Visual Activities for Assessing Non-science Majors' Understanding in Intro Astronomy

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What is a Visual Activity?

A conceptual exercise that couples …

Conceptually rich questions.

Interactive tools -

- Simulations
- Figures
- Photos

The union enhances formative & summative assessment.

See for example …
Cox, A.J., Belloni, M., Dancy, M., & Christian, W. 2003. "Teaching thermodynamics with Physlets in introductory physics," Physics Education, **38**(5)

What is a Visual Activity?

A conceptual exercise that couples …

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Interactive tools -

- Simulations
- Figures
- Photos

Paired with feedback & hints served from a database, VA's present interesting opportunities for self-paced activities - e.g. homework.

Multiple Platforms are Available

This talk's examples are on Mastering-Astronomy

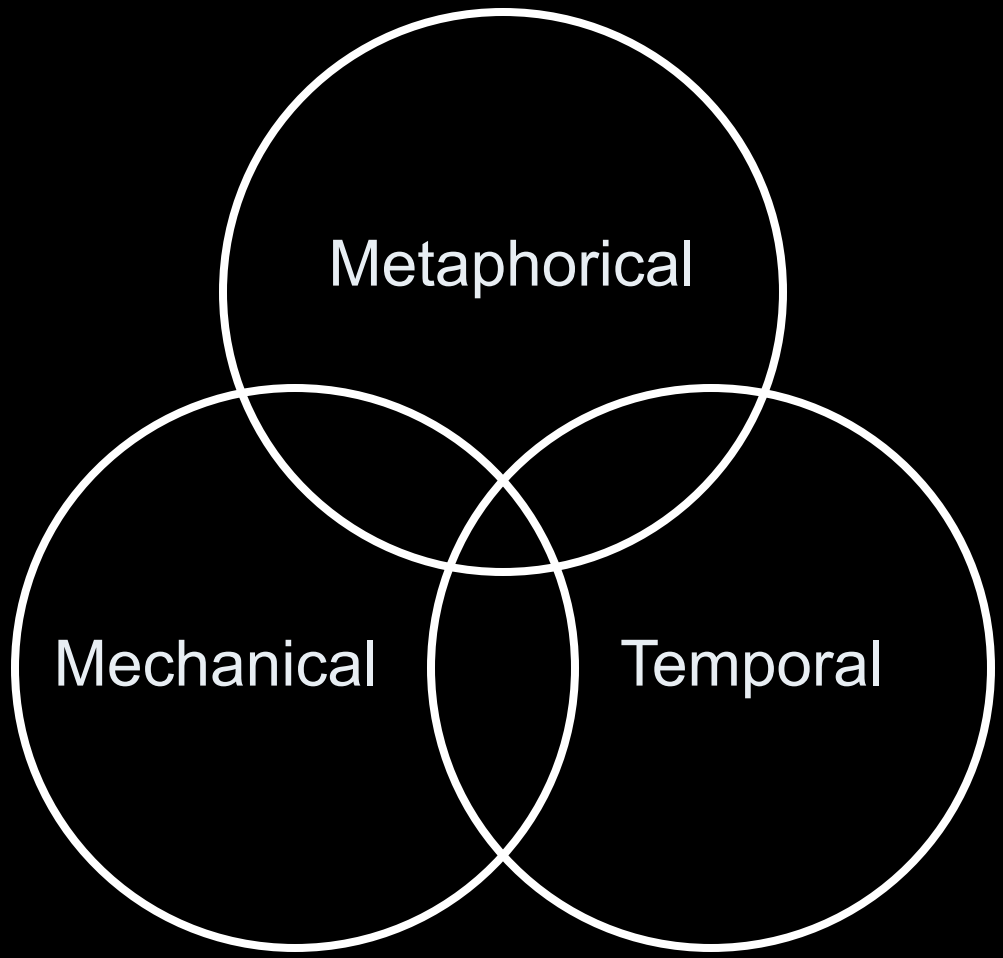
Question Branches

- MOODLE
- LON-CAPA

Interactive Figures

- Flash
- JAVA & JavaScript

Overlapping Genres of Interactive Tools

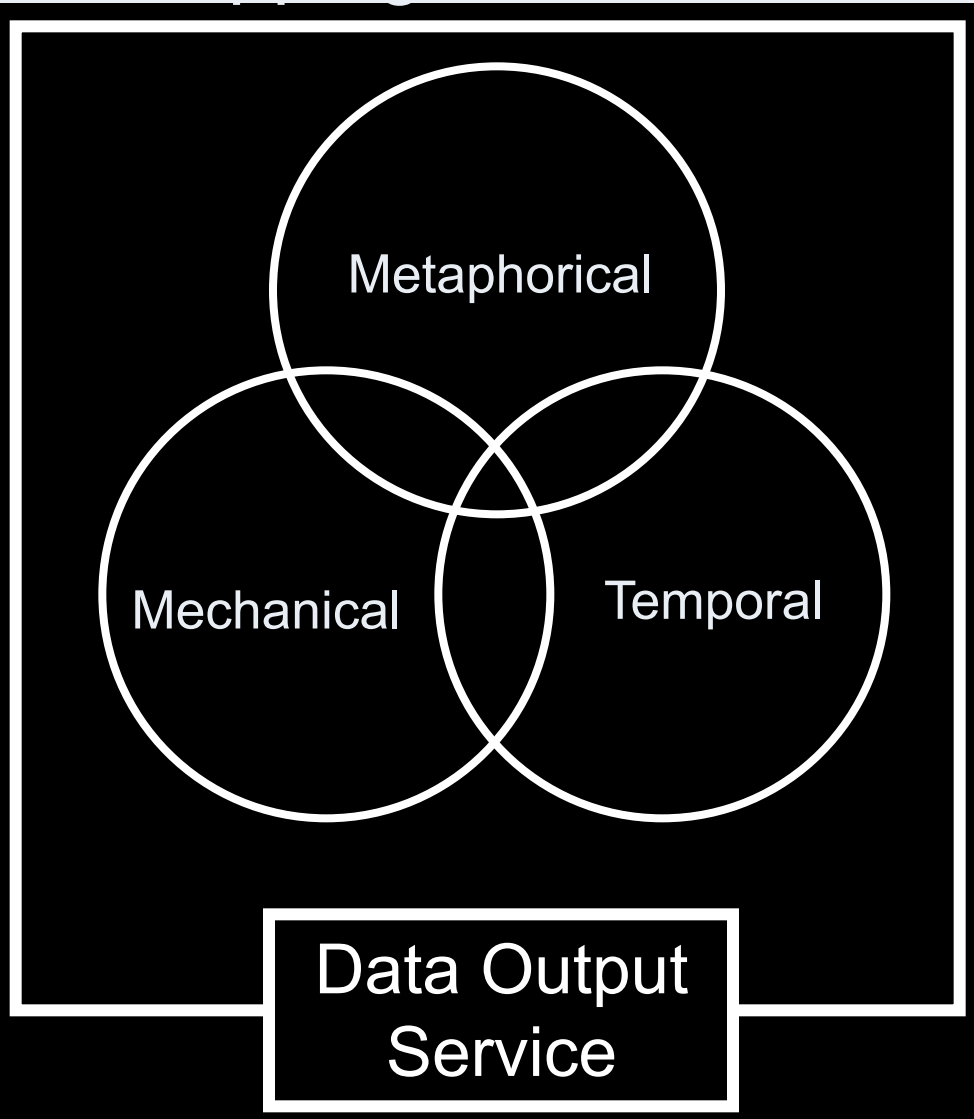


Metaphorical - tells a story.

Mechanical - exposes a mechanism.

Temporal - displays evolution in time.

Overlapping Genres of Interactive Tools



Data Output can be …
- Automated
- Student gathered

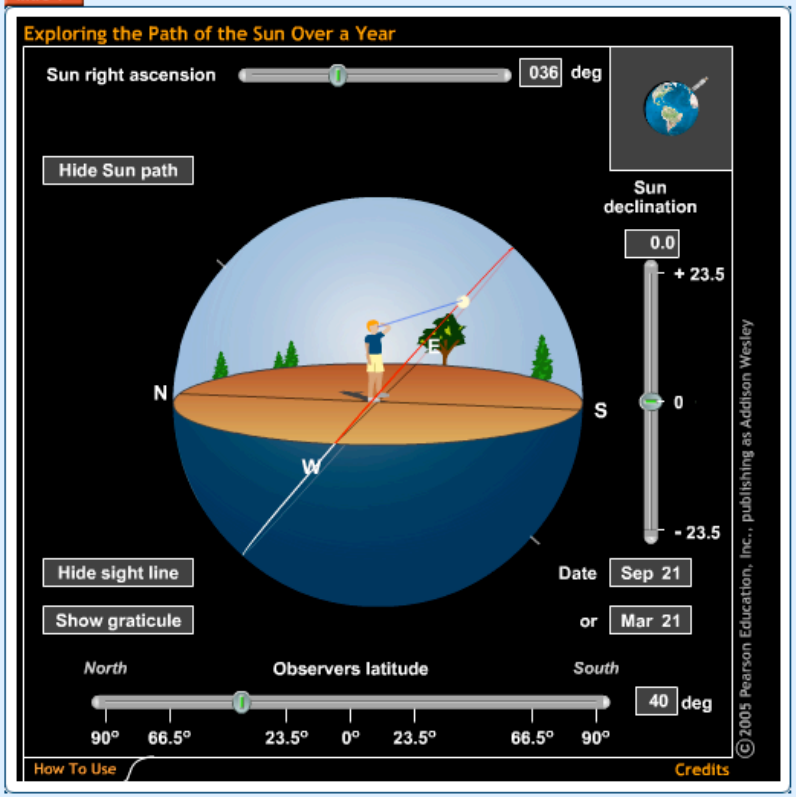
Example data …
- mass
- position
- elapsed time

Examples: *Mechanical*

STP | Visual Activity Exploring the Path of the Sun Over a Year | Difficulty: 1 | Time: 6m | Action: (select action)

Visual Activity Exploring the Path of the Sun Over a Year — Daniel Loranz

Intro 1



Part A

Explore the interactive figure thoroughly before answering the questions. Be sure to note that strictly for exploration purposes, the figure allows you to separately adjust both the Sun's right ascension (RA) and declination (dec), when in fact these are not independent of each other.

Due to Earth's rotation, the Sun appears to trace out a complete circle centered on Earth every 24 hours. Imagine viewing the sky from somewhere north of 66.5 degrees north latitude (the Arctic Circle) during the summer solstice (June 21). How much of the Sun's apparent path through the sky would you observe during one 24-hour period?

- ◯ less than half the circular path of the Sun
- ◯ exactly half the circular path of the Sun
- ◯ more than half (but not all) the circular path of the Sun
- ◯ the whole circular path of the Sun

submit | hints | my answers | give up | review part

Part B

If viewing the sky from anywhere on the equator, how much of the Sun's apparent path through the sky would you observe during one 24-hour period?

- ◯ During the summer months you would observe more than half the circular path of the Sun.
- ◯ During the winter months you would observe less than half the circular path of the Sun.
- ◯ You would observe exactly half the circular path of the Sun – but only on each equinox.
- ◯ You would observe exactly half the circular path of the Sun any day of the year.

submit | hints | my answers | give up | review part

Part C

Consider the following statements about the Sun's maximum altitude as seen at different locations on different days of the year.

1. If located somewhere in the northern hemisphere, you will see the Sun reach a higher altitude in your sky on June 21 than on December 21.
2. Regardless of your location on Earth, the Sun passes directly overhead every day at local noon.
3. If located anywhere on the equator, the Sun will pass directly over your head every day at local noon.
4. If located anywhere on the equator, you will see the Sun reach a higher point in the sky on June 21 than on March 21.

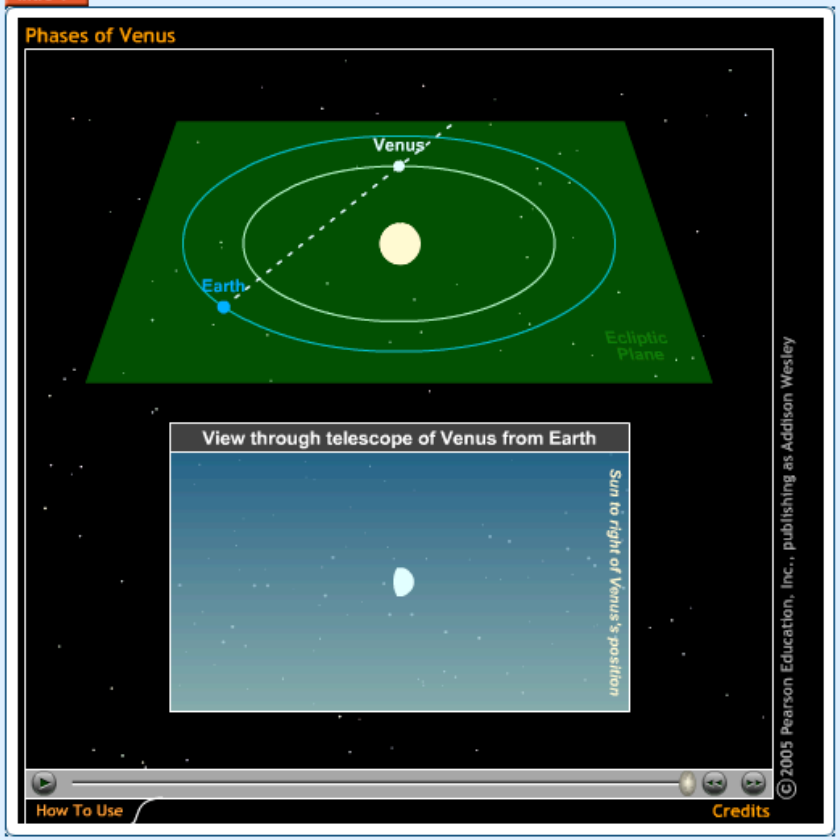
Which are true?

Examples: *Mechanical*

STP | Visual Activity: Phases of Venus | Difficulty: 1 | Time: 9m | Action: (select action)

Visual Activity: Phases of Venus

Intro 1



Part B

In the Earth-centered model of the solar system, Venus never appears opposite the Sun in our sky, and the distance between Venus and Earth does not change very much. Given that the Sun (and not Earth) is really at the center of our solar system, which of the following statements is true?

- Venus never appears opposite the Sun in our sky, and the distance between Venus and Earth does not change very much.
- Venus never appears opposite the Sun in our sky, but the distance between Venus and Earth changes dramatically.
- Venus and the Sun sometimes appear opposite each other in our sky, but the distance between Venus and Earth does not change very much.
- Venus and the Sun sometimes appear opposite each other in our sky, and the distance between Venus and Earth changes dramatically.

submit | hints | my answers | give up | review part

Part C

When would a new Venus be high in the sky?

- noon
- sunset
- midnight
- sunrise

submit | hints | my answers | give up | review part

Part D

Which phase of Venus would you expect to see high in the sky at midnight?

- waxing gibbous
- waning crescent
- full
- No phase is visible since Venus is *never* high in the sky at midnight.

submit | hints | my answers | give up | review part

Part E

Knowing that Venus always appears relatively near the Sun in our sky, which phases of Venus can only occur because Venus and Earth both orbit the Sun?

- new Venus phase
- crescent Venus phases
- gibbous (nearly but not quite full) Venus phases

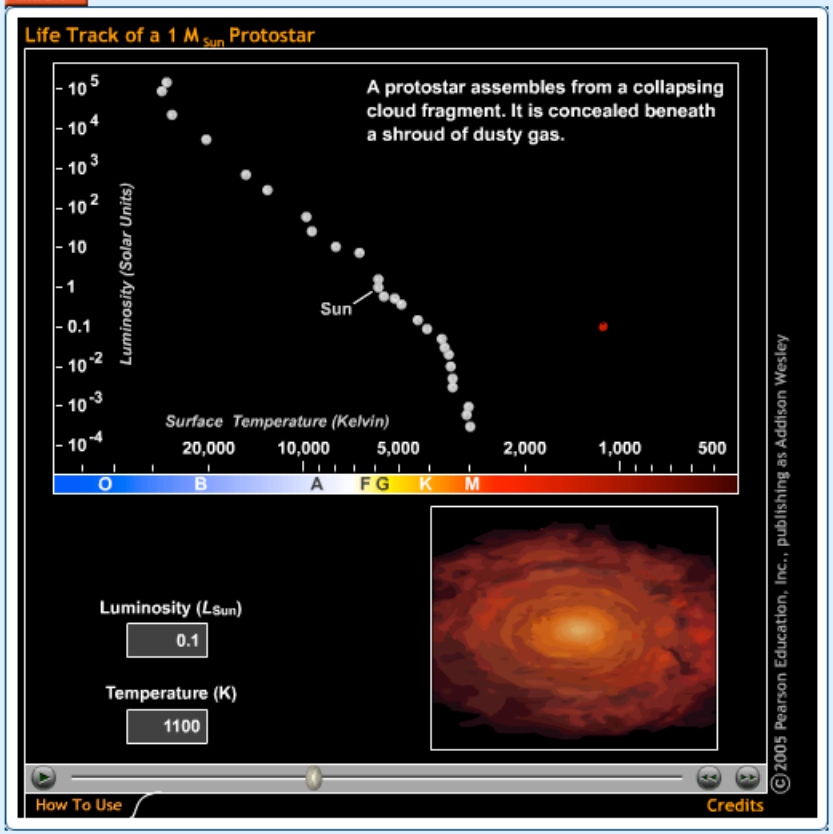
submit | hints | my answers | give up | review part

Examples: *Temporal*

STP | Visual Activity: The Life Track of a One-Solar-Mass Protostar | Difficulty: 1 | Time: 5m | Action: (select action)

Visual Activity: The Life Track of a One-Solar-Mass Protostar

Intro 1



Explore the interactive figure before beginning to answer the questions.

Part A

As a clump of interstellar gas contracts to become a main-sequence star, its changing position on the H-R diagram tells us _____.

- how it moves through the galaxy
- the time during which it existed in the history of the universe
- how its outward appearance is changing

submit | hints | my answers | give up | review part

Part B

How does the protostar change during the period of time just after losing its surrounding gas cloud (as it begins the final stages of becoming a main-sequence star)?

- Its surface temperature and luminosity both increase.
- Its surface temperature increases, but its luminosity decreases.
- Its surface temperature and luminosity both decrease.
- Its surface temperature decreases, but its luminosity increases.

submit | hints | my answers | give up | review part

Part C

When does a newly forming star have the greatest luminosity?

- when its surface temperature is the highest
- right when it first becomes a main-sequence star
- sometime during its protostar stage
- when its internal temperature is highest

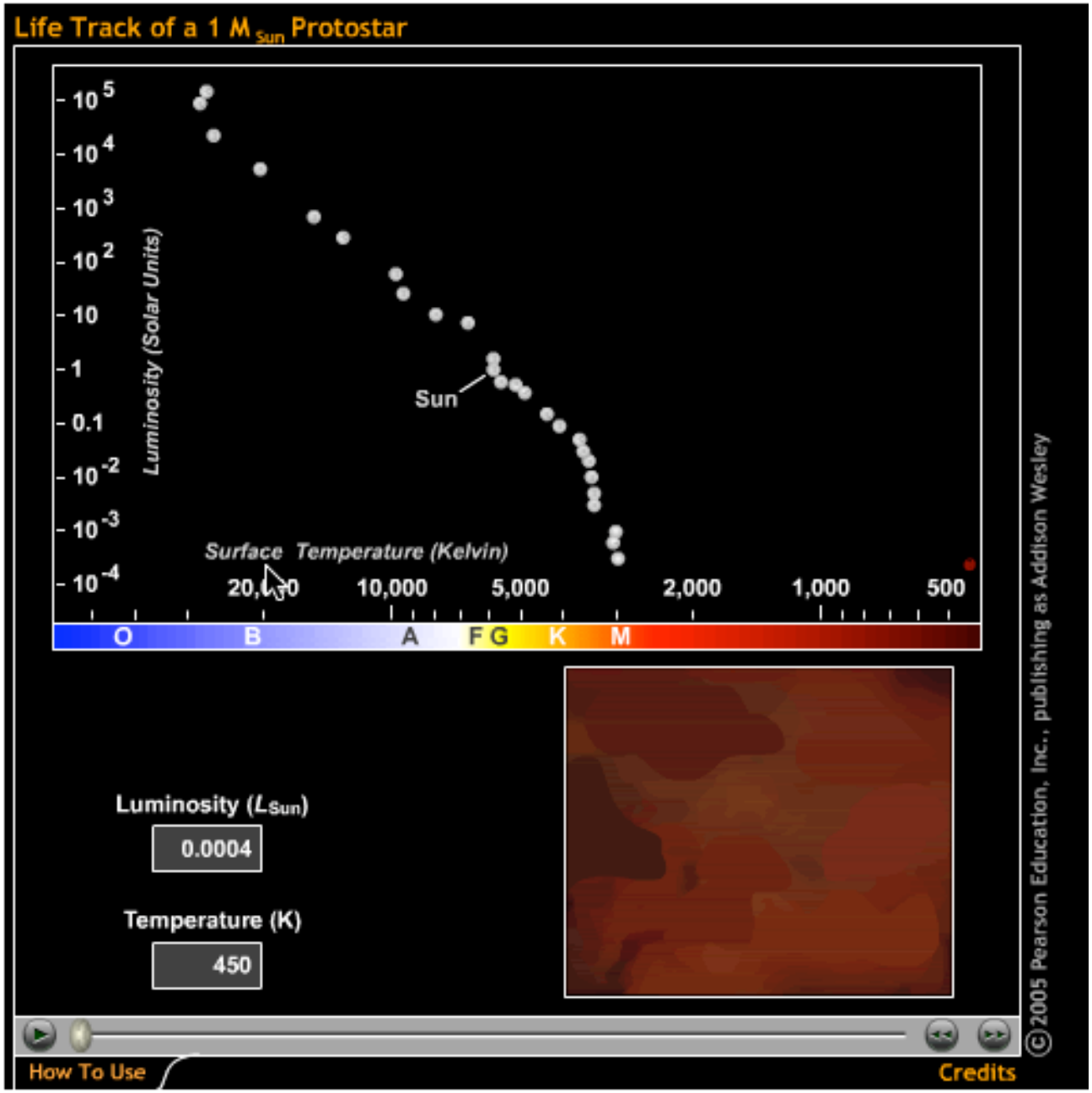
submit | hints | my answers | give up | review part

Part D

When a newly forming star is at its greatest luminosity, what is its energy source?

- gravitational contraction
- nuclear fusion of hydrogen into helium
- radioactive decay of unstable isotopes
- A newly forming star has no energy source, since it does not shine at all until it becomes a true main-sequence star.

submit | hints | my answers | give up | review part


Life Track of a 1 M Sun Protostar
10 5
10 4
10 3
10 2
10
1
0.1
10 -2
10 -3
10 -4
Luminosity (Solar Units)
Sun
Surface Temperature (Kelvin)
20,000
10,000
5,000
2,000
1,000
500
O
B
A
F G
K
M
Luminosity (L Sun)
0.0004
Temperature (K)
450
How To Use
Credits
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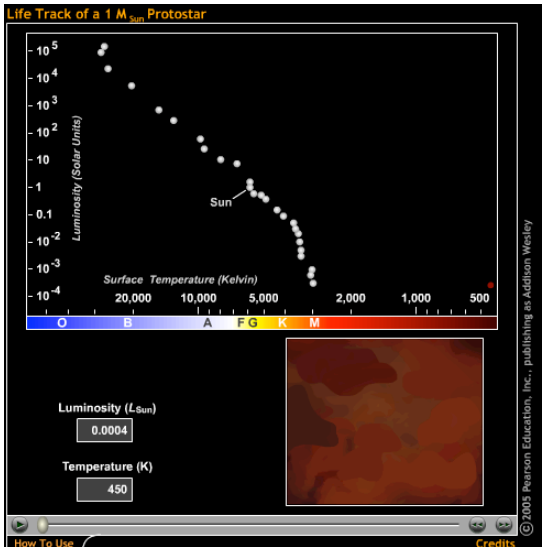
Life Track of a 1 M_{Sun} Protostar
Luminosity (Solar Units)
Surface Temperature (Kelvin)
20,000 10,000 5,000 2,000 1,000 500
O B A F G K M
Sun
Luminosity (L_{Sun})
0.0004
Temperature (K)
450
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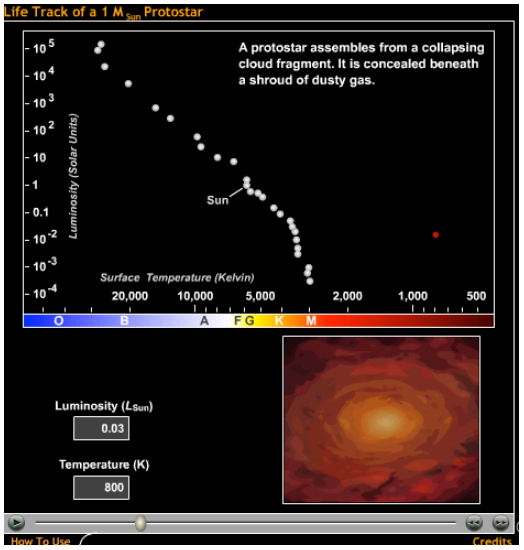
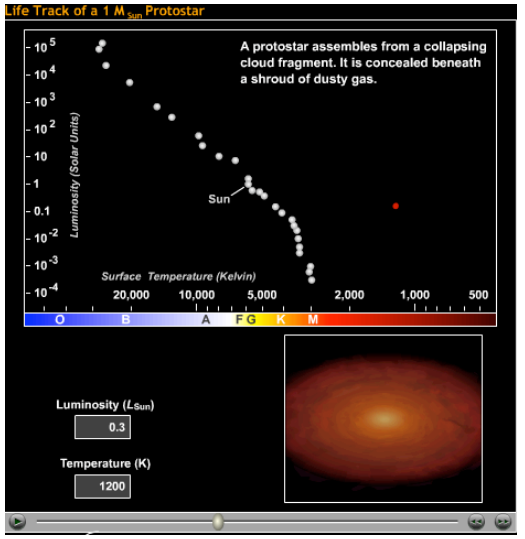
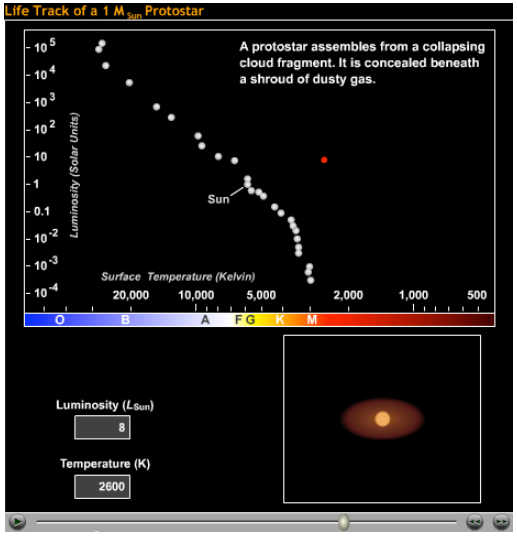
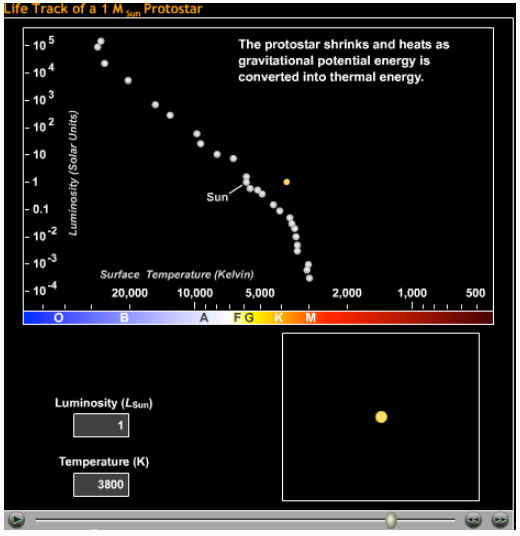
How To Use
Credits


Life Track of a 1 M_{Sun} Protostar
A protostar assembles from a collapsing cloud fragment. It is concealed beneath a shroud of dusty gas.
Luminosity (Solar Units)
Surface Temperature (Kelvin)
20,000 10,000 5,000 2,000 1,000 500
O B A F G K M
Sun
Luminosity (L_{Sun})
0.03
Temperature (K)
800
How To Use
Credits


Life Track of a 1 M_{Sun} Protostar
A protostar assembles from a collapsing cloud fragment. It is concealed beneath a shroud of dusty gas.
Luminosity (Solar Units)
Surface Temperature (Kelvin)
20,000 10,000 5,000 2,000 1,000 500
O B A F G K M
Sun
Luminosity (L_{Sun})
0.3
Temperature (K)
1200


Life Track of a 1 M_{Sun} Protostar
A protostar assembles from a collapsing cloud fragment. It is concealed beneath a shroud of dusty gas.
Luminosity (Solar Units)
Surface Temperature (Kelvin)
20,000 10,000 5,000 2,000 1,000 500
O B A F G K M
Sun
Luminosity (L_{Sun})
8
Temperature (K)
2600

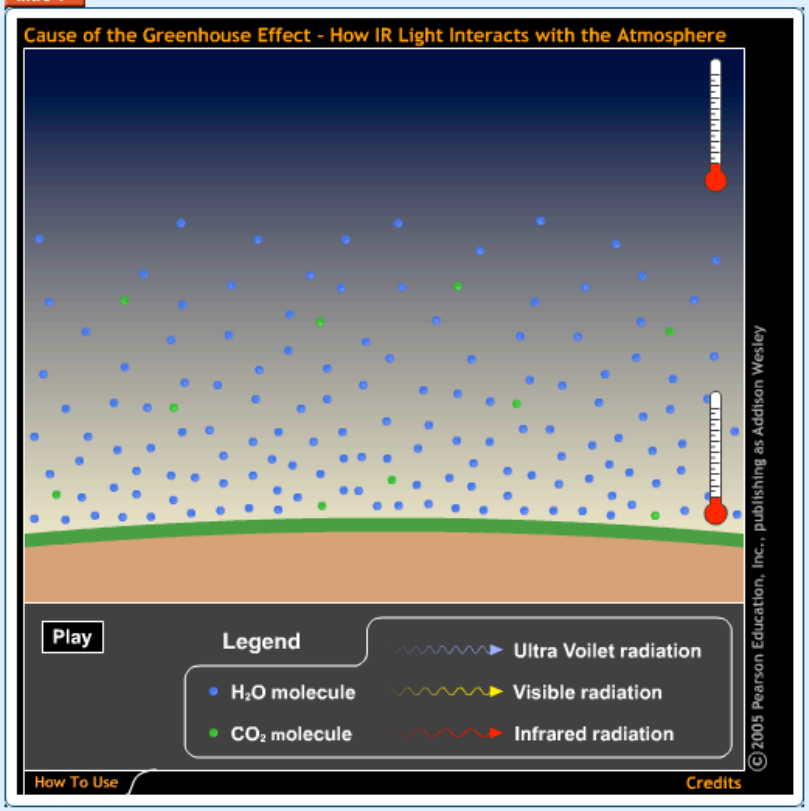

Life Track of a 1 M_{Sun} Protostar
The protostar shrinks and heats as gravitational potential energy is converted into thermal energy.
Luminosity (Solar Units)
Surface Temperature (Kelvin)
20,000 10,000 5,000 2,000 1,000 500
O B A F G K M
Sun
Luminosity (L_{Sun})
1
Temperature (K)
3800

Examples: *Metaphorical*

STP | Visual Activity: Exploring the Cause of the Greenhouse Effect | Difficulty: 1 | Time: 4m | Action: (select action)

Visual Activity: Exploring the Cause of the Greenhouse Effect — Daniel Loranz

Intro 1



Explore the interactive figure before answering the questions. Note that, in the interactive figure, while Earth's surface is changing temperature the surface thermometer flashes. You will be able to change the atmospheric composition and the cloud cover only after the thermometer has stopped flashing.

Part A

On a cloudless day, what happens to most of the visible light headed toward Earth?

- It is reflected by Earth's atmosphere.
- It is absorbed and reemitted by gases in Earth's atmosphere.
- It is completely reflected by Earth's surface.
- It reaches Earth's surface and is either scattered or absorbed and its energy gets reradiated as infrared light.

submit | hints | my answers | give up | review part

Part B

On a day with complete cloud cover, what happens to much of the visible light headed toward Earth?

- It is scattered by the clouds in Earth's atmosphere.
- It is absorbed by the clouds in Earth's atmosphere and reemitted as infrared radiation.
- It passes directly through the clouds in Earth's atmosphere.

submit | hints | my answers | give up | review part

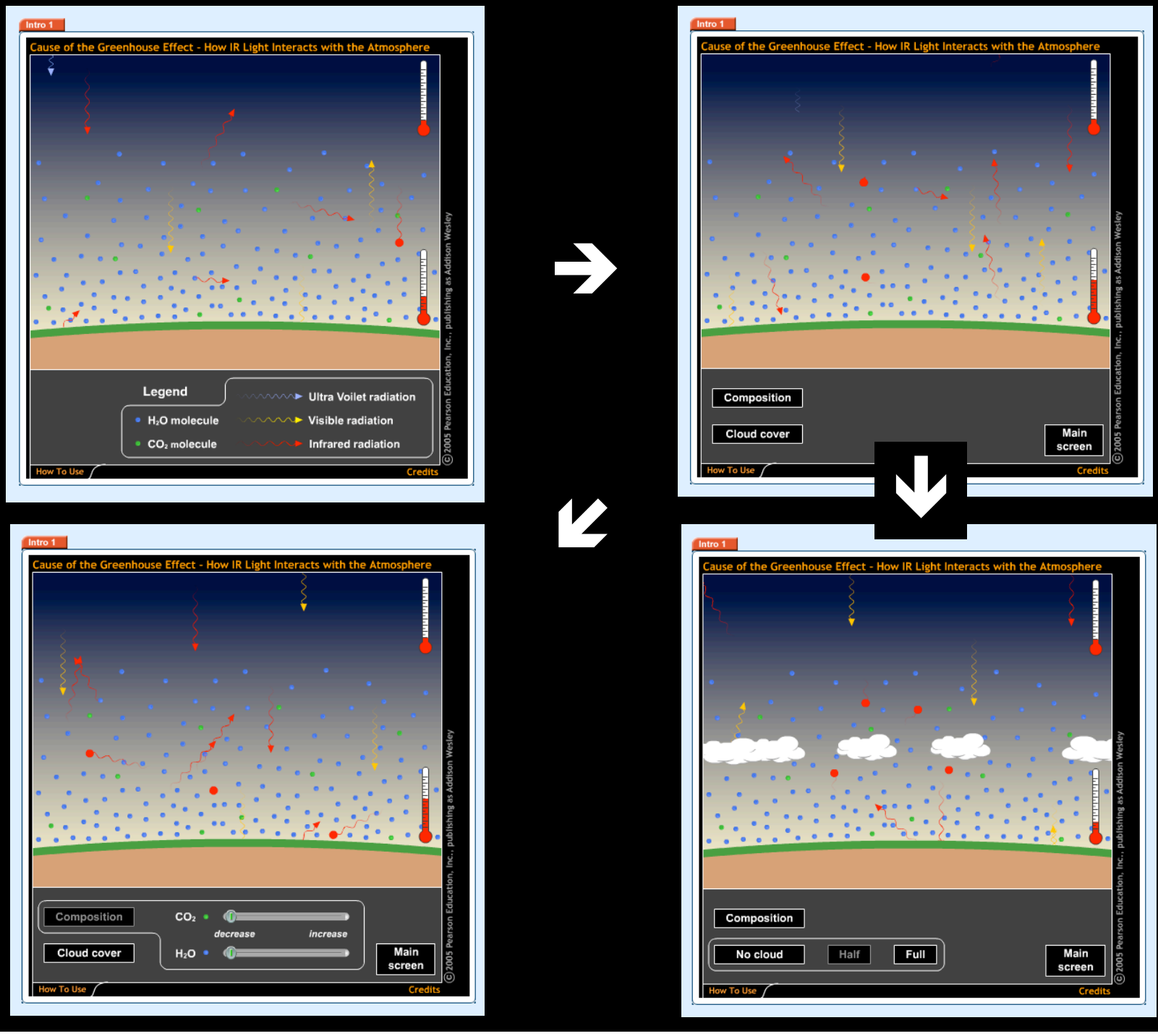
Part C

The greenhouse effect causes Earth's surface temperature to be higher because the infrared light radiated by Earth's surface _____.

- travels directly out to space
- becomes permanently trapped by greenhouse gases
- is temporarily absorbed by greenhouse gases and then reemitted as infrared light
- is temporarily absorbed by greenhouse gases and then reemitted as UV light

submit | hints | my answers | give up | review part

submit problem


Intro 1
Cause of the Greenhouse Effect - How IR Light Interacts with the Atmosphere
Legend
Ultra Voilet radiation
H_2O molecule
Visible radiation
CO_2 molecule
Infrared radiation
How To Use
Credits
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Intro 1
Cause of the Greenhouse Effect - How IR Light Interacts with the Atmosphere
Composition
Cloud cover
Main screen
How To Use
Credits
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Intro 1
Cause of the Greenhouse Effect - How IR Light Interacts with the Atmosphere
Composition
Cloud cover
CO_2
decrease
increase
H_2O
Main screen
How To Use
Credits
©2005 Pearson Education, Inc., publishing as Addison Wesley
Intro 1
Cause of the Greenhouse Effect - How IR Light Interacts with the Atmosphere
Composition
No cloud
Half
Full
Main screen
How To Use
Credits
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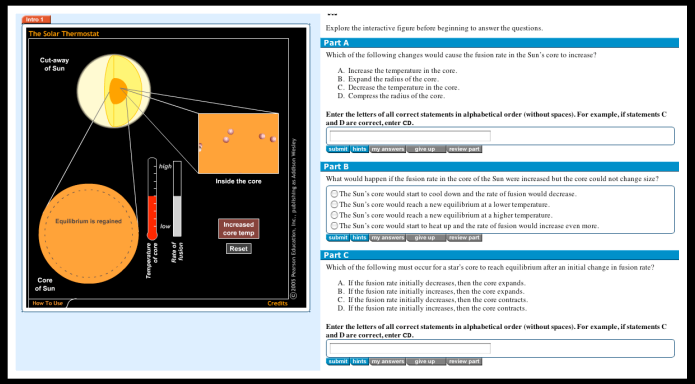
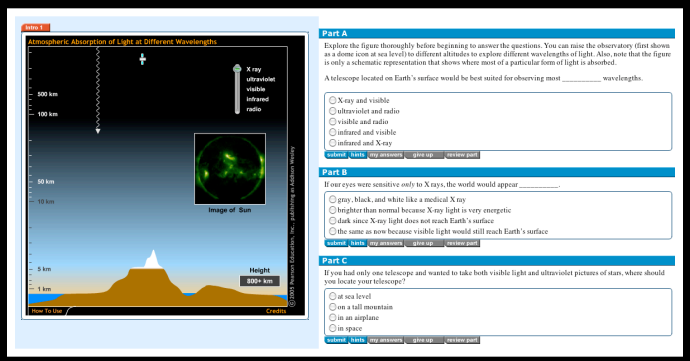
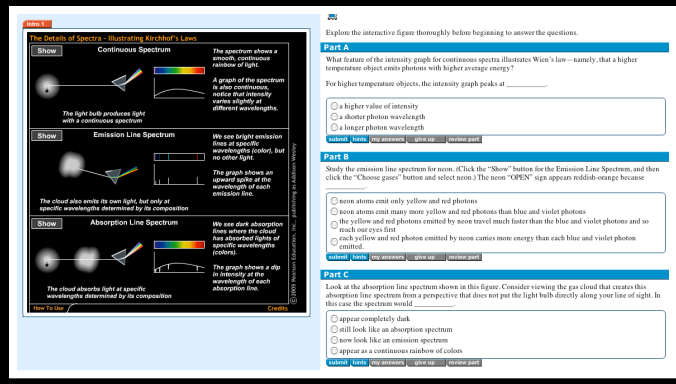
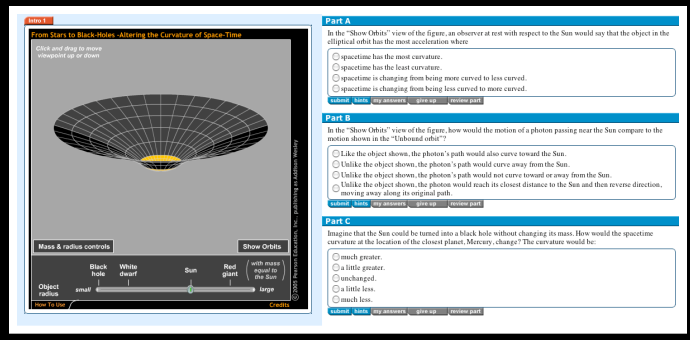
Current Status

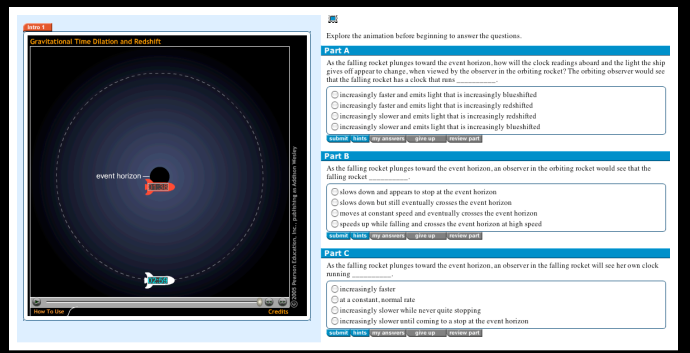
1. 28 VA's sampling full range of Intro-Astro
2. Initial student response data



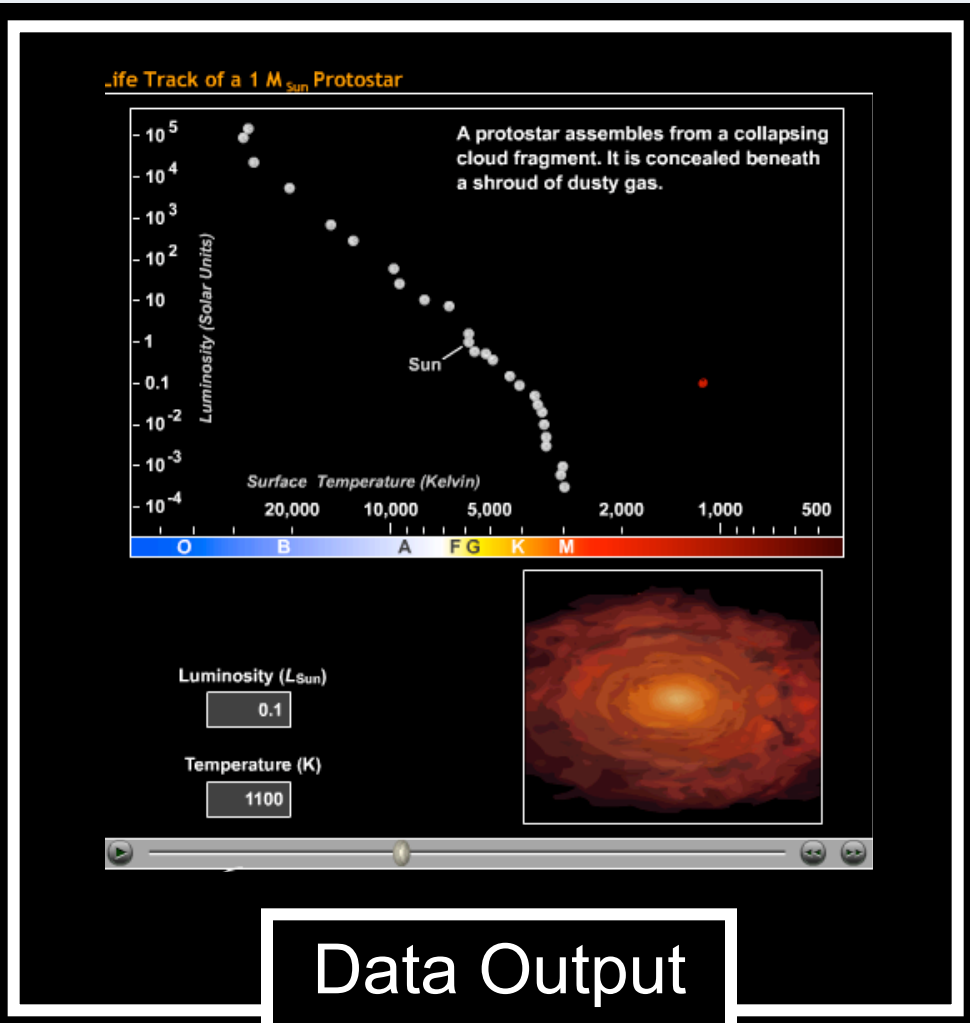








Student Pitfalls with Interactive Tools



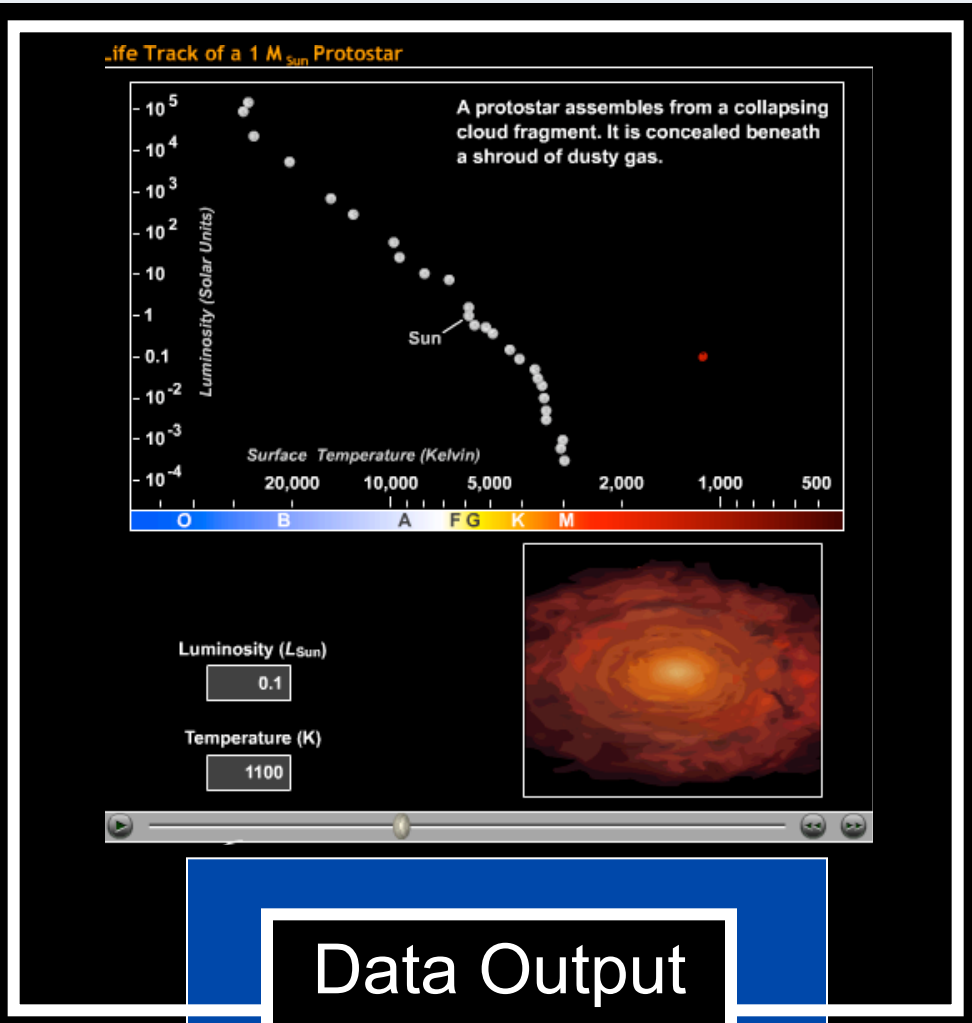
Data Output Service

Students implicitly trust "truth" of the interactive tool!

No concern for developer …

- Deceit
- Error in understanding
- Error in implementation.

Student Pitfalls with Interactive Tools

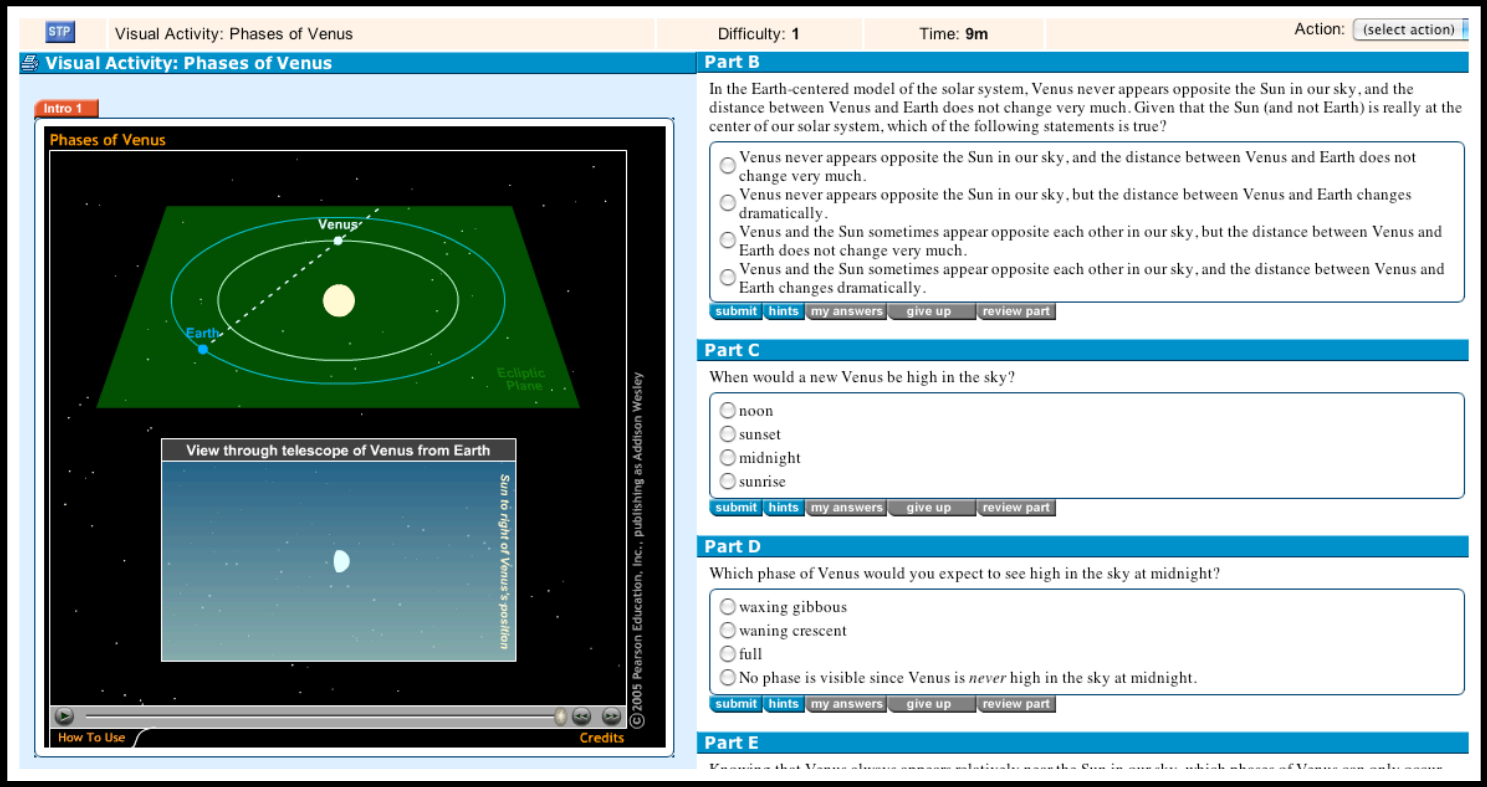


Data Output Service

By comparison …

Students readily point out discrepancies between numerical output and their expectations as computer error!

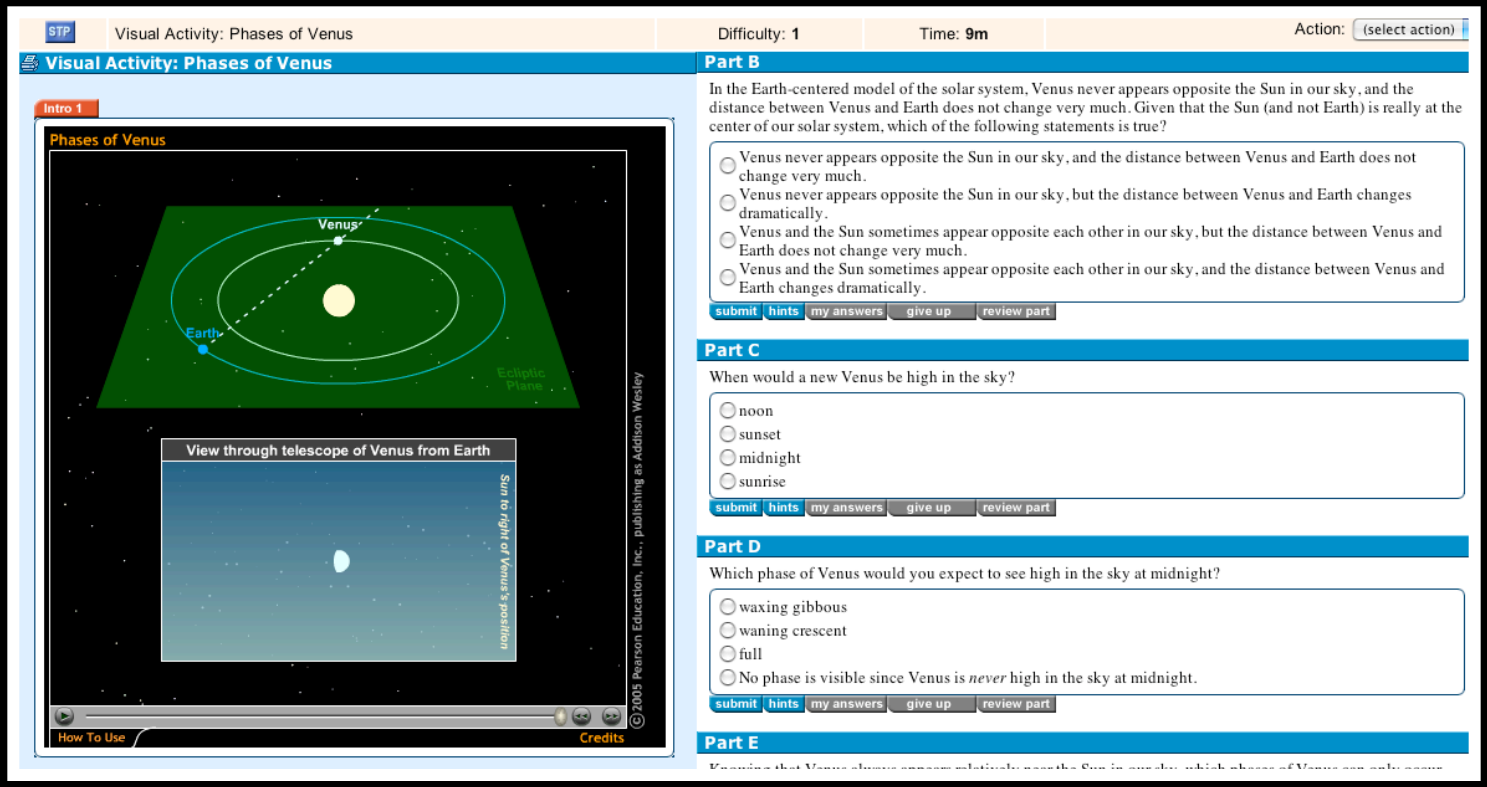
Student Difficulties with Visual Activities



Avoidance of the Interactive Tool

Opportunity for "learning to learn"?

Student Difficulties with Visual Activities



Accustomed to no-cost/low-cost penalties for incorrect answers

Visual Activities for Assessing Non-science Majors' Understanding in Intro Astronomy

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