

**Annual Report for Award # 0715777**  
**Biology Scholars Program (BSP)**  
(formerly Enhanced Learning Improvements through Evidence Scholars Program)  
**Project Findings**

**Pilot Project: Science Education Writing and Publishing Institute**

We offered a pilot program to increase faculty expertise in science education writing and publishing and, based upon feedback and formative evaluations, have modified the program for 2010. The residency objectives were to enhance biologists’:

- Performance in developing manuscripts for submission to journals and online collections
- Skills in developing abstracts that clearly summarize the research described in the article
- Skills in identifying and selecting appropriate journals and online venues for submission of manuscripts
- Understanding of the guidelines for preparing manuscripts and assigning authorship

The Institute’s outcomes for biologists are that they are able to:

- Identify the characteristics of a good story
- Identify venues for publishing their work
- Evaluate whether their work is ripe for publication and if not, why not
- Develop a plan, as necessary, for additional data collection and analysis
- Organize data and outline a manuscript according to publication guidelines
- Cite references and resources accurately
- Identify a plan to dedicate time for writing

In post-Institute evaluations, all participants noted that the goals were definitely or somewhat met. When asked to identify their skill levels on various components of writing and publishing (e.g., reviewing manuscripts for publication potential, identifying superfluous information or data, or using education-based literature to inform a manuscript), participants noted an average learning gain of 1.4 using a 5-point scale ranging from no skill to very high skill. All participants said that they accomplished what they had hoped to at the Institute.

There were many lessons learned from the pilot study. The Writing Residency’s original benchmark for success—that all Scholars would publish within 12 months—is unlikely to be met. Applicants who were selected based upon evidence of conducting science education research are not ready to publish. Initially, upon acceptance, Scholars were asked to prepare a 10-page manuscript as a basis for the onsite training. However, we learned that our expectations were too high. Although Biology Scholars understand and practice their disciplinary research very well, there is a tremendous learning curve for Scholars transitioning to science education research. Most encountered a number of challenges to writing a manuscript, including faulty research designs, inadequate literature searches, and lack of community feedback. Research is an iterative process, and most Scholars had no prior opportunities to share preliminary findings and deepen their knowledge base. They were void of a community, and sought the Institute as their community.

As a result of the pilot project, coleaders have modified the program for 2010. Modifications include renaming the Residency to a more appropriate title, Transitions Residency: from Science Education Research to Publishing, and changes to the learning goals, learning outcomes, and requisite knowledge of the selected Scholars (Table 1). The revised residency’s kickoff event is the Transitions Institute: Transitioning for Educational Research to Publishing on June 11-14, 2010, in Washington, DC.

**Table 1. Transitions Residency: from Science Education Research to Publishing**

<b>Concern</b>	<b>Modification</b>
Ensure that applicants are at an appropriate point before they are selected	Planners modified the application requirements to ensure that Scholars are further along in the writing process. In the past, Scholars submitted a one-page abstract of their research and reasons for attending. For 2010, two new essay questions were added, one about the problem being addressed and related questions of study, and a second describing the applicants' unique journey into science education research. These additional questions should help reviewers assess Scholars' readiness to write.
Address participant concerns about timing, schedule, content, and follow-up	These two concerns have been addressed simultaneously with the new Transitions Institute: Transitioning for Educational Research to Publishing. Changes have been made for 2010; the program:
Provide a different type of Institute for people who have completed the Research Residency, but are not ready for the Writing Residency	<ul style="list-style-type: none"><li>• Is scheduled in June rather than January (visit <a href="http://www.biologyscholars.org">www.biologyscholars.org</a> for final agenda)</li><li>• Is planned for three, not two, days</li><li>• Offers an introduction to and practice on a dedicated wiki prior to face-to-face training</li><li>• Offers 10-plus hours of writing time under the mentorship of editor and peers</li><li>• Offers guidelines and tools for providing standardized feedback</li><li>• Offers yearlong follow-up assignments and check-in conference calls</li><li>• Has identified a more feasible outcome—a revised manuscript, gap analysis, and plan for next steps</li></ul> Planners recognize that a draft manuscript is required at the application stage to meet an outcome of final submission for publication. However, most biologists (that the Biology Scholars Residency Program seeks) are not at this stage professionally.

#### **Fourth Annual Research Residency (2008-2009)**

The Research Residency held each year in July includes several components: a four-day Scholarship of Teaching and Learning Institute, follow-up activities and e-mentoring, and a half-day Capstone Workshop. The purpose of the 2008 Research Residency is to develop biologists':

- Understanding of evidence-based research in biology education learning
- Skills to create, design, and implement an experiment to assess student learning
- Community of practice available for consultation and support

The Institute outcomes for biologists are that they are able to:

- Develop a hypothesis to explore student learning in biology
- Design an experiment using their classes to test the hypothesis
- Identify existing resources regularly used to assess student learning
- Understand methods of collecting and interpreting data used to measure student learning
- Understand IRB requirements for conducting research on students
- Identify appropriate venues for publishing their research

In the four years of implementation, the Research Residency has remained somewhat stable in content, structure, and process. Interested applicants apply and are accepted into a "cohort." Once accepted, they begin work using Internet tools (e.g., a listserv or wiki) and assignments and

subsequently attend a four-day interactive and intensive SoTL training program followed by more assignments and check-in conference calls.

The 2008 Research Residency helped 20 biologists develop the knowledge and skills to conduct science education research and provided two active forums ([wiki.biology-scholars.org](http://wiki.biology-scholars.org) and [bspresearch08@mail.asmus.edu](mailto:bspresearch08@mail.asmus.edu) listserv) to share ideas. They were the largest group ever and represented Scholars from four-year and primarily undergraduate teaching institutions. Post-Institute evaluations, follow-up surveys, and focus group meetings of the 2008–2009 cohort indicate very high satisfaction with both the Institute and their experience as Scholars. A major goal for the 2008 program was to expand to the biological sciences (from microbiology), and 71% of the Scholars agreed to the statement, “Even though I am not a microbiologist, I felt welcome at the Institute.” Twenty-nine percent indicated that they were unsure or had no opinion; these may have been the responses of actual microbiologists. One hundred percent of respondents noted that they were either satisfied or very satisfied with the Institute, and 100% of respondents noted that they would recommend the Institute to a colleague. The majority of participants indicated that most of the learning objectives were met for them personally. Interestingly, this group appears to be more “skilled” than their former cohorts, as indicated by the average learning gains from survey responses. A number of “skill sets” (for example, using a variety of teaching approaches, including active learning, developing learning goals, addressing student needs, assessing student learning and revising accordingly, including regular formative assessments, and measuring student learning) in the past would have averaged at least a 1.0 learning gain and a BEFORE score of 2.5. The 2008-2009 cohort surpassed each of these. For example, the 2008 cohorts’ learning gain ranged from 0.5 to 1.0 and the BEFORE scores ranged from 2.8 to 3.6. Finally, Scholars ranked other components of the residency with attending the SoTL Institute, implementing their assessment project, and participating in the 2009 ASMCUE conference as having the most impact on their professional growth. Scholars found these three components to be most valuable.

Scholars have engaged in a number of activities as a result of participating in the program. Ninety-three percent of survey respondents indicated that they had identified a teaching problem to address through classroom research, identified literature and research design related to their problem, and conducted some research. Eighty-six percent indicated that they gained IRB approval and gathered and interpreted some data.

The cohort made recommendations which have been incorporated into the 2009-2010 Research Residency (Table 2)

**Table 2. Research Residency Changes Implemented Between 2008 and 2009**

Component	Concern	Modification of Program
Institute	Incorporate more practical knowledge and less theoretical information; use more engaging presentations, such as having the Scholars themselves serve as the case studies	<ul style="list-style-type: none"> <li>• Eliminated journal club discussions as stand-alone sessions and incorporated this training in each presentation regarding research methods</li> <li>• Moved case studies to first day to illustrate the Scholars’ journey through SoTL</li> <li>• Allocated more time for team and individual time for participants to describe their journeys/cases</li> </ul>
	Include more information about types of research methods and schedule the program so that Scholars can attend several of the sessions	<ul style="list-style-type: none"> <li>• Scheduled a “series of five presentations” on research methods rather than a schedule of two sessions on research methods and forcing participants to select two out of five sessions to attend; we learned that participants need more training than originally planned in this content area</li> </ul>

Institute	Define and communicate the role and responsibility of the critical friend; consider matching critical friends after the participants learn more about one another	<ul style="list-style-type: none"> <li>Developed guidelines articulating the uniqueness of the critical friend, team members, team leaders, and facilitators</li> <li>Added a session on the last day to plan the yearlong residency</li> </ul>
	Other modifications based upon post-Institute surveys	<ul style="list-style-type: none"> <li>Expanded program three hours</li> <li>Articulated goals and objectives for each presentation/day</li> <li>Added three hours of facilitator training</li> <li>Moved all training on the <a href="http://wiki.biologyscholars.org">wiki.biologyscholars.org</a> to before the Institute to allow more face-to-face training on individual challenges</li> </ul>
Other Components	Use follow-up conference calls to answer specific questions and check in rather than "report out"	<ul style="list-style-type: none"> <li>Incorporated more extensive use of wiki and preconference call assignments so that time during calls can focus more on individual challenges</li> </ul>
	Incorporate the use of a master calendar	<ul style="list-style-type: none"> <li>Improved calendar and posted it to wiki</li> <li>Incorporated automatic reminders about deadlines.</li> </ul>
	Clarify expectations for attending ASMCUE and presenting	<ul style="list-style-type: none"> <li>Will develop guidelines and expectations for attending ASMCUE and presenting;</li> <li>Will communicate guidelines to 09 cohort prior to attending 2010 ASMCUE.</li> </ul>

In addition, three 2008 Scholars have been invited to join three facilitators from 2008 to plan, lead, and facilitate the 2009 residency program. These include Carol Hurney from James Madison University in Virginia (representing the PKAL/AACU SENCER Program), Jenny Knight from the University of Colorado (representing the ASCB), and Mary Pat Wenderoth from the University of Washington in Seattle (representing the APS).

### Implementation of Classroom Assessments: Results of Three Cohorts from 2005-2008

Follow-up studies were conducted from scholars participating one, two, and three years ago. The areas generating the highest gains were formative assessment, student learning assessment, and developing learning goals. Respondents were asked to indicate their skill (S) or knowledge (K) levels BEFORE and AFTER their Scholars experience using a scale from 1 = 5 (1 = no S/K, 2 = low S/K, 3 = some S/K, 4 = high S/K, and 5 = very high S/K) (Table 3).

**Table 3. 2005-2008 Biology Scholar Cohort's Learning Gains in Knowledge and Skills about SoTL**

Skill	Before	Now	Average Gain
Including regular formative assessment in courses	2.3	4.0	1.7
Assessing student learning and revising teaching methods accordingly	2.6	4.0	1.4
Developing learning goals based upon students' understanding of the material	2.4	3.8	1.4
Developing learning goals that reflect the nature of science	2.7	3.8	1.1
Giving and receiving constructive feedback about teaching	2.9	3.9	1.0
Drawing on knowledge and experience of colleagues	3.3	4.1	0.8

## **Scholars' Contribution to the SoTL: Results of Three Cohorts from 2005-2008**

The Scholars definitions of SoTL continue to evolve and be refined. About one-third of the respondents focused on the practice of teaching and learning (the "T" and "L" of SoTL):

- SoTL is the metacognition of teaching skills and practices.
- The facilitation of learning that is student centered, active, and leans towards androgyny instead of pedagogy.
- The process of identifying the learning objectives for a course (or even a piece of a course) and assessing the extent to which your students actually learn the intended objectives.
- Student-centered learning that is an active process for both the teacher and the learner.
- Systemic process of identifying a problem in student learning, designing an activity to address.
- The problem and then measure of the effect the activity had on some aspect of student performance.
- Study of the effect of pedagogical changes on student learning. Upon determining the impact of the pedagogical changes, if positive, including those changes in courses.
- Inquiry into one's teaching and its effect on student learning.
- Incorporate good teaching practices based on how students learn and their diverse backgrounds.

Another third of the respondents focused on the "scholarship" or research aspects of SoTL (the "S" in the acronym) in their definitions:

- Applying scientific principles to understanding what happens within the classroom.
- SoTL involves the creation of communities of teachers and sharing of resources.
- SoTL is a scholarly approach to determine best practices to enhance student learning. It is hoped that this research can be disseminated to fellow teachers through publication and presentation. Approaching teaching as we would any research question. Define a problem, devise a way to address the problem, gather data, analyze data, and publish the results. Teaching IS a scholarly pursuit.
- Partly taking scholarly teaching public (publishing/presenting/sharing in a peer-reviewed venue) the results of careful (evidence-based) learning interventions, the impact on student learning (assessment), often carried out in an iterative process.
- SoTL is a process through which student learning can be analyzed scientifically in order to draw conclusions as to which methods are more effective for developing students' grasp of particular subjects.
- It is the systematic study of classroom techniques and how they affect learning in your own classroom.

These final respondents incorporate all of the aspects of SoTL in their definitions:

- SoTL is an area of study directed at understanding how students learn, with the ultimate goal of disseminating learning outcomes so that the cumulative body of literature can impact the instructional process.
- The systematic study of teaching methods and the resulting student learning and the dissemination of those findings to the educational community.
- Thinking, experimenting, and reflecting about teaching and learning and making it all public.
- SoTL is fundamentally about innovation and assessment to systematically improve student learning outcomes. This involves reflection on teaching, research, and discussion of works with peers through presentation and publications. Making it public.
- It involves a questioning, scientific approach to understanding how, and how much, our students learn. Caring about it, measuring it, paying attention to it... and engaging in peer dialogue of observations and results.

## Application of SoTL in Practice

Even though it is important for the scholars to be able to define and understand the concepts of SoTL, it is even more critical to know if they are applying what they learned due to their participation in the program. Table 4 shows that responses to the follow-up survey questions about application indicate large skill and knowledge gains in the practice of SoTL, moving from "low" or "some" skill scores to an average of "high skill" in identifying a teaching problem and measuring student learning.

<b>Skill</b>	<b>Before</b>	<b>Now</b>	<b>Average Gain</b>
Measuring student learning	2.5	4.1	1.6
Identifying and solving teaching challenges	2.7	3.9	1.2

When asked how they practice SoTL, a sample of the survey respondents wrote:

- I practice inquiry and conceptual-based teaching actively with students using a variety of techniques; thinking about how to effectively and consistently assess student learning; reflecting and sharing practices and experiences with colleagues.
- I am always questioning how much my students are learning. Engaged in mentoring education students as they prepare for a career in teaching. Dialogue with peers, and publish my own results and studies when I can. I also work with K-12 teachers and am able to communicate with them about how to teach science more effectively and measure it.
- With the creation of an environment that the students deem "safe" so that they feel confident in voicing opinions and viewpoints that may not be popular—I have incorporated peer review (student to student) in writing assignments and engaged them in discussion during class time as much as possible—also the use of a case study format that utilizes formative evaluation and feedback with no penalty of a poor grade, and then summative evaluation after the students' understand what is expected.
- I have worked with three other faculty members to assess the implementation of a new set of lab exercises in the cell biology course. The labs were designed with specific learning goals in mind. The new labs (three labs) and the assessment have been submitted for publication and reviewed. The review was very positive, and we can easily address the reviewers' complaints. It was clear from the reviews that they liked our assessment piece. I credit the ASM SiR program with showing me the importance of assessing my teaching practice with the final, soon to be successful, outcome in the form of a solid pedagogical publication for four faculty at my institution.
- I share all of my teaching resources. I collect data on how students learn. During the course of a semester I alter my teaching practices to adjust to the class.
- I have developed detailed learning objectives and goals for every class I teach. I introduce activities and assess them.
- I have been evaluating the effectiveness of our laboratory course design on teaching the process of science.
- I identify particular problems/goals/challenges for each class. Review literature; design an approach or intervention or activity. Design formative and summative assessments. Apply for IRB approval. Implement, assess, analyze. Repeat (or tweak and repeat). Hopefully collect enough interesting data to write up for publication. Along the way, talk to colleagues, present posters at meetings to get feedback.
- Through ASM Scholars, I determined that adding a discussion group program to a BIO 101 course enhances student critical thinking so, I have continued to incorporate discussion groups into my courses. My exams include questions to determine my Intro BIO student's level on the expert to novice continuum—and teach to help students become "experts." I developed prelaboratory modules to ensure that the students are prepared for laboratory and set up a pedagogical study to determine if the modules helped. I will be evaluating the data

this summer. Finally, based upon others' work, I have incorporated the clickers system into my courses to assess student learning during my lectures.

- Have a primary component of my duties relating to research in my teaching methods.
- I am involved with developing a campus culture of SoTL through the creation of a teaching center. My personal research focuses on effective ways to teach students about the ethical implications of the human genome project.
- I employ SoTL literature to design curricula and learning assessment studies that will add to the understanding of how students learn. Current projects involve an introductory biology curriculum and high school outreach.
- I regularly gather data from my classroom, especially if I am using a new technique. I continue to refine good reaching strategies, using classroom assessment and student learning outcome to justify effective teaching skills. As seen from these comments, many of the respondents extended their application of SoTL knowledge to a larger community.

These data complement participants' agreement with various statements BEFORE their Scholars experience and AFTER using a scale from 1 to 5 (1 = strongly disagree, 2 = somewhat disagree, 3 = neutral, 4 = somewhat agree, and 5 = strongly agree). Most importantly, they moved from a neutral stance about their interest in publishing findings about student learning, to a "high"/"very high" response average. See Table 5.

**Table 5. 2005-2008 Biology Scholar Cohort's Interest in Publishing, Practicing and Advancing SOTL**

Statement	Agreement Level		
	Before	After	Average Gain
I am interested in publishing my findings about student learning	2.8	4.4	1.6
I feel part of a community of teachers	2.8	4.4	1.6
I can mentor other teachers and teachers-in-training	2.6	4.2	1.6
I regularly experiment with new teaching approaches	3.3	4.3	1.0
I am a good teacher	3.6	4.1	0.5

**Contributions to SoTL and the Larger Base of Knowledge about Student Learning: Results of Three Cohorts from 2005-2008**

Impact on Career

These data indicate that a majority of the scholars continue SoTL work, seek to contribute to the larger knowledge base about student learning, and often take on further leadership roles. Furthermore, many of the Scholars' careers have been very positively impacted by their participation:

- I gained promotion from "assistant" to "associate." I feel my credentials as a teaching scholar played a role in that.
- I earned a Ph.D. and was promoted from rank of instructor to rank of assistant professor on the tenure track.
- I have taken a major career turn as a result of the Scholars program. I am currently a PhD student in our faculty of Education, looking at the scientific (biological) literacy of our undergraduate students as they move through our biology program (and how our program influences their perceptions of science and biology).
- I have been promoted to senior academic professional.
- I have been asked to carry out other responsibilities (run a SoTL group on campus and chair our institution's IRB).

- I was (at the time of participation) a non-tenure track assistant professor. I have since been "converted" to the tenure track, with SoTL as my area of scholarship.
- I received tenure/promotion, and I was just appointed chair of my department.
- I moved from non-tenure track lecturer to tenure-track assistant professor.
- I was promoted to associate professor.
- I now regularly practice SoTL and get credit for this with my P&T committee.
- This experience helped me receive tenure and promotion. I have also been asked to review our pretenure faculty's teaching portfolios. Finally, this experience enhanced my CV so that I was a more attractive applicant for the chair position (which I received).
- The outcome of the ASM Scholar's experience has been incredibly positive. It has had a profound impact on my research program (now ~50% SoTL work). The scholar's program provided me with the confidence and resources to make this major career shift with very positive outcomes.

### Impact on Philosophy of Teaching

Lastly, the Scholars noted that their overall view of teaching and learning has changed, which is reflected in the "philosophy of teaching" each shared:

- Before my philosophy was based on the limits I needed to place on how I developed courses and interacted with students. Now I actively push for student-based course design, assessment, and interactions to improve the learning experience of students in my classes.
- My philosophy has not changed a lot. What has changed is my ability to measure learning and my confidence in engaging in that learning community.
- I feel that I have gained a solid foundation in SoTL and plan to build from what I have learned.
- The main outcome for me is a boost in my confidence as a teacher and also as a microbiologist.
- The Scholars program has also opened up new and interesting research projects for my students, independent of the microbiology course.
- My teaching philosophy has changed in that I now try to consider the purpose of each aspect of the course. I find I can more easily prepare exams that match what I teach, at least I think I do. This has been a problem in my teaching, and I feel I am much better at testing my students on what I tried to teach. This may sound goofy, but this is why I feel more confident as a teacher.
- It has interested me in learning more about my teaching and how to change it so my students can learn.
- I have actually been humbled by the experience. My assessment of student learning actually showed that my course design made little difference, even though I thought it was really cool!
- I make students more responsible for their own learning and give more assignments that are on fewer topics but are designed to really reflect what students need to learn.
- More active/interactive, less concerned about covering everything, more interested in determining if students are learning less content but more deeply and meaningfully.
- I focus on developing students' critical thinking skills and enhancing students' ability to transition on the expert-to-novice continuum.
- Hasn't really changed, but I have a better understanding of how to be a successful SoTL scholar.
- My philosophy has not changed dramatically - I always saw learning as a shared endeavor between the student and teacher. However, I feel more empowered and confident in my statement of that philosophy after the ASM scholar program. Just like learning should not be a solitary activity for the students, teaching should not be a solitary activity for professors. It is important to have a SoTL community whom we know and can feel comfortable contacting to ask for ideas, feedback, and criticism. This now exists for me through the ASM Scholars program. I stay in touch with many of those in my cohort, and just this weekend met one of

my cohorts at a local ASM meeting. I have presented a joint workshop with another of my cohorts.

- I evaluate my teaching more critically than before and am more responsive to students needs.
- I modify teaching strategies after understanding how students learn.