Based on student feedback, we changed:

*While undergraduate students have no doubt
heard of the importance of nanotechnology and
nanoscience, relatively few can appreciate how the
scale of matter affects the fundamental science or
behavior of a system.
*Most learning on this topic tends to occur in upper-
level electives or in senior thesis projects or REU
programs.
*Further, our undergraduate curricula do not include
either exploration-based laboratory courses, in
which students work towards solving a problem in
collaborative teams, rather than following “step-by-
step” lab procedures.

Create a New Lab Course in Nanobiotechnology:

- While undergraduate students have no doubt
heard of the importance of nanotechnology and
nanoscience, relatively few can appreciate how the
scale of matter affects the fundamental science or
behavior of a system.
- Most learning on this topic tends to occur in upper-
level electives or in senior thesis projects or REU
programs.
- Further, our undergraduate curricula do not include
enough exploration-based laboratory courses, in
which students work towards solving a problem in
collaborative teams, rather than following “step-by-
step” lab procedures.

Objectives:

- Increase students’ knowledge of nanobiotechnology
- Increase the skills of undergraduate engineering
students in developing research methodology
- Enhance the interest and enthusiasm of undergraduate
students for nanobiotechnology
- Prepare students to deliver high-quality oral and written
presentation projects
- Disseminate nanobiotechnology modules to colleagues
in a range of engineering departments at other
institutions

Overview:

<table>
<thead>
<tr>
<th>Students who participated in the program</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 students in year 1</td>
</tr>
<tr>
<td>14 students in year 2</td>
</tr>
<tr>
<td>Overall 55% male, 45% female</td>
</tr>
<tr>
<td>Students came from several departments: Chemical Engineering, Mechanical Engineering, Biomedical Engineering, Biology &amp; Biotechnology, Physics, Materials Science</td>
</tr>
<tr>
<td>93% of students reported no prior experience with nanotechnology</td>
</tr>
<tr>
<td>60% juniors, 40% sophomores</td>
</tr>
</tbody>
</table>

Evaluation and Assessment:

Overall Rating of Program:

90% rated the course as Good or Excellent

What words or phrases come to mind when you think of nanobiotechnology?

First Class Words: Bacteria, nanotechnology, microorganisms, small, biomedical, lab, cure

Last Class Words: tiny, chemical, bio, medical, biology, recent, cutting-edge, research, new, technology, future

Overall 55% male, 45% female

Participants:

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Kindergarten</td>
<td>5</td>
</tr>
<tr>
<td>Second Grade</td>
<td>10</td>
</tr>
<tr>
<td>Third Grade</td>
<td>10</td>
</tr>
<tr>
<td>Fourth Grade</td>
<td>10</td>
</tr>
<tr>
<td>Fifth Grade</td>
<td>10</td>
</tr>
<tr>
<td>Sixth Grade</td>
<td>10</td>
</tr>
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An Example of How Data Informed Future Planning:

- Based on student feedback, we changed the method we used to prepare the nanoparticles from year 1 to year 2, in order to find a more reliable method.
- In year 1, students recommended adding more control groups to the data so that they could do a more thorough analysis of the final data. This issue was raised with the class in year 2, and that group of students designed better control experiments.
- Specific guidance was given so that higher quality videos were produced in year 2.

Lab Activities:

- Develop nanomaterial-coated substrates
- Test bacterial adhesion to nano-coated surfaces
- Learn and use cutting-edge procedures (SEM, AFM)
- Create videos of lab experience to share with others

Results:

- Students were able to correlate surface roughness (measured with AFM), size of nanoparticles (measured with SEM), and chemistry conditions (related to solution preparation) with the adhesion of bacteria to the surface.

Outreach: Introduce a Girl to Engineering Day:

- The girl participated in the program rated it enthusiastically. Almost all (94.9%) of the girls noted that they were “very
interested” (69.5%) or “interested” (25.4%) in engineering after the day.
- We received 58 surveys for a 98.3% response rate.

Feedback from Girls (year 2, n=60):

- The girls who participated in the program rated it enthusiastically. Almost all (94.9%) of the girls noted that they were “very
interested” (69.5%) or “interested” (25.4%) in engineering after the day. We received 58 surveys for a 98.3% response rate.
- Ratings for individual activities were also high. On a scale from 1 (“did not like it”) to 5 (“liked it”), the average rating was 4.57
(stdev = .55) for girls who participated in all eight activities.

This work was supported by the National Science Foundation (DUE 0941746). We thank Jared Quinn, Anastasia Padilla, Ivan Ivanov, Sophia D’Angelo, Andrea Gaul, Xi Geng, Dirk Yao, and Andrew Boucher for assistance with developing the course.