

# Mapping Your Science Education Program

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PRECOLLEGE AND UNDERGRADUATE SCIENCE EDUCATION PROGRAM

**HHMI**  
HOWARD HUGHES MEDICAL INSTITUTE

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In order to understand the effectiveness of science education programs and in planning for future program activities, it is helpful to have a common language for program planning and assessment. The HHMI Precollege and Undergraduate Science Education Program has developed this document to help current and future grantees summarize the resources and strategies used to reach a set of outcomes. This process, sometimes called a “Logic Model,” can help you formulate the questions and define the methods you will use to evaluate your program. This can be a powerful tool for reflecting on your progress and planning for continuous improvement.

In this booklet, we refer to the two parts of this process as the “Map” and the “Measures.”

## How to Develop Maps and Measures

The first step is to describe your science education program; then you can formulate the questions you will need to answer in your program evaluation and define the measures you will use to answer those questions. The following steps outline a useful process for coming up with your “map” and your “measures.”

## Step One: Develop the Map

The following broad categories describe the natural or logical flow of program planning:

**Inputs** are the resources required to do the job (money, employees, and equipment) that make your program run and are essential for program activities, whether in place or needed in the future.

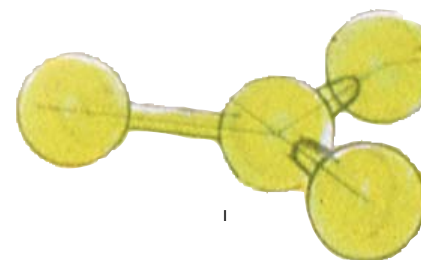
**Strategies** (what you will do) include a range of activities from broad to detailed. Strategies should include enough detail to accurately describe the strategic plan and to enable the reader to see its feasibility.

**Outputs** (immediate results) include data that will be captured, such as numbers and demographics of participants, features and characteristics of an activity, and responses to surveys. Generally, outputs should be items that are measured on an annual basis.

**Outcomes** (short- and medium-term effects of the program) are anticipated gains or achievements of the HHMI program. Generally, outcomes should be broad and captured every two years or at the end of a grant period.

**Impacts** (the big picture and long-term aspirations) reflect long-term effects of the program activities, usually not limited to a specific program. Generally, impacts should be something that is achieved beyond the lifetime of the four-year grant. They should reflect institutional (not just departmental), national (not just local), and societal (not just individual) impacts of the program.

As one example, here is a Map that describes some of the aspects of the HHMI Exceptional Research Opportunities Program (EXROP).



## SAMPLE : EXROP Planning Map

Inputs	Strategies	Outputs	Outcomes	Impacts
<p>Bright and motivated students from diverse and/or disadvantaged backgrounds identified by HHMI grantees</p> <p>HHMI investigators and professors who will be research advisers</p> <p>Mentors in research-intensive laboratories</p> <p>Research projects in laboratories of excellent scientists</p> <p>HHMI program support</p>	<p>HHMI grantees identify an appropriate student</p> <p>HHMI matches students with labs</p> <p>Students form peer networks and serve as peer mentors to fellow EXROP alumni/students beginning at the annual EXROP meeting</p> <p>HHMI places students into local summer programs and housing</p> <p>Students engage in summer mentored research experiences for 40-plus hours per week, ranging from 9 to 14 weeks</p> <p>Students further mentored in undergraduate institutions following the summer</p>	<p>Number and demographics of EXROP students who:</p> <ul style="list-style-type: none"> <li>• graduate in science</li> <li>• graduate in other majors</li> <li>• continue to engage in science</li> </ul>	<p>Students value the experience</p> <p>Students have enhanced knowledge regarding graduate and professional school in the sciences</p> <p>Students plan to engage in science careers post-baccalaureate degree</p> <p>Students continue in science degree programs (M.S., Ph.D., M.D.-Ph.D., M.D., etc.)</p> <p>Students earn science graduate degrees (M.S., Ph.D., M.D.-Ph.D., M.D., etc.)</p> <p>Students pursue positions leading to faculty appointments (postdoc and other fellowships)</p>	<p>Students become faculty members and role models in diversifying the sciences</p> <p>Students become leaders in the scientific and academic community</p> <p>Grantee institutions and research advisers develop and improve effective mentoring strategies</p>

## Brainstorm

A great way to get the information you need for your map is to bring together a team of people with a variety of expertise and experience to brainstorm the basic elements of your program.

Use the sample chart in this brochure as a template and start at the RIGHT by defining the program's envisioned **impacts**. Consider your intended impacts--the **outcomes** that will lead to this vision should become apparent. As you continue to work toward the left, the measurable **outputs** and the **strategies** you will use to achieve these outcomes/impacts should become apparent. From there, the resources, or **inputs**, necessary to carry out your project will emerge. Finally, the important elements of the environment (or the context) in which this program intervention exists can be described.

During the brainstorming process, your map will likely include many more items than you see in the final EXROP model. However, the process is the same: for example, the EXROP map states that an intended impact is that students will **"become leaders in the scientific and academic community."** The outcomes that relate to this goal include: **the program has value, students gain knowledge, and students plan to continue in the field of study.**

How will this be measured? Outputs in this case are primarily measures of the number and demographics of students for each of these outcomes. The strategies that will be used to meet the outcome include **matching and connecting students to mentors and summer programs.** Finally, the inputs that will be necessary to carry out the strategies include the **students, the mentors, the programs, and program support.**

As you collect this information, don't attempt to filter—YET. Brainstorming is only the first step, and it is critical that everyone's voice is heard.

## Simplify and Categorize

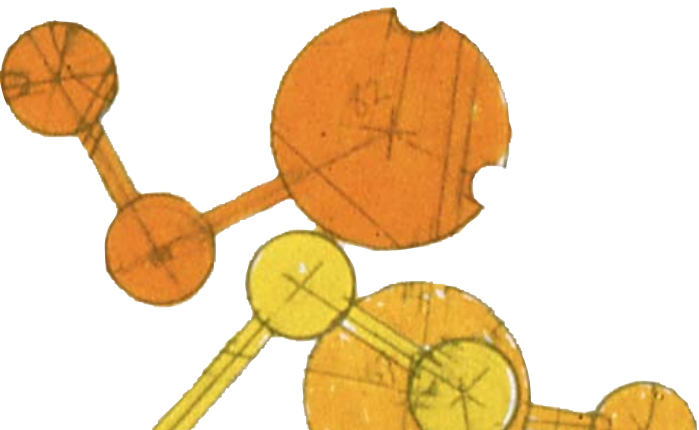
After everyone's ideas are collected, work as a group to organize specific ideas into more general themes. For each stage of the plan, group like ideas into clusters and then name those clusters. For example, the following may have been suggested as strategies: "work with university labs," "contact investigators engaged in research," and "identify students with an interest in research." These were then combined as, "HHMI matches students with labs."

Remember, this map should illustrate your project's design. It is not an evaluation document, but a tool that can be used effectively to develop an evaluation plan, which brings us to Step Two.

## Step Two: Develop the Measures

Benefits of Program Assessments:

- Increase knowledge
- Guide decision-making
- Improve programs
- Determine strategic direction

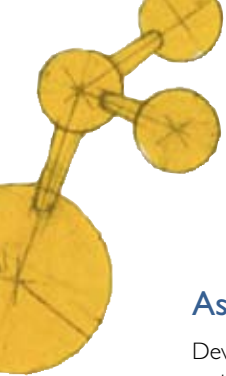


While you still have everyone together, spend some time coming up with overarching questions you want to answer about your program and the measures and processes you will use to answer these questions.

## SAMPLE: EXROP Measures

Evaluation Questions	Indicators	Methods and Tools	Expertise Needed
<p>1. How was the EXROP experience valuable or not valuable for the students both short term and long term? What are the perspectives of the students, selectors, mentors, and supervisors on the students' experiences?</p> <p>2. What do students do after they graduate from their colleges/universities? How do students continue to be involved in science after they graduate from their colleges/universities?</p> <p>3. How are students involved in diversifying the sciences in academe and as leaders in the scientific community?</p>	<p>1. a) Continue to major in science</p> <p>b) Graduate with science degree</p> <p>c) Pursue additional research experiences before graduation.</p> <p>d) Expect to continue in research post-EXROP experience</p> <p>e) Value summer research experience</p> <p>f) Express student-specified gains</p> <p>2. a) Pursue science and research-related activities after graduation, and at 5 and 10 years post-graduation particularly through their job/education</p> <p>3. a) Applied for, received, and accepted academic faculty positions, including type of faculty positions (e.g., tenure-track)</p> <p>b) Engaged in research or science leadership roles (e.g., industry, government, associations, and societies)</p> <p>d) Mentor diverse students or be involved in organizations that serve diverse students</p> <p>e) Earned honors and awards in mentorship and education</p>	<p>1. a) Student Exit Questionnaire</p> <p>b) Interview</p> <p>c) Supervisor, Mentor, Summer Program Director, and Selector Feedback</p> <p>d) Focus Group</p> <p>e) SURE*</p> <p>2. a) Tracking Questionnaire</p> <p>b) Contacting Undergraduate Institution and Selector</p> <p>c) Alumni search</p> <p>d) National Surveys (NSF, AAMC, etc.)</p> <p>e) Grants, honors, and awards</p> <p>f) Publication searches</p> <p>g) Citation Impact</p> <p>3. a) Tracking Questionnaire</p> <p>b) Alumni search</p> <p>c) Interview</p> <p>d) Focus Group</p> <p>e) Peer review through panels, awards, etc. gauging research and mentoring contributions, particularly for diverse students</p>	<p>Evaluation/ instrumentation</p> <p>Interviewing skills</p> <p>Programmatic expertise</p> <p>Statistical analysis expertise</p>

\*Lopatto, D. 2007. Survey of Undergraduate Research Experiences. *CBE-LifeSci. Educ.* 6:297-306.



## Ask the Questions

Developing an assessment plan based on a program map makes a lot of sense. Starting with your map, important questions are likely to suggest themselves. Assessment questions can be related to each of the areas described in your program map. You might start with the following generic questions and tailor them to your program:

- What has been the impact or degree of change?
- Are we obtaining the desired outcomes?
- How well have we implemented strategies?
- How efficiently have we used our resources in pursuing our objectives?

## Define the Indicators

What are you going to measure? Numbers of students enrolled, numbers of students involved in research, or publications, diversity of graduates? Again, try to get input from all stakeholders as each will have a different idea about the information that will be most meaningful.

## Consider the Methods

Ask your team about a variety of evaluation methods, tools, and tasks. A few possibilities are suggested by the EXROP model, but there are others that may serve your purposes better. In some cases, you may find that evaluation tools have already been developed that you can adapt to your purposes. And remember, for each purpose you want to use variables that will be meaningful to that particular audience.

## Consider the Expertise

If you don't have evaluation expertise on your team, be sure to seek out advice in this area. And remember, the methods you choose now may be narrowed or expanded as formal assessments are chosen, developed, or modified and as information comes in that leads to adjustments in the program itself.

As your program gets underway, you will be gathering, analyzing, and interpreting the data you need for your program assessment and then using the findings to improve your program. This completes the circle and ultimately leads to more effective science education.

## Frequently Asked Questions (FAQs)

### Who should be involved in developing our map?

Your program map should not be developed in isolation. Assemble a team of key players (e.g., program associates, faculty members, curriculum developers, evaluation experts) to develop your model.

### How long should it take to develop my program map and measures documents?

Basic program map and measures documents might be developed in a few hours. However, because this is a living document, it should not ever be considered "final." Rather, regular and periodic review and revision will be critical to it remaining viable.

### How much detail is HHMI looking for?

If developed correctly, your map can be adapted for multiple uses—program planning, public relations, new staff orientation, and program evaluation. HHMI will continue to be interested in receiving maps and measures that capture the important themes of key components of your project. Remember that your primary audience will be peer reviewers and HHMI staff.

### Doesn't my program evaluation need a control or comparison group?

There are a number of ways that a program might be evaluated and it is important to design your assessment plan to fit the project and to be practical. For example, it may be useful to compare measures before and after an activity, or to track trends over a period of time after the activity. It is also important to understand how your progress compares to published stories.

### Whom can I call if I get stuck?

301-215-8872  
bestugrad@hhmi.org

You can also find helpful information on the following Web sites:

\*W.K. Kellogg Foundation: Logic Model Development Guide:  
<http://www.wkkf.org/pubs/tools/evaluation/Pub3669.pdf>

United Way of the Bay Area: Developing Your Logic Model:  
<http://www.uwba.org/about/logicmodel.DOC>