Teacher Cohort
HHMI/MRI Summer Research Program
Tom Cubbage C. M. Russell HS
Dan Rediske East Middle School
Rob Truax Great Falls HS
Sponsored by the Howard Hughes Medical Institute 2007 PreCollege Grant # 51006094
Summer 2012

- Authored and modified activities and labs.
- Wrote curriculum and planned implementation for new technology and equipment purchased with grant funds.
- Collected, modified, and created teaching material and animations.
- Connected with community organizations and individuals for collaboration.
- Enjoyed the time provided by the HHMI/MRI grant to reflect on our practice as teachers and work on enhancing our practice and classrooms to improve science instruction.
The McLaughlin Research Institute/Howard Hughes Medical Institute Teacher Cohort

This site is a clearing house of labs, activities and information developed by the teacher cohort during the past three summers of work developing curriculum and designing activities to promote science education and STM (Science, Technology, and Math) literacy and career choice. Teachers
Summer work

- Visited with individuals and organizations that fund and study research opportunities for teachers and students.

- Traveled to other institutions with programs for teachers and students to do scientific research.

- Studied the literature and collected data for a paper on the effects and characteristics of research programs for teachers and students.
“Science learning in highly structured classroom environments may become bound to those formal settings and exert very restricted influence on student’s experiences and thinking beyond the confines of schools.” (Sadler et al. 2010).
Appreniceship Model

- These research experiences are modeled after the tradition of apprenticeship and trade based learning experiences where novices in a given field are mentored by an expert in their field of work and engage in a on the job training program that leads to their become the mentor for the next generation of trades people.
NSF, HHMI, PEW, NIH, M.J. Murdock

- Millions of dollars are spent each year to fund and encourage these research opportunities. Even so, precious little research has gone into the evaluation of such programs. Why are these programs funded?
High Quality Professional Development

- Change in Teacher Efficacy
- Change in Instructional Practices

- Change in Student Motivation in STEM coursework

Increase pool of STEM professionals in U.S.
High Quality Professional Development

Change in Teacher Efficacy

Change in Instructional Practices

Change in Student Motivation in STEM coursework

Increase pool of STEM professionals in U.S.
What research exists on the effects of teacher and student research experiences?

- 22 programs focused on secondary students
- 22 Programs for Undergraduates
- 13 programs for Teachers
## How are the programs evaluated

<table>
<thead>
<tr>
<th>How evaluated</th>
<th>Secondary Students</th>
<th>Undergraduates</th>
<th>Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surveys and questionnaires</td>
<td>13</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td>Tests of content knowledge</td>
<td>3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Interviews</td>
<td>8</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>Lab notebooks and journals</td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Teacher or mentor observations</td>
<td>5</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Mentor evaluations</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Self assessment</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Project or presentation</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Case Study</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total number of programs</strong></td>
<td><strong>22</strong></td>
<td><strong>22</strong></td>
<td><strong>13</strong></td>
</tr>
</tbody>
</table>
What are the Benefits to Teachers?

- Appreciation for the time and persistence that is required to do good research.
- Content knowledge and experience.
- Improved confidence and self-efficacy especially with laboratory activities.
- Collaboration with researchers and post secondary institutions.
- Changes in Teacher practices. (Transfer issues)
What are the benefits to students?

- Appreciation for the time and persistence that is required to do good research.
- Content knowledge and experience. (NSF)
- Improved confidence and self-efficacy.
- Intellectual development.
- Skill development.
- Satisfaction.
- Preparation for post secondary education. (MRI)
- Columbia Research Silverman? 3-4 year delay for benefits.
What are the benefits of research experience on the STEM pool?

- Increased interest in science careers.
- Increased retention in undergraduate science majors.
- Increased desire to attend graduate schools.
- Positive correlation between participation in apprenticeship experiences and matriculation to graduate school.
- Teacher transfer to research careers. (Murdock)
- (Patterns and correlation no valid data)
Suggestions from the research

- Longer experiences show more correlation to benefits reported.
- Provide explicit attention to desired learning outcomes.
- Engage participants in higher order thinking and full immersion in the research process.
- MRI/HHMI program is on track and doing a great job!
My summer at McLaughlin

Daniel Rediske
Wisconsin Fast Plants

- *Brassica rapa*
- Member of the crucifer family of plants, cabbage, cauliflower, broccoli.
- Program developed at the University of Wisconsin-Madison over 30 years
- Application ranging from elementary to high school.
- Several key features to make it successful in the school setting.
FAST PLANTS LIFE CYCLE
Simple Planting Systems

- Grows in small spaces using minimal soil.
- Constant access to water.
Lighting

- Require 24 hours of lighting
- Cool white fluorescent is sufficient, no need for grow bulbs.
Diverse Traits

• Over 10 varieties of Fast Plants with different genetic traits; purple stem, non-purple stem, hairy, hairless, and so on.

• Fast Plants do not self-pollinate, requiring insect or human intervention.
So what now?

• These plants are great models to use when teaching students genetics and actually allow them to perform Mendelian experiments.

• Time this summer was spent refining and troubleshooting methods for growing the plants.

• Lighting banks were installed in the classroom.

• Labs were generated and modified to match our 7th and 8th grade curriculum.
Other Great Opportunities...

- Composting at EMS
  - With help from the Garbage to Gardens program, establishing a composting program.
  - Help reduce the nearly $4000 spent each year on shipping cost for wasted food.

- Seedlings for community garden
  - EMS greenhouse to grow seedlings.
  - Work with MTCC Vista Members and Great Falls Community Food bank to supply plants for their planned community garden.
Opportunities continued...

• Recycling
  o Pacific Steel helping to implement paper recycling school wide.

• Review online labs and simulations
  o Generate a collection of online labs and simulations.
  o Test run on school computers.

• Stem Expo
  o Work with Dr. Brenda Canine to expand and redesign McLaughlin's Stem Expo booth.
Curricular Modification and Animation Creation

Robert Truax
August 15th, 2012
Curricular Modification

- Focus on quantitative data collection
- Focus on variable isolation
**Old Lab**

1. Count how many times you can tightly squeeze a rubber ball in your hand in 20 seconds. Record in Table 2.

2. Repeat the squeezing nine more times and record results. Do not rest between trials.

<table>
<thead>
<tr>
<th>Trial</th>
<th># of Squeezes in 20 seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

**New Lab**

1. Instruct the subject to rapidly grip and relax his/her grip on the sensor (approximately twice per second). Start data collection. The subject should exert maximum effort throughout the duration of the experiment.

2. At 90 s, the lab partner(s) should encourage the subject to grip even harder. Data will be collected for 100 s.

<table>
<thead>
<tr>
<th>Time interval</th>
<th>Maximum force (N)</th>
<th>Δ Maximum force (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–10 s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20–30 s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40–50 s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60–70 s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80–90 s</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Example

- Muscle Fatigue
- Diffusion
- Osmosis
- Balance

- EKG
- Blood Pressure
- Lung Volumes
- $O_2$ Extraction
Animation Creation

- DNA Replication
- Action Potential
- Electrophoresis
- Enzyme Activity
- ETC
- Eye Physiology
- Heart Circulation
- Intrinsic Conduction of Heart
- lac Operon
- Light Reactions of Photosynthesis
Animations Continued

- Meiosis
- Mitosis
- Movement Across Membranes
- Nephron Physiology
- Nondisjunction
- Osmosis-U Tube Pressure
- RNA Transcription
- Substrate-Level Phosphorylation
- Synapse
- Translation
Example
Thank You!

• Howard Hughes Medical Institute
• McLaughlin Research Institute; Dr. Cabin, Dr. Carlson, Dr. Gunn
• Brenda Canine and Jill O’ Moore
• The Great Falls Public Schools