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Development of the Biology Competencies Assessment Series (BCAS)

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Preview of Award 1245104 - Final Project Report

[Cover](#) |
[Accomplishments](#) |
[Products](#) |
[Participants/Organizations](#) |
[Impacts](#) |
[Changes/Problems](#)
| [Special Requirements](#)

Cover

Federal Agency and Organization Element to Which Report is Submitted:	4900
Federal Grant or Other Identifying Number Assigned by Agency:	1245104
Project Title:	Development of the Biology Competencies Assessment Series (BCAS)
PD/PI Name:	Michelle Smith, Principal Investigator
Recipient Organization:	University of Maine
Project/Grant Period:	07/15/2012 - 03/31/2013
Reporting Period:	07/15/2012 - 03/31/2013
Submitting Official (if other than PD\PI):	Michelle Smith Principal Investigator
Submission Date:	04/25/2013
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	Michelle Smith

Accomplishments

* What are the major goals of the project?

We requested CRP workshop funds to gather TUES-funded scholars from multiple institutions to plan the development of a series of biology assessments that are aligned with the core concepts and competencies outlined in *Vision and Change*. These assessments, renamed from the Biology Competencies Assessment Series (BCAS) to Bio-MAPS (for

Biology-Measuring Achievement and Progression in Science), are intended to be administered at multiple points in the biology curriculum to monitor student progress and enable targeted curricular reform.

We requested workshop funds to accomplish the following goals:

1. Share and provide expert validation on questions we have written in three topic areas: molecular/cellular biology, physiology, and ecology/biodiversity
2. Ensure that both current and future questions address concepts and competencies highlighted by the reports mentioned above.
3. Agree on a protocol for response-validating selected questions with student interviews.
4. Develop a plan to collect data on a pilot set of questions.

*** What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?**

Major Activities: Major Activities: TUES scholars from four institutions met from July 15-17, 2012, immediately following the Society for the Advancement of Biology Education Research (SABER) meeting in Minneapolis, MN. During this time we developed a plan to write, validate, and administer pilot assessment questions during the fall 2012 semester. Following the workshop, we wrote eight questions using a multiple true/false (T/F) format, in which each question consists of a stem introducing a scenario, followed by related T/F statements; students choose T or F for each statement. Student performance is measured based on answers for each statement as well as for the question as a whole; the output thus provides a more detailed portrait of student understanding than does the multiple-choice format. We response-validated these eight questions by interviewing 16 introductory and 16 advanced students from multiple institutions. We also piloted these questions to 1700 students at three different research I (R1) universities and five different community colleges (CC). The results of our pilot data collection were included in a TUES II grant application that we submitted in January 2013.

Specific Objectives: We met all of our specific objectives during the workshop and in the months following the workshop and were able to write, validate, and collect pilot data immediately following the workshop.

Significant Results: To determine whether the eight response-validated molecular and cellular biology questions distinguish between introductory and advanced students on a wider scale, we administered a pilot assessment to 1700 students at eight different institutions. Students were asked to take the assessment at the beginning of either an introductory or an advanced course and were offered points for their participation. We constructed Wright maps, which provide visual displays of how many questions are functioning to discriminate at each different level of student performance, and we found that Bio-MAPS statements cover a broad range of difficulties and are suitable for the target populations. When we looked at performance on the entire pilot assessment, advanced R1 students outperformed introductory students by ~15%, while introductory R1 students do slightly better than introductory CC students. We also calculated the average percent correct for each question and found that advanced students perform significantly better than introductory students on all eight questions (t -tests, $p < 0.05$).

Key outcomes or Other achievements: These preliminary results indicate that our collaborative research team is able to efficiently work together to establish a framework for the assessments, design and validate questions, and analyze the effectiveness of questions. If awarded a TUES II grant, we will extend this work to create a complete and effective set of Bio-MAPS assessments.

*** What opportunities for training and professional development has the project provided?**

Two postdocs, Brian Couch and Sara Brownell, helps collect, analyze and write about Bio-MAPS assessment data.

*** How have the results been disseminated to communities of interest?**

Dr. Michelle Smith has spoken about this work in her departmental faculty meeting and while giving presentations at the University of British Columbia and Simon Fraser University. Dr. Brian Couch spoke about this work at a departmental faculty meeting, a local discipline-based education research (DBER) seminar series, and a departmental seminar at the University of Nebraska. Dr. Knight spoke about this work at departmental seminars at University of Wyoming, University of Richmond, and at an ASBMB-sponsored workshop at St. Mary's College, Maryland. At the University of Washington, Dr. Alison Crowe and Dr. Sara Brownell have spoken about this work in departmental faculty meetings and at a local Scholarship of Teaching and Learning Symposium.

Products

Books

Nothing to report.

Book Chapters

Nothing to report.

Conference Papers and Presentations

Nothing to report.

Inventions

Nothing to report.

Journals

Nothing to report.

Licenses

Nothing to report.

Other Products

Nothing to report.

Other Publications

Nothing to report.

Patents

Nothing to report.

Technologies or Techniques

Nothing to report.

Thesis/Dissertations

Nothing to report.

Websites

Nothing to report.

Participants/Organizations**What individuals have worked on the project?**

Name	Most Senior Project Role	Nearest Person Month Worked
Smith, Michelle	PD/PI	1
Crowe, Alison	Faculty	1
Freeman, Scott	Faculty	1
Knight, Jennifer	Faculty	1
Brownell, Sara	Postdoctoral (scholar, fellow or other postdoctoral position)	1
Couch, Brian	Postdoctoral (scholar, fellow or other postdoctoral position)	1

Full details of individuals who have worked on the project:**Michelle Smith**

Email: michelle.k.smith@maine.edu

Most Senior Project Role: PD/PI

Nearest Person Month Worked: 1

Contribution to the Project: Collected data, analyzed data, wrote grant, and conducted weekly meetings.

Funding Support: NSF MSP Grant DUE 0962805 PI: Susan McKay. Smith currently serves as one of three faculty members in new tenure-track positions that are bridged by this NSF support

International Collaboration: No

International Travel: No

Alison Crowe

Email: acrowe@u.washington.edu

Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: Collected data, analyzed data, wrote grant

Funding Support: University of Washington

International Collaboration: No

International Travel: No

Scott Freeman

Email: srf991@u.washington.edu

Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: Collected data, analyzed data, wrote grant

Funding Support: University of Washington

International Collaboration: No

International Travel: No

Jennifer Knight

Email: Jennifer.Knight@Colorado.EDU

Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: Collected data, analyzed data, wrote grant

Funding Support: University of Colorado

International Collaboration: No

International Travel: No

Sara Brownell

Email: sebbbers@gmail.com

Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)

Nearest Person Month Worked: 1

Contribution to the Project: Collected data, analyzed data, wrote grant

Funding Support: University of Washington

International Collaboration: No

International Travel: No

Brian Couch

Email: Brian.Couch@Colorado.EDU

Most Senior Project Role: Postdoctoral (scholar, fellow or other postdoctoral position)

Nearest Person Month Worked: 1

Contribution to the Project: Collected data, analyzed data, and contributed to grant writing

Funding Support: University of Colorado

International Collaboration: No

International Travel: No

What other organizations have been involved as partners?

Name	Type of Partner Organization	Location
University of Colorado	Academic Institution	Boulder, Colorado
University of Washington	Academic Institution	Seattle, WA

Full details of organizations that have been involved as partners:

University of Colorado**Organization Type:** Academic Institution**Organization Location:** Boulder, Colorado**Partner's Contribution to the Project:**

Collaborative Research

More Detail on Partner and Contribution:

University of Washington**Organization Type:** Academic Institution**Organization Location:** Seattle, WA**Partner's Contribution to the Project:**

Collaborative Research

More Detail on Partner and Contribution:

What other collaborators or contacts have been involved?NO

Impacts**What is the impact on the development of the principal discipline(s) of the project?**

The CRP money allowed our group to begin to develop the Bio-MAPS assessments. Because the Bio-MAPS assessments will be aligned to *Vision and Change*, they will provide a much-needed resource for departments engaging in curricular reform. Data from the Bio-MAPS assessments will catalyze change by: 1) diagnosing areas in which students continue to struggle despite instruction, 2) allowing two-year community colleges to evaluate how well they are preparing students for transfer to four-year institutions, 3) inspiring and directing faculty and institutional conversations about enacting change at the programmatic level, 4) helping administrators focus limited resources on aspects of the curricula that have the strongest need for revision, and 5) challenging faculty to re-design course curricula to effectively scaffold student learning of difficult concepts. Biology departments can also use Bio-MAPS assessments to demonstrate evidence of student learning for accreditation processes.

What is the impact on other disciplines?

Science departments throughout the country are responding to regional accreditation agencies tasked with gauging the effectiveness of higher education. Over the past decade, the measuring stick used by these agencies has evolved, and many agencies now require evidence of student learning and data on how well programs meet the needs of diverse student populations. This new focus on tangible learning outcomes requires that institutions have a means of quantitatively measuring student progression through a curriculum, and other science disciplines will likely be interested in developing similar assessments for their students.

What is the impact on the development of human resources?

Although the CRP workshop funds did not directly increase human resources, the TUES II proposal we recently

submitted included support for the following important human resources in biology education research:

1. *Undergraduate research opportunities*: We are committed to providing research opportunities for students from underrepresented groups. We will advertise undergraduate positions at the UM Wabanaki Center's Native Scholar Educational Outreach Project, CU Miramontes Arts and Sciences Program, and UW McNair Program.

2. *Postdoctoral research and professional development*: We currently employ two postdocs and will hire one new postdoc at UM. These postdocs will help fuel the growth of discipline-based education research as they lay the groundwork for careers as tenure-track faculty in biology education.

What is the impact on physical resources that form infrastructure?

Nothing to report.

What is the impact on institutional resources that form infrastructure?

Nothing to report.

What is the impact on information resources that form infrastructure?

Nothing to report.

What is the impact on technology transfer?

Nothing to report.

What is the impact on society beyond science and technology?

Bio-MAPS assessments represent an important component of a larger movement towards greater concept- and competency-based education. Having assessment tools aligned to the core concepts and competencies from biology will help departments ensure that their students are achieving mastery of these critical ideas. We anticipate that this will ultimately benefit society through graduates who pursue careers outside of academia, such as K-12 education, health care, government, and law.

Changes/Problems

Changes in approach and reason for change

Nothing to report.

Actual or Anticipated problems or delays and actions or plans to resolve them

Nothing to report.

Changes that have a significant impact on expenditures

Nothing to report.

Significant changes in use or care of human subjects

Nothing to report.

Significant changes in use or care of vertebrate animals

Nothing to report.

Significant changes in use or care of biohazards

Nothing to report.

Special Requirements

Responses to any special reporting requirements specified in the award terms and conditions, as well as any award specific reporting requirements.

Nothing to report.

 RSR Award Detail

Research Spending & Results

Award Detail

Awardee:	UNIVERSITY OF MAINE SYSTEM
Doing Business As Name:	University of Maine
PD/PI:	Michelle Smith (207) 581-2604 michelle.k.smith@maine.edu
Award Date:	07/20/2012
Estimated Total Award Amount:	\$ 4,243
Funds Obligated to Date:	\$ 2,241 FY 2012=\$2,241
Start Date:	07/15/2012
End Date:	03/31/2013
Transaction Type:	Grant
Agency:	NSF
Awarding Agency Code:	4900
Funding Agency Code:	4900
CFDA Number:	47.076
Primary Program Source:	490106 NSF Education & Human Resource
Award Title or Description:	Development of the Biology Competencies Assessment Series (BCAS)
Federal Award ID Number:	1245104
DUNS ID:	186875787
Parent DUNS ID:	071750426
Program:	TUES-Type 2 Project
Program Officer:	Jose Herrera (703) 292-5128 jherrera@nsf.gov

Awardee Location

Street:	5717 Corbett Hall
City:	ORONO
State:	ME
ZIP:	04469-5717
County:	Orono
Country:	US
Awardee Cong. District:	02

Primary Place of Performance

Organization Name:	University of Maine
State:	ME
ZIP:	04469-5751
County:	Orono
Country:	US
Cong. District:	02

Abstract at Time of Award

This project is supporting a workshop to convene biology education researchers to plan out the development and validation of a Biology Competencies Assessment Series (BCAS). The BCAS will consist of several multiple-choice and short-answer questions validated by students and designed to evaluate student progress on learning biology concepts and achieving the competencies recommended in "Vision and Change: A Call to Action." In particular, the workshop is bringing together Principal Investigators of both new and established TUES projects related to developing assessment tools to address effectiveness of instruction.

Intellectual merit: The project provides the opportunity for experts in biology educational research to work towards the development of assessments that track the progress of students at multiple points in their undergraduate careers. The opportunity to plan also allows participants to share (and not replicate) efforts to standardize the protocols for validating the questions important to the biology community.

Broader impacts: The project plans a consensus set of tools to help the larger biology community assess how well students are mastering the concepts and competencies outlined in national initiatives. From an educational perspective, this workshop provides promising advances to standard measurement for student learning that allows biology departments across the country to use data-driven processes to align their teaching practices and curricula with learning goals prescribed in several national reports including "Vision and Change."

This project is being funded by the Directorate for Education and Human Resources, Division of Undergraduate Education as part of its efforts toward supporting the goals and objectives of "Vision and Change in Undergraduate Biology Education."

Project Outcomes Report

Disclaimer

This Project Outcomes Report for the General Public is displayed verbatim as submitted by the Principal Investigator (PI) for this award. Any opinions, findings, and conclusions or recommendations expressed in this Report are those of the PI and do not necessarily reflect the views of the National Science Foundation; NSF has not approved or endorsed its content.

Over the past decade, there has been a national effort to transform undergraduate biology education so that we teach biology in a way that reflects how we practice biology. More recently, the NSF and AAAS sponsored a series of conversations with over 500 stakeholders in biology education that resulted in a report entitled *Vision and Change in Undergraduate Biology Education: A Call to Action*. *Vision and Change* articulated a set of core concepts for biological literacy and discipline-specific core competencies, while incorporating the current model of how students learn. Although this report marks a notable accomplishment, to date no validated assessments exist to measure whether students are making progress toward these objectives as they advance through the undergraduate curriculum.

To begin to develop an assessment to meet these needs, TUES-funded scholars from multiple institutions met to plan the development of a series of biology assessments aligned with the core concepts and competencies outlined in *Vision and Change*. We generated a plan to develop, validate, and field-test a collection of biology assessments called Bio-MAPS (for Biology-Measuring Achievement and Progression in Science). In total, we plan to develop four Bio-MAPS assessments: an assessment for each of three focal areas—molecular and cellular biology, physiology and neuroscience, and ecology and evolution—and a comprehensive assessment including questions from each of the three individual assessments. The Bio-MAPS assessments will be administered at multiple points in the biology curriculum to monitor student progress and enable targeted curricular reform.

Following our CRP-funded planning workshop, we wrote eight assessment questions, response validated these questions by interviewing 16 introductory and 16 advanced students from multiple institutions, and piloted these questions to 1700 students at three different Research I (R1) universities and five different community colleges. This pilot project helped

inform our question development process, galvanized our group communication processes, and provided important preliminary data that served as the basis for a TUES II grant application that we submitted in January 2013. These preliminary results indicate that our collaborative research team is able to efficiently work together to establish a framework for the assessments, design and validate questions, and analyze the effectiveness of questions. If awarded a TUES II grant, we will extend this work to create a complete and effective set of Bio-MAPS assessments.

Intellectual Merit: The CRP-funded workshop was the first step towards defining core concepts and competencies from *Vision and Change* and fostering programmatic assessment in undergraduate biology. The research team will work with biology faculty to develop a framework that outlines expectations for what students should know and be able to do at different collegiate levels and utilize best practices from the field of educational assessment to develop standardized assessments for use in departments nationwide. The Bio-MAPS project thus represents a unique effort to articulate common learning goals and monitor longitudinal student learning in biology.

Broader Impacts: Because the Bio-MAPS assessments will be aligned to *Vision and Change*, they will provide a much-needed resource for departments engaging in curricular reform. Data from the Bio-MAPS assessments will catalyze change by: 1) diagnosing areas in which students continue to struggle despite instruction, 2) allowing two-year community colleges to evaluate how well they are preparing students for transfer to four-year institutions, 3) inspiring and directing faculty and institutional conversations about enacting change at the programmatic level, 4) helping administrators focus limited resources on aspects of the curricula that have the strongest need for revision, and 5) challenging faculty to re-design course curricula to effectively scaffold student learning of difficult concepts. Biology departments can also use Bio-MAPS assessments to demonstrate evidence of student learning for accreditation processes.

Last Modified: 04/25/2013

Modified by: Michelle Smith

For specific questions or comments about this information including the NSF Project Outcomes Report, contact us.