2026 ASEE ANNUAL CONFERENCE June 21–24, 2026 | Charlotte Convention Center, NC
Host Sponsor UNC Charlotte
Paper ID #53406

Making the Invisible Visible: Hands-On Models of Bioengineering Imaging for K-8 Classrooms (Resource Exchange)

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Stephanie Dietrich holds a master's degree in library and information sciences and is a certified K-12 teacher, with experience teaching computer science and engineering design to K-8 students. She currently serves as the Educational Programs Manager at the Cancer Center at Illinois, where she leads K-12 outreach and community engagement initiatives, inspiring young learners through hands-on STEM activities and cancer education.

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Dr. Marcia ("Marci") Pool is the Assistant Director for Education at the Cancer Center at Illinois and a Teaching Associate Professor in Bioengineering. She holds a Ph.D. in Biomedical Engineering, has served for sixteen years as teaching faculty/staff in biomedical/bioengineering and nine years in departmental/institute educational administration, and is an ABET program evaluator for Bioengineering/Biomedical Engineering. She focuses on identifying and evaluating mechanisms to enhance the educational experience and develop students into engineers and researchers. Her work includes interventions to enhance training for high school students, undergraduate students, and predoctoral (graduate students) and postdoctoral trainees through training programs such as NIH T32s. These programs include curricular, extracurricular, and professional and career development components with required evaluation and tracking of student participants.

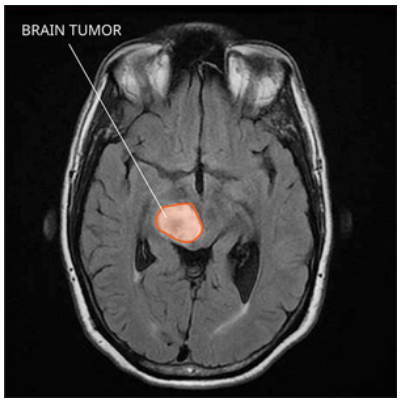
Making the Invisible Visible:
Hands-On Models of Bioengineering Imaging for K-8 Classrooms (Resource Exchange)

Cancer Center at Illinois
UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

Developed by:	**Cancer Center at Illinois Cancer Research Training and Education Coordination Team in collaboration with students from the Cancer Scholars Program**

Time	**60 Minutes**	**Grade Level:**	**Middle School**

OVERVIEW



MRI of a diffuse midline glioma in the brain. Credit: NCI-CONNECT Staff

Bridging the gap between basic science and engineering, this resource offers K-8 students a comprehensive look at how technology drives healthcare solutions. Through NGSS-aligned activities, students build a foundational understanding of oncology before exploring the bioengineering behind medical imaging. Using a hands-on physical model, students simulate fluorescence imaging by deploying "probes" (velcro-coated, glow-in-the-dark balls) that bind to a hidden "tumor" (fabric/receiving velcro). This simulation allows students to visualize the critical role bioengineers play in making cancer detectable for diagnosis and successful surgical removal. Full activity details and adaptations are available in the digital repository.

Learning Goals

1. **Identify** the difference between healthy and cancerous cell growth (uncontrolled proliferation).
2. **Explain** the role of cellular imaging in medical diagnosis and treatment.
3. **Model** how targeted probes (fluorescence) allow engineers to "see" internal structures that are otherwise invisible.
4. **Iterate** on a model to represent different clinical scenarios (e.g., tumor size, location, or multiple sites).

Student Brief Design

Goal: Successfully map the perimeter of a hidden "tumor" using the fewest number of fluorescence probes.
Criteria: The glowing shape in the dark box must match the hidden "tumor" shape with 80% accuracy.
Constraints: You only have 3 "imaging rounds" (drops) to identify the shape before the "patient" goes to surgery.

Materials

Large cardboard box, velcro strips or dots (both sides), UV flashlight, receiving velcro/fabric "tumor" – formed into a shape, normal (not glow in the dark) balls, glow in the dark balls with velcro attached, glue/adhesive

Standards Alignment

Engineering and Scientific Standards (NGSS)

- MS-LS1-3: Body systems and subsystems
- MS-ETS1-1: Define criteria and constraints of a design problem
- MS-ETS1-3: Analyze data from tests to determine similarities and differences among design solutions
- MS-ETS1-4: Develop a model to generate data for iterative testing and modification

Preparations

Prepare the "Probes": Glue a small piece of velcro onto the glow-in-the-dark balls.
Prepare the "Patient": Place a "tumor" (receiving velcro/fabric structure) at the bottom of the cardboard box.
The Box: Ensure the box is dark inside, except for the light emanating from the viewing hole.

Instructional Procedures

The Problem: Doctors cannot always see where a tumor starts and ends. How can engineering help us "see" what is hidden?

The Technology: Introduce fluorescence microscopy. Explain that "probes" are like tiny lanterns designed to bind to specific markers on cancer cells.

The Hands-On Simulation

- **The "Injection":** Students take a set number of mixed balls (regular and velcro).
- **The "Imaging":** Students drop the balls through the hole in the top of the box.
- **Observation:** Students look through the viewing hole. As the velcro balls fall, they stick to the hidden "tumor", while regular balls roll away.
- **Detection:** After several "doses", use the UV flashlight to see a glowing shape that begins to form at the bottom of the dark box. Students must sketch the shape they see and predict where the "surgeon" (the teacher) should operate.
- **Reflection:** How many "probes" were needed to correctly determine the shape? What are some problems that could arise if the tumor shape were not correctly identified?

Scan Me

Contact:
Project Link: https://go.illinois.edu/CCILoutreach
This outreach is supported by the Cancer Center at Illinois.

Reference:

- Gomes, C.J., Harman, M.W., Centuori, S.M. et al. Measuring DNA content in live cells by fluorescence microscopy. Cell Div 13, 6 (2018). https://doi.org/10.1186/s13008-018-0039-z
- Diffuse Midline Glioma: Diagnosis and Treatment. National Cancer Institute. https://www.cancer.gov/rare-brain-spine-tumor/tumors/diffuse-midline-gliomas