Smartphone Simulations for the Introductory Astronomy Classroom

University of Nebraska Lincoln

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Project Details:

Development and Research on Engaging Smartphone Simulations in Introductory College Astronomy

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NSF Award #2214481 is a 3-year IUSE Level 1 project.

It focuses on creating astronomy simulations targeted at student smartphones for usage in the astronomy classroom with embedded questions so that tasks can conveniently be assigned to students through QR codes and question numbers projected on a PowerPoint slide.

Research questions include:

1) how does the use of smartphone simulations influence undergraduate students' attitudes related to astronomy (and science in general)?
2) how does the use of smartphone simulations influence undergraduate students' conceptual understanding related to astronomy?
3) what affordances and constraints of smartphone-based simulations impact undergraduate students' attitudes and conceptual understanding related to astronomy?

All project materials are publicly available at: https://astro.unl.edu

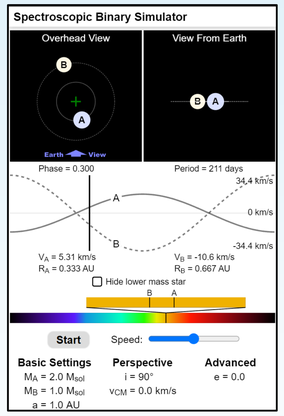
Example #1 - Spectroscopic Binary Simulator:

https://astro.unl.edu/smartphone/SpectroscopicBinary/

One of the two important types of binaries – it utilizes many course principles including center of mass, orbital motion, spectral lines, doppler shift, and radial velocity.

Example Exploration:

Question 6: Press the System 2 button to create a system of stars in circular orbits viewed directly along the plane of their orbit where one star has a mass twice as great as the other star. Describe the directions of motion of both stars at the instant when Star A has its maximum velocity. How about for star B?



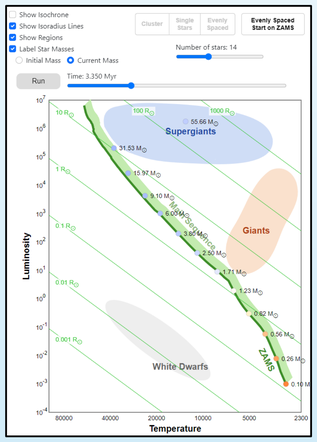
Example #2 - Stellar Evolution Simulator:

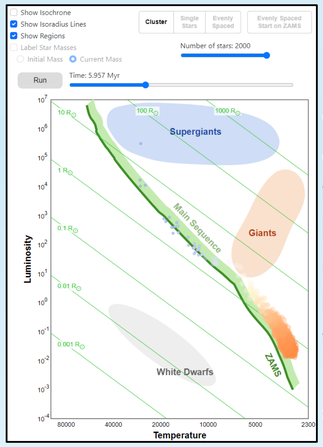
https://astro.unl.edu/smartphone/hrdiagram3/

This simulation makes use of the MIST stellar evolution codes. A general simulation on the characteristics of the HR Diagram precedes its usage.

Example Explorations:

Question 5: Select "Evenly Spaced Start on ZAMS". Note that this construct artificially specifies stars with a range of masses on the ZAMS. A) Predict what you think will happen as time evolves, and B) then click Run and view the evolution.

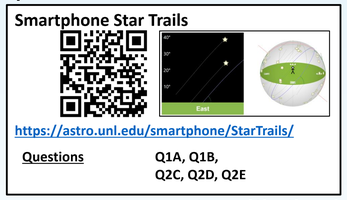




Question 9: Select "cluster" to configure the simulation for a typical cluster of stars with the Number of Stars set to its maximum value of 2000. Click Run and scrutinize the evolution of the cluster. Do low-mass stars and high-mass stars ever exist at the same time?

Classroom Usage:

PowerPoint slides are used to direct students to the simulations through QR codes and assign both embedded and typed-out questions.



A debrief follows commensurate with the importance of the topic to the class.

Collection of Research Data:

Several forms of data are being collected to address the research questions:

- Pre & Post Surveys on students' conceptual understanding of astronomy utilizing questions from the Astronomy Diagnostic Test 2.0 (Hufnagel, 2002), the Test of Astronomy Standards (Slater 2014), and the Light and Spectra Concept Inventory (Bardar *et al.,* 2008)
- Pre & Post Surveys on students' attitudes toward astronomy utilizing the Attitudes Toward Astronomy (Zeilik, 2012) Survey
- COPUS (Smith *et al.*, 2013) class observations
- Interviews with selected students focusing upon learning science via mobile technologies

Student Comments:

Interviewer: "So with the smartphone simulations, do you think that those are a good test of your understanding?"

Student #1: "Overall , yes! I feel sometimes there is a bit of a learning curve. It is a little bit on you to play around with it … you definitely have to be reading and seeing what you can do to manipulate the simulation, but once you actually start changing it and messing it around and noticing what the changes do … then it definitely does help you."

Interviewer: "What are your general beliefs about using mobile technology to learn science and astronomy in particular?"

Student #2: "I think it's good, I think it is helpful because there's a lot of things that we can't really do in astronomy, because obviously, it's across the universe. We can't just see Earth spin in a circle … there's not a lot of models that are readily accessible. So I feel that having simulations and in our class vote on stuff was really helpful in the learning process of things. I thought it was helpful, very helpful in getting the picture."

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