NASCENT
NANOMANUFACTURING SYSTEMS FOR MOBILE COMPUTING AND MOBILE ENERGY TECHNOLOGIES
A NATIONAL SCIENCE FOUNDATION NANOSYSTEMS ENGINEERING RESEARCH CENTER

Simulation Applications in Medicine

Subject Area(s) science & technology

Activity Title Simulation Applications in Medicine

Header Insert image 1 here, align right, wrap text

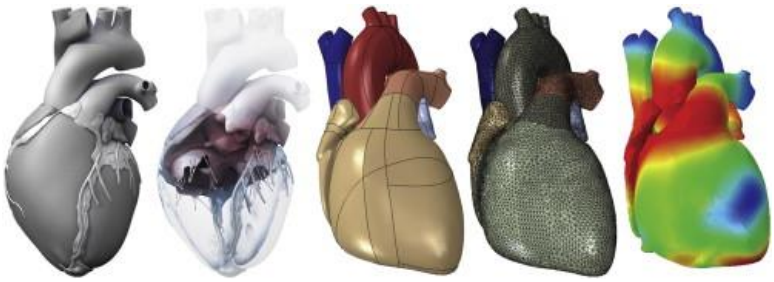
Image 1

Image file: livingheartimage.jpg

ADA Description: This shows five different views of the living heart simulation. This image shows how the simulation allows us to fully explore every aspect of the human heart.

Source/Rights: Copyright © laurencemarks.wordpress.com

Caption: Simulations can allow us to explore the human body like never before.



Grade Level 8 (8-12)

Activity Dependency none

Time Required 360 minutes

Group Size 3

Expendable Cost per Group US $0

Summary

Students are introduced to the world of computer simulations by learning about its increasing use in medical research, development and practice. The overlap in the engineering fields and their use of technology is explored. Students see how technological progress promotes the advancement of science and mathematics not only in what they may think of as traditional engineering fields, such as mechanical engineering, but all fields of engineering.

Engineering Connection

Students see how biomedical enginners use simulations in research, development and practice.

Engineering Category = #1. Relating science and/or math concept(s) to engineering

Keywords biomedical, technology, coding, simulations, heart, science, engineering, data, math

Educational Standards

Texas – Technology 6-8 Subchapter B: Middle School, 2011

Research and information fluency. The student acquires, analyzes, and manages content from digital resources. The student is expected to: process data and communicate results. *(Grades 6 - 8)*
Technology operations and concepts. The student demonstrates a thorough understanding of technology concepts, systems, and operations. The student is expected to: create and edit files with productivity tools, including: a spreadsheet workbook using advanced computational and graphic components such as complex formulas, advanced functions, data types, and chart generation;

ITEEA 2000

The Nature of Technology

Standard 3. Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study. In order to appreciate the relationships among technologies and other fields of study, students should learn that:
F. Knowledge gained from other fields of study has a direct effect on the development of technological products and systems. *(Grades 6 - 8)*

J. Technological progress promotes the advancement of science and mathematics. *(Grades 9 - 12)*

NGSS Standard (strongly recommended)

CCSS Standard (strongly recommended)

Pre-Requisite Knowledge
Students should have a general idea of what engineers do. FamiliaFamiliarity with coding language could be helpful for both students and teachers, but is not required.

Learning Objectives
After this lesson, students should be able to:
- Use computer simulation software to explore aspects of medical research and practice.
- Identify how mathematical computer simulations can assist biomedical engineers in research and practice.

Materials List
Each group needs:
- Access to a computer with internet and presentation software, such as PowerPoint or Keynote (It may be helpful to preinstall the Wolfram CPF Player on the computers in advance)

To share with the entire class:
- Projector and screen

Introduction / Motivation
Students watch a video showing a scenario of the potential benefits of the living heart simulation.

Students read *Simulation Grows in Medical Importance* article from Desktop Engineering (attached). This could be done for homework. Discuss the following questions in a group or in an online discussion:

- What stimulated the FDAs move toward promoting the use of simulation in testing? How are they responding?
- Do you think simulation will become the only way we test medical devices and procedures? Why or why not? What does the FDA think? How does this relate to the use of simulation in other fields?
- What was the main idea of this article? How does it fit in the "big picture" of health care?

Vocabulary / Definitions

Word	Definition
simulation	A computer simulation or a computer model is a computer program that attempts to simulate an abstract model of a particular system. (Science Daily)
Biomedical Engineering	The application of engineering principles and design concepts to medicine and biology for healthcare purposes (e.g. diagnostic or therapeutic). This field seeks to close the gap between engineering and medicine: It combines the design and problem solving skills of engineering with medical and biological sciences to advance healthcare treatment, including diagnosis, monitoring, and therapy. (Wikipedia)

Procedure

1. Students explore Wolfram's online simulations. Before this activity, the Wolfram CDF Player should be installed onto the computers students are using. Once students spend some time exploring the models, they should choose one to focus their research on. You may choose to make this an individual or group activity. Guidelines for choosing a simulation to focus on:
    a. Simulation should be in the "Life Science" category.
    b. This category contains some simulations that are simply virtual models. Find a simulation that allows you to manipulate variables and gives data on the possible outcomes.
2. Students take time to understand their chosen simulation. Students should take notes on any trends they see. Encourage students to try and predict what will happen before they use the simulation. You can require students to make a minimum number of predictions and describe the outcome. Students can use a search engine to help them define any words or concepts they are unfamiliar with. It may be helpful for them to keep track of any websites or publications they find that help them understand the simulation.
3. Students should prepare a short presentation to share with their group or the whole class, the simulation they found. Students should use the rubric as a guideline for creating this presentation.

    Standards-based Rubric:

Progression (D and below)	Proficient (B and C Grades)	Advanced (A Grades)
• Student includes some background information but the purpose of the simulation is not clear to all audience members. • Students give a very basic explanation of the simulation, lacking true depth of understanding.	• Students describe how computer simulation technology is used in at least one particular part of medical research, development or practice. • Student includes any background information audience members may need. • Students identify the trends and patterns that were made clear from the simulation.	• Students thoroughly explain their simulation in a way anyone could understand. • Presentation includes opportunities for audience participation and feedback. • Students give a brief history of computer simulation technology.
• Students give broad outcomes for the simulation. • The connection on how this simulation will promote the improvement of health care	• Students describe how the knowledge gained from simulation could have a direct effect on the development of	• Students relate simulation to examples of outcomes in medical science practice or make specific predictions on how it will be used in the

is unclear.	technological products and systems. (how could it be used in the real world?) • Students show how this simulation and others like it promote the advancement medical science	future.
• Students sometimes fail to make eye contact or speak clearly. • Presentation is attractive, but may also sometimes be used as a script for presenters.	• Students present in a professional fashion. • Presentation includes a list of sources.	• Students speak loudly and clearly, maintaining eye contact with audience members. • Presentation is well organized and attractive, supporting the ideas presented. • Presentation includes a list of sources in MLA format

Background

Simulations are being used in all fields of engineering to quickly design and prototype. Now, biomedical engineers are using simulations to help solve health problems and increase the quality of medical care. These simulations are particularly helpful when they allow use to quickly model a situation that could occur, and collect data on the outcome.

Before the Activity

- Open up the Wolfram Demonstrations Project site and download the CFP Player. Explore the life science demonstrations.
- Optional: make copies of Desktop Engineering;s *Simulation Grows in Medical Importance* article.
- Load the Living Heart Project video to computer connected to a projector.

With the Students

Students may complete the procedure with the whole class, or in small groups as part of stations, or even as homework.

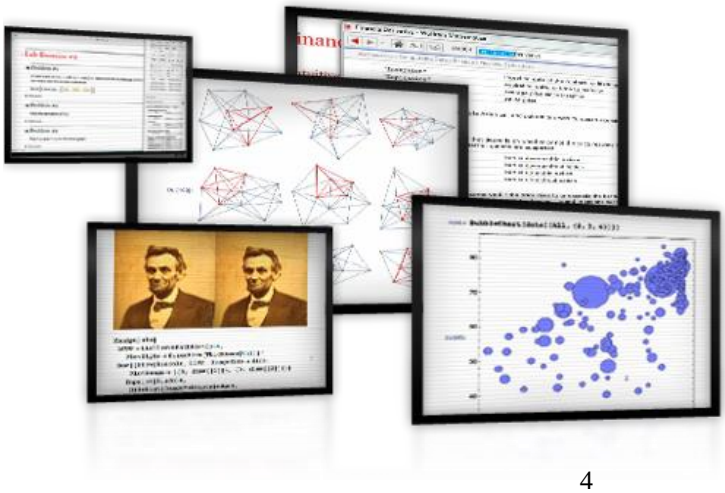
Image Insert Image # or Figure # here (use Figure # if referenced in text)

Figure 1

Image file: wolfram.jpg

ADA Description: Pictured are five different images of the Wolfram Mathematica Project demonstrations. The images contain graphs, shapes and a photo of Abraham Lincoln.

Source/Rights: Copyright © Wolfram.com



Attachments

Simulation Grows in Medical Importance article*PDF*

Living Heart Project Video (wmv)

Safety Issues

- none

Troubleshooting Tips

Some browsers may request permission to run the Wolfram CDF Player. Students should click on the bar at the top of the browser to allow the player to run.

Investigating Questions

How do simulations assist different types of engineers? How are there simulations changing the way we experiment and collect data?

Assessment

Pre-Activity Assessment

Math and Science: What is the relationship between math and science? Are they two separate ideas? Does one support the other? Give a real world example.

(We are hoping students see through this activity that we are using math to simulate our scientific processes. The results of these simulations are both mathematical and scientific.)

Activity Embedded Assessment

Multiple Choice Check for Understanding

Simulation will someday replace real world experimentation in medicine entirely.

A. True
B. False

Simulation could be used in all of the following engineering fields EXCEPT:

A. Mechanical
B. Biomedical
C. Aerospace
D. Civil
E. Answer not found here

Simulations assist engineers in all of the following ways EXCEPT:

A. Increasing the likelihood a prototype with test successfully
B. Eliminating the need to perform other tests before putting a product on the market
C. Shortening the time required to design a prototype
D. Shortening the time required to test a prototype

Post-Activity Assessment

Reflection

1. How does using simulations contrast to traditional ways of collecting data in medical research?

2. Does learning about this topic spark and further curiosities or questions?

3. Are there any potential pitfalls to using simulations in medical research, development and practice?

4. What is the relationship between math and science? Are they two separate ideas? Does one support the other? Give a real world example.

Activity Extensions

Ask students to develop the next innovation in medical technology. How would simulation play a role in the design of their product?

Activity Scaling

- For lower grades, students could observe one of the more simple computer models on the Wolfram Mathematica Demonstrations Project site.
- For higher grades, Students could use computer simulation software to create and/or test simulations.

Additional Multimedia Support

None

References

None

Other

None

Redirect URL

None

Contributors

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