# Research Experience and Mentoring (REM) Program Background

This program was initially launched as a semester long, fused introduction to biomedical research and professional development program that we developed for underrepresented undergraduate students in Science, Technology, Engineering, and Mathematics (STEM) degree programs. Underrepresented minority engagement and retention within the STEM fields continues to be an issue. To provide students with a portfolio of knowledge and confidence within STEM, we constructed professional development modules that can be readily coupled with a hands-on, interactive laboratory experience or a classroom-based research overview. We postulate that the fused experience of professional development and research provides a valuable life and career skill set with potential for lasting positive impact. That is, we believe the coupling of research application with professionalism tutorials results in a mindset that will benefit the mentee along their career path. We first began testing this approach using a minimally taxing laboratory immersion experience which the students completed over 1 semester. Participants completed the California Critical Thinking Skills Test (CCTST) immediately prior to and following the course. This information was paired with professional development activities to assess the modules developed during the semester-long research class. Students were also assessed with open-ended questions including their thoughts on the class and follow -up questions including summer opportunities in which they participated following completion of the course. Findings from the CCTST did not show longitudinal statistical differences but suggested improvements occurred in student interpretation, a category defined by the CCTST. Interpretative skills are used to determine the precise meaning and significance of a message or signal, which are given in a variety of visual or auditory forms; contextual understanding is important in interpretation. A majority of the students followed up participation in the program with a career-driven summer experience and all described their experience in this program as a positive experience that provided them with a new found confidence in pursuing science-suited careers. Since this initial pilot, we have tested the module approach in a traditional class setting with approximately 40 enrolled students and in one-on-one research mentee/mentor settings. The modules are meant as a starting point for adaptation to a particular setting.

**The logo found on each page of the modules is a constant reminder that our students face real and perceptual challenges; we must continually address both types of challenges to help our students succeed.**

# Using the Modules

We have worked to define a consistent learning design in each module. We have defined “Learning Objectives” to help students think about the question “What will I learn in this module?”. We have used popular cognitive taxonomies to assign knowledge-based levels to define expectations for proficiency. (Bloom’s, California Critical Thinking Skills Test) The student is given the “Opportunity to Learn” through the materials, activities, and exercises in each module. There should be a clear connection between the learning objectives and how the module activities foster learning. Each module has associated assignments or other deliverables that can be evaluated to determine whether or not the learning objectives have been met. “Assessment” of what the students have learned should occur in your conversations with the students as they respond to the prompts in the modules and their effort on assignments. Provide students feedback on your impressions so that they know how well they learned a topic. A suggested evaluation rubric is provided, see REM\_Assessment\_Rubric.docx. This can be used by mentees as a self-assessment guide, as well as by mentors as they review submitted work and conduct discussions with mentees.

The modules can be used a la carte or followed in the order they are provided according to the needs of the program and students. All modules are stand-alone.

The personal dynamics of using the modules with multiple students compared to a single student will be very different. Some exercises may not translate well and could be done as “thought experiments” when there is only one or two students. Assignments and materials have been developed and curated by the REM team, but mentors are welcome, even encouraged, to tailor the modules to best fit their needs in the case that alternative materials or assignments would be more pertinent to your specific mentees. We provide some examples of presentations and assignments that cover that are adapted from the modules for use in a traditional class setting that is not coupled with a hands-on laboratory experience.

The timeline for using the modules is based on a week for each module. The modules as presented are designed for a weekly mentor-mentee meeting (or group meeting), where a module is given to the mentees with brief explanation, the mentee works through the module over the course of the week, and the content is discussed at the weekly meeting:

* The mentor assigns a module from the Workbook to the mentee(s), the mentees review the module and the mentor provides an overview of why the module is important and how it fits into the larger research picture. (10 minutes)
* The mentee works on the module content. The assignments should be due at the next weekly meeting. (mentees spend ~1 hr during week completing module)
* At the weekly meeting, mentor and mentee(s) discuss the assignments and any module exercises. (40 minutes)
* The 5-Minute reflection is discussed at the mentor-mentee meeting (10 Minutes). This is the mentor’s opportunity to determine if the module content has been conveyed in a meaningful, helpful manner or if further clarification and discussion is necessary. Sample 5-Minute Reflections are contained in REM\_Sample\_Student\_Reflections.pdf

# What is in a Module?

## Student Workbook / Module Overview

* Learning Objectives
* Checklist
  + Prior to meeting with mentor
  + Discussion with mentor
* Introduction to Topic Material
* Materials for this Module
* Assignment(s) for this Module
  + Five-Minute Reflection

## Mentor Guide

* Checklist
  + Prior to meeting with advisee(s)
  + Discussion with advisee(s)
* Suggested Module Schedule
* Considerations

## Additional Materials

# Module Topics

* Guidance for Mentors
* Expectations (Analysis, Interpretation)
* Laboratory Readiness (Interpretation)
* Standard Operating Procedures (SOPs) (Deduction, Interpretation)
* Article Perspective (Analysis, Evaluation, Interpretation)
* Finding Research Articles (Analysis, Evaluation, Interpretation)
* Abstract Critique (Evaluation, Interpretation)
* Experimental Design (Analysis, Deduction, Evaluation, Interpretation)
* Article SWOT Analysis (Analysis, Evaluation, Interpretation)
* Presentation Skills (Interpretation)
* Elevator Speech (Application, Interpretation)
* Resume Writing (Interpretation)
* Career Panel (Explanation, Inference)
* Requesting Letters of Recommendation (Interpretation)
* Scientific Community (Analysis, Application, Induction, Inference)
* Final Reflections and Evaluation (Analysis, Evaluation, Interpretation)

# Customizing Modules for Your Application

Within the included modules, we have worked to provide a strong foundation of introductory material for engagement in undergraduate research. However, it is our belief that these modules will become most effective when you, as the mentor, are able to add your own unique expertise and experiences to this material to make it most relevant for your mentees. To this end, we hope that you will take the opportunity to customize this material where you see fit, to make it as beneficial as possible during the introductory research experience. We believe that this can best be accomplished by familiarizing yourself with the material in each module. You may find that several modules can be combined together (see Example\_Module Use for Large Class) to address certain areas of interest, or that some information discussed is not as relevant for the mentees that you are working with. By working through the modules once or twice as written, you can familiarize yourself with the material and then customize it where you see fit. Going through module(s) at least once, as written, is an important step in understanding the timing and logistics of delivering this content effectively.

# Cognitive Taxonomy

(Adapted from cognitive levels on Bloom’s Taxonomy and the California Critical Thinking Skills Test)

1. Interpretation
   1. Determine precise meaning and significance of message or signal
   2. Explain idea or concepts
   3. Correct interpretation dependent on understanding both message and context
   4. Includes clarifying, grouping or categorizing information, and determining significance
2. Application
   1. Use information in another situation
   2. Implement concepts in authentic environments and situations
   3. Relate concepts to various contexts
3. Analysis
   1. Identify assumptions, reasons, claims, and examine how they interact in formation of argument
   2. Gather information from charts, diagrams, spoken language, documents
   3. Strong analytics attend to patterns and to details
   4. Identify elements of a situation and determine how elements interact
   5. Strong interpretation can support analysis by providing insight into significance
4. Inference
   1. Draw conclusions from reason and evidence
   2. Offer thoughtful suggestions and hypotheses
   3. Conclusions, hypotheses, recommendations, or decisions can be mistaken if based on faulty analyses even if excellent inference
5. Evaluation
   1. Assess credibility of sources of information and the claims they make
   2. Justify a decision or course of action
   3. Determine strength and weakness of arguments
   4. Judge the quality of analyses, interpretations, explanations, inferences, options, opinions, beliefs, ideas, proposals, and decisions
   5. Strong explanation can support evaluation by providing evidence, reasons, methods, criteria, or assumptions behind claims
6. Explanation
   1. Describe the evidence, reasons, methods, assumptions, standards, or rationale for decisions, opinions, beliefs, and conclusions
   2. Discover, test, and articulate the reasons for beliefs, events, actions, and decisions
7. Induction
   1. Decision making in contexts of uncertainty
   2. Inductive reasoning skills when drawing inferences about what is probably true based on analogies, case studies, prior experience, statistical analyses, simulations, hypotheticals, and familiar circumstances and patterns of behavior
   3. Does not yield certainty, but provides basis for confidence in our conclusions
8. Deduction
   1. Decision making in precisely defined contexts where rules, operating conditions, core beliefs, values, policies, principles, procedures, and terminology completely determine the outcome
   2. Moves with exacting precision from the assumed truth of a set of beliefs to a conclusion that cannot be false if those beliefs are true
   3. Validity is rigorously logical and clear-cut.
   4. Validity leaves no room for uncertainty, unless one alters the meanings of words or the grammar of the language