	3.5 mph	N/A	Fog	Shallow Fog
4:53 AM	44.1 °F	100%	6.0 mi	West	3.5 mph	N/A	Fog	Shallow Fog
5:53 AM	43.0 °F	100%	6.0 mi	Calm	Calm	N/A	Fog	Patches of Fog
6:22 AM	42.8 °F	100%	4.0 mi	Calm	Calm	N/A	Fog	Shallow Fog
6:36 AM	42.8 °F	100%	6.0 mi	West	3.5 mph	N/A	Fog	Shallow Fog
6:53 AM	41.0 °F	100%	6.0 mi	Calm	Calm	N/A	Fog	Shallow Fog
7:53 AM	45.0 °F	97%	10.0 mi	WNW	4.6 mph	N/A		Scattered Clouds
8:28 AM	46.4 °F	93%	5.0 mi	WNW	4.6 mph	N/A		Mostly Cloudy
8:39 AM	44.6 °F	100%	0.5 mi	WNW	5.8 mph	N/A		Mostly Cloudy
8:41 AM	44.6 °F	100%	0.2 mi	WNW	5.8 mph	N/A		Mist
8:53 AM	46.0 °F	100%	0.2 mi	West	3.5 mph	N/A	Fog	Fog
9:51 AM	48.2 °F	93%	6.0 mi	WNW	5.8 mph	N/A		Scattered Clouds
9:53 AM	48.0 °F	96%	7.0 mi	WNW	4.6 mph	N/A		Scattered Clouds
10:53 AM	53.1 °F	74%	10.0 mi	NW	5.8 mph	N/A		Partly Cloudy

Effective Anchoring Phenomena...

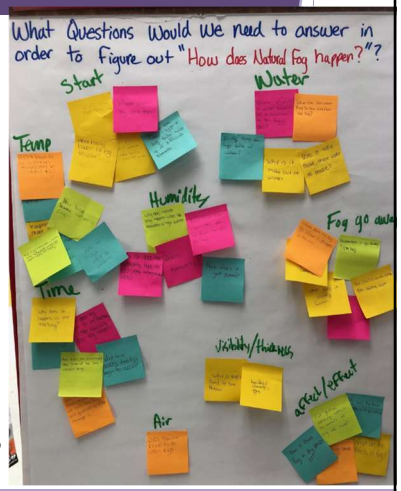
- Are immediately (or progressively) interesting to explore
- Lead us to wonder
- Generate controversy (competing explanations)
- Connect to other experiences that students have had with related phenomena in the world.

Students generate questions



Here are some of the students questions.

- Why is fog so hard to see through?
- Why does fog only happen in the morning or at night?
- Why does natural fog only happen when it is humid outside?
- How does it get humid?
- How does temperature affect fog?
- Where does fog come from?
- Is there more than one type of fog made from different elements?
- What role does water play in the creation of fog?
- Where does fog go when it disappears from the air?
- What does air have to do with fog?



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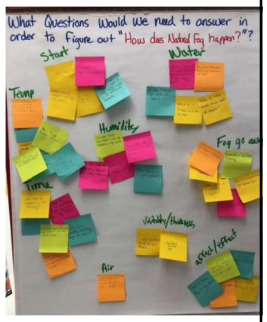
- Generate questions

Students brainstorm ways to investigate their questions

- Watch videos on fog - (to figure out) how it spreads / see how it forms?
- Looking at weather patterns in different areas.
- look at ways to increase humidity.
- talk to a weather experts.
- boil water?
- investigate what happens with fry ice.
- go to the beach/ water sources



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- Connect to other experiences that students have had with related phenomena in the world.
- Generate questions and ideas for investigations

What have we accomplished so far?

Students Explore the Anchoring Phenomenon

What do we notice?

Students attempt to make sense of the Phenomenon

How can we explain this? Do our explanations agree?

Students Identify Related Phenomena

Where else does something similar happen?

Develop Questions & Next Steps

What can we do to figure out how to explain all this?

Effective Anchoring Phenomena...

- Are immediately (or progressively) interesting to explore
- Lead us to wonder
- Generate controversy (competing explanations)
- Connect to other experiences that students have had with related phenomena in the world.
- Generate questions and ideas for investigations
- Becomes our goal to try explain (by some later point in the unit).

In this role we refer to such a phenomena as an anchoring phenomena as it anchors the launch of the unit and is something we will revisit in future lessons.

Anchoring and Investigative Phenomena

We will show how we use an Anchoring Phenomenon to drive learning of a complex idea in a Middle School Unit

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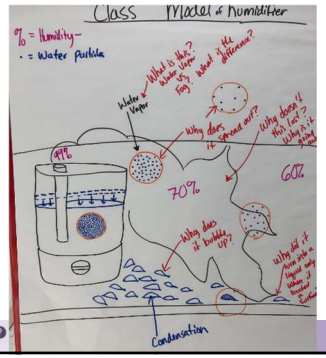
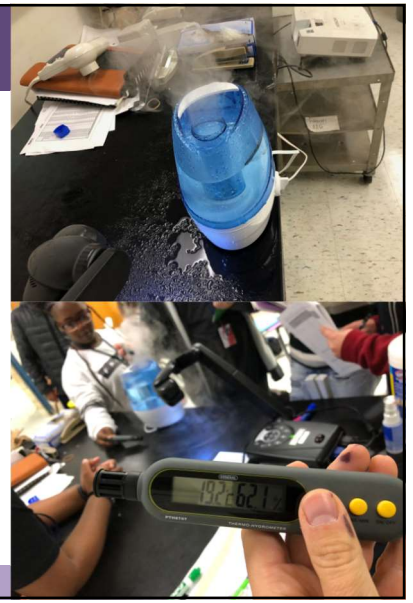
What is humidity? and how do we make air more humid?

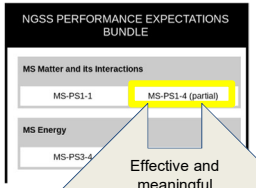




Why are we doing this investigation?

We need to find out more about why humidity is so important in fog?

Teacher's Perspective: Students need to build and use science ideas



Effective and meaningful investigative phenomena

Kids' Perspective: We're trying to see What humidity is and how we can increase it in the air.

MS-PS1.4 Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

Because we're trying to answer our Driving Question **"What role does Humidity play with fog and why does it need to be near 100% for fog to form?"**

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Teacher's Perspective: Students need to build and use science ideas

NGSS PERFORMANCE EXPECTATIONS BUNDLE
MS Matter and its Interactions
MS-PS1-1
MS-PS1-4 (partial)
MS Energy
MS-PS3-4

Effective and meaningful investigative phenomena

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Because we're trying to answer our Driving Question **"What role does Humidity play with fog and why does it need to be near 100% for fog to form?"**

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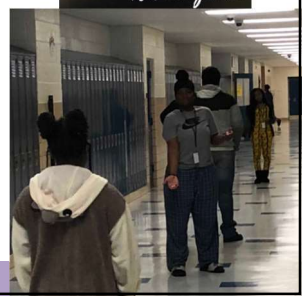
Results of this investigation led to more questions….



Students want to understand why they cans see the humidity when the particles are close to the humidifier but they seem to disappear the further away the particles get.

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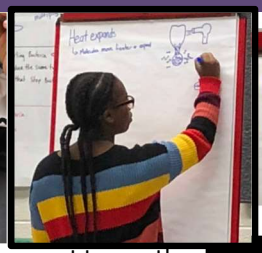
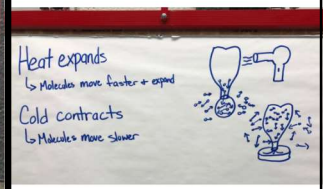
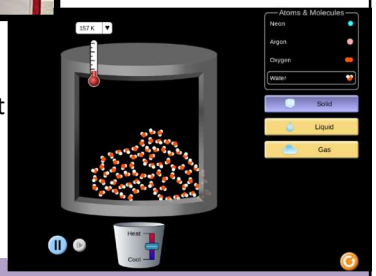
How Do We Push Students to Go Deeper and Revise Their Ideas?







Students decide they want to see the role of temperature in the air. After a lab students in a circle discussion come up with a model to explain what they observed… needing more information they look to zoom in using a computer simulation

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Investigations Can Center On Multiple Phenomena

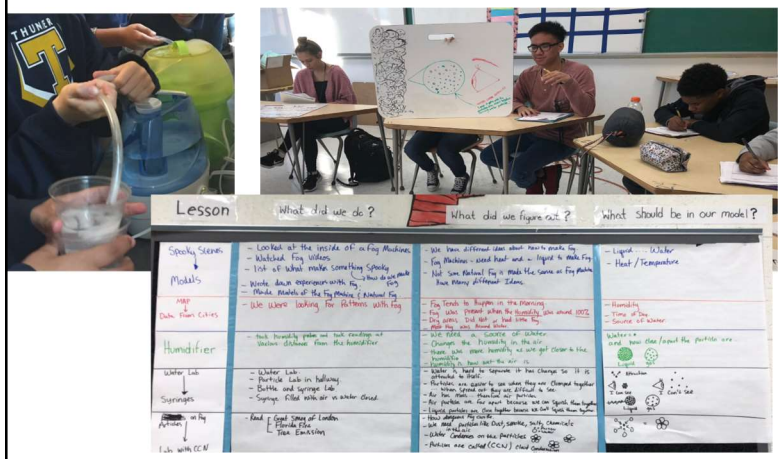
- Throughout the unit, students use multiple investigative phenomena. After the anchoring phenomenon, we use more phenomena to make progress on our questions...which often leads to more questions and more phenomena we need to explore

In this role we refer to such a phenomena as an investigative phenomena as it forms the basis for our investigations.

Effective Phenomena...

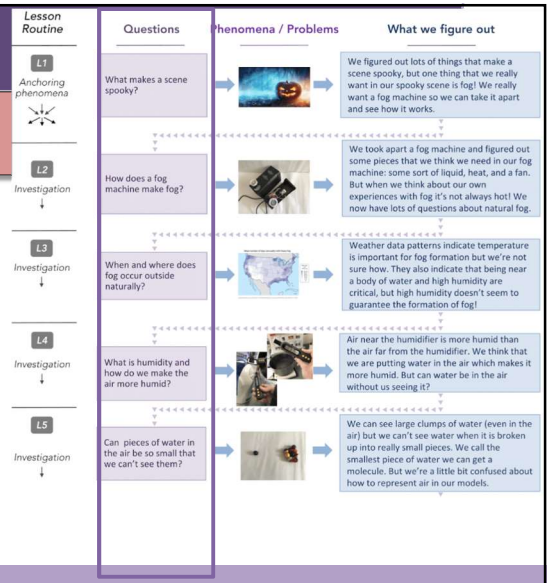
- Are immediately (or progressively) interesting to explore
- Lead us to wonder
- Generate controversy (competing explanations)
- Connect to other experiences that students have had with related phenomena in the world.
- Generate questions and ideas for investigations
- Advance our understanding of the key science ideas at our grade level as we work to explain it
- Become part of the puzzle we have figured out that is going to eventually help us explain other phenomena (e.g. the anchoring phenomenon).

How do students put their ideas together?



Storylines

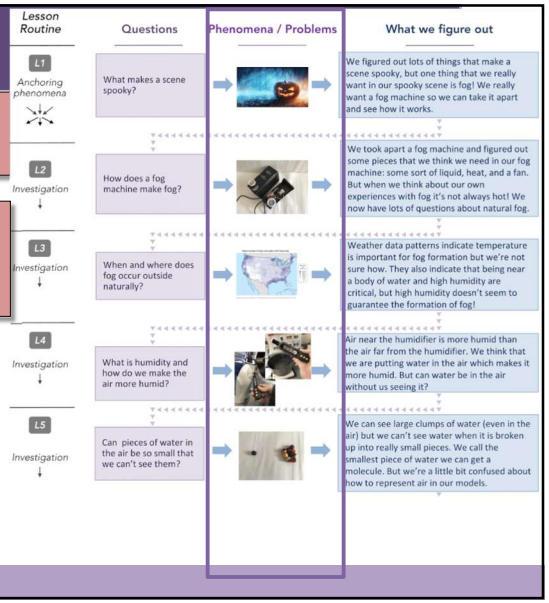
Student questions motivate each lesson



Storylines

Student questions motivate each lesson

Students use practices to make sense of phenomena

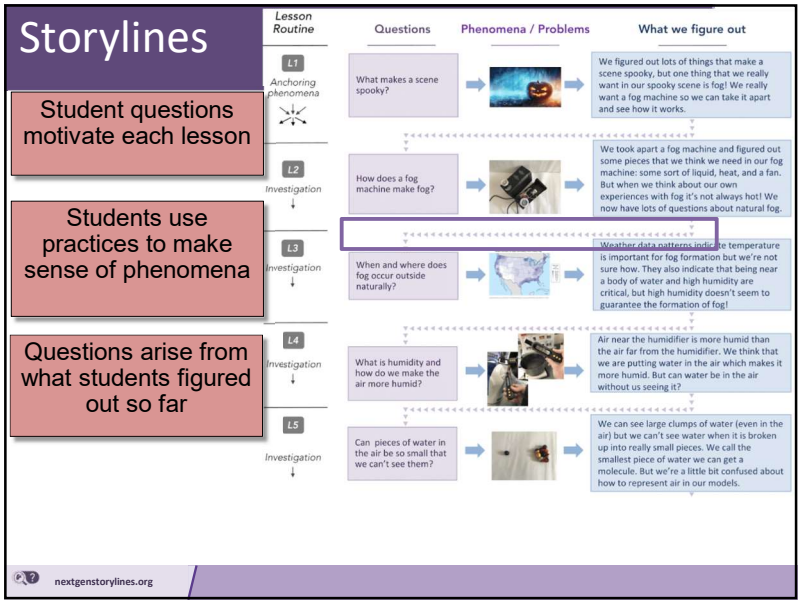


Storylines

Student questions motivate each lesson

Students use practices to make sense of phenomena

Questions arise from what students figured out so far



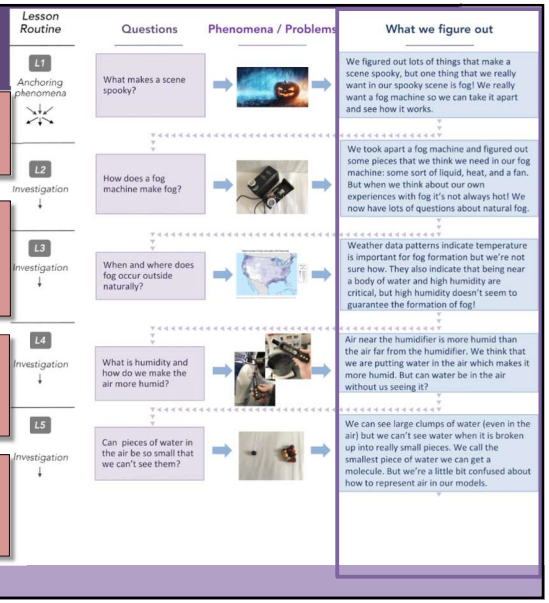
Storylines

Student questions motivate each lesson

Students use practices to make sense of phenomena

Questions arise from what students figured out so far

Students build ideas incrementally over time



Summary

- The teacher and unit design work together to support students in developing questions or identifying problems to solve about the phenomenon
- ***Students'*** questions and problems become the motivation for each investigation or design challenge
- Students put their ideas together across lessons to make sense of phenomena and solve the problem.

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The examples we showed are open source materials developed by teams of teachers and are freely available, along with supporting teacher guides and lesson plans to try out. There are other K-12 examples available at this site too, and more are coming soon.

Questions?

Download this unit and other open-source storylines: http://www.nextgenstorylines.org

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