To Deepen and Sustain Innovation: Incorporating the scholarship of teaching and learning into a diverse and diffuse science education systemic reform project

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Abstract:

Science Education for New Civic Engagements and Responsibilities (SENCER) is a systemic effort to reform undergraduate science education in the U.S. and the signature project of the National Center for Science and Civic Engagement (NCSCE). Since 2002, more than 1100 faculty, administrators, and students from over 300 high schools, colleges, and universities located in 166 US congressional districts and 13 foreign nations have participated in the project. The community of practice that has evolved through the SENCER project is both diverse and geographically diffuse and therefore represents a unique context for initiating and implementing the scholarship of teaching and learning (B). This article describes the development of SENCER to the point where individual faculty members were suggesting that SoTL work be initiated within and the initial steps taken by NCSCE leadership to implement programs that would support this desire on the part of individual faculty. Both early successes as well as challenges are described. Our hope is that the initial experiences of initiating and implementing SoTL related programs will be useful both to those involved in the reform of undergraduate science education as well as those who seek to implement SoTL within contexts that are more diverse and diffuse than typical institutions of higher education.

Key Words:

SoTL, scholarship of teaching and learning, teaching commons, orientation, faculty development, STEM education, science education.

Introduction

During the mid 1990's a series of reports from a variety of organizations - the National Science Foundation (NSF), the National Research Council, Project Kaleidoscope, and others- highlighted growing concerns with the state of education in science, technology, engineering, and mathematics (STEM) in the United States. While

a more detailed description of these concerns can be found in the two "meta-analyses" done by Project Kaleidoscope (2002, 2006), in brief these concerns included:

- the level of science literacy demonstrated by many Americans;
- the dominance of lecture as a pedagogy that did not engage students in the process of how science was actually done;
- the lack of substantive connections between what students were expected to learn and real world issues that involved a significant STEM component.

In response, NSF solicited and funded a number of projects that sought to implement systemic level reform in STEM education. As one of these systemic reform projects, "Science Education for New Civic Engagements and Responsibilities" (SENCER) was started by David Burns and Karen Oates in 2001. SENCER (http://www.sencer.net) sought to improve learning in undergraduate science courses and develop civic engagement by teaching "to" basic, canonical science and mathematics "through" complex, capacious, often unsolved issues of civic consequence. This approach was seen as a way to (1) get more students interested and engaged in learning in STEM courses, (2) help students connect STEM learning to their other studies, and (3) strengthen students' understanding of science and their capacity for responsible work and citizenship. As the ideals of the project (available on the website) made clear, SENCER sought to invite students to put scientific knowledge and the scientific method to use on matters of immediate interest to students, and thereby help them understand the power of science by identifying the dimensions of a public issue that can be better understood with mathematical and scientific ways of knowing. Through this approach, SENCER also hoped to help reveal to students the limits of science by identifying the elements of public issues where science does not help us decide what to do. By doing so, SENCER hoped to help students overcome both their unfounded fears and their unquestioning awe of science. Through its focus on contested issues as the context for learning science, SENCER hoped to encourage student engagement with "multidisciplinary" issues and civic questions that require attention now. The project worked to promote large-scale reform in undergraduate STEM education through intensive faculty professional development, a strong focus on local systemic change, and the use of improved assessment practices.

From the outset, SENCER worked to encourage and support faculty development through a wide ranging and coordinated set of activities and programs. There were model courses featured by the project that provided concrete examples of what the SENCER approach looked like in the context of a course or learning community. Periodically commissioned background papers served to explore a wider range of issues that linked science and complex civic challenges. Starting in the summer of 2002 the project sponsored an annual SENCER Summer Institute (SSI) that served as team-based residential institutes for faculty and administrators planning to initiate SENCER approaches. The program at SSI featured a mix of plenary sessions, workshops, and concurrent sessions as well as networking opportunities over a period of four days for 250 to 300 participants. SENCER also supported the development of the SENCER-SALG (Student Assessment of Learning Gains) Instrument as a tool to gather information on what students felt they had gained from taking SENCER courses. In many ways, SENCER has, since its inception encouraged and supported what Huber

and Hutchings (2005) described as a teaching commons, "a conceptual space in which communities of educators committed to pedagogical inquiry and innovation come together to exchange ideas about teaching and learning and use them to meet the challenges of preparing students for personal, professional, and civic life." (Huber and Hutchings, x)

Initially the framework for SENCER was developed at the American Association of Colleges and Universities. However, in 2004 the project moved to a new home with the establishment of the National Center for Science and Civic Engagement (NCSCE) at Harrisburg University of Science and Technology. The Center's mission focused was to "develop and house activities and projects that encourage and strengthen campus-based efforts to reform undergraduate science education, enhance student learning, engage students with pressing civic questions, and address important issues of our common health." While several areas of focus are currently identified on the Center's website (www.ncsce.net), SENCER remains the signature program of NCSCE.

SoTL Work Within SENCER Before Joining the Affiliates Program

While NCSCE applied to participate in the CASTL Affiliate program in late 2006, there had been some prior SoTL related work within SENCER that had been organized by individuals within the community. Jacqueline Dewar (Mathematics, Loyola Marymount University), a 2003 Carnegie Scholar, presented a session at the 2004 SENCER Summer Institute on "Turning Teaching Problems into Research Problems**."** In response to calls from SENCER alumni, Matt Fisher (Chemistry, Saint Vincent), a 2005 Carnegie Scholar, organized a plenary session, "SENCER and the Scholarship of Teaching and Learning" at that year's summer institute. There was a growing sense among those individuals involved with SENCER for several years that the challenge of how to advance and deepen the SENCER project would require involved faculty to take more of a "meta-cognitive approach" to their work. SoTL was seen as a valuable tool in meeting this challenge. The first part of the plenary focused on a SoTL project done by an individual faculty member as a starting point to examine what types of questions could be asked about student learning and what evidence could be gathered towards answering these questions. The second part of the session was a panel discussion that looked at questions, challenges, and resources that would be helpful for faculty interested in approaching their SENCER work as scholarship of teaching and learning.

Initial efforts to incorporate SoTL into the program of SSI had been grassroots efforts by faculty involved in SENCER. By late 2006, NCSCE leadership saw several reasons for applying to the CASTL Affiliates Program. They saw the promise of the growing work in SoTL as the natural next step for faculty who had been involved in SENCER's work for several years and who had reached a point of asking deeper, more complex questions related to student learning. Up to that point, SENCER's own assessment of student learning in SENCER courses had focused on using tools such as the Student Assessment of Learning Gains (SALG) initially developed by Elaine Seymour and colleagues at UC-Boulder and revised for SENCER by Sue Lottridge. The data gathered to date - some of which has been published in the *Journal of Chemical Education* (Middlecamp et al, 2006) - led the SENCER community to focus more on the question of how students learn science in a SENCER course and how this might differ

from student learning in more traditional STEM courses. These questions were viewed as ones that required the systematic, evidence-based, and reflective approach that increasingly characterized SoTL. There was also the sense that NCSCE's participation in the CASTL Affiliates Program would help those in leadership roles within SENCER learn from the work of other institutions while providing NCSCE and SENCER a means to share the work that some of the SENCER faculty were doing. The goals that NCSCE articulated when applying to participate in the CASTL Affiliates Program were 1) to help faculty participating in SENCER develop scholarship of teaching and learning projects, 2) to disseminate the results of scholarship of teaching and learning work throughout the SENCER community and outside of SENCER in the context of scientific societies, and 3) to connect student learning in SENCER courses to broader questions of student learning in STEM courses nationally.

SENCER incorporated several new features into the SSI program to support and promote SoTL. The 2007 and 2008 Summer Institutes each included a pre-institute workshop on SoTL that lasted for the equivalent of a full day. The workshops focused on helping attendees refine questions they wanted to pursue and identify appropriate sources of evidence. From 2007 on, the Summer Institute program has included a session titled "Inquiring Into Our Students' Learning: The Scholarship of Teaching and Learning" that presented an overview of SoTL. In 2008 and 2009 this session highlighted the work of selected workshop participants from the previous year. We anticipated several impacts from involvement in the CASTL Affiliates Program. While some faculty within the SENCER community had already been engaged in SoTL, the hope was that these new activities would result in an increase in the number of faculty - from a range of institutions - engaged in SoTL. We also hoped to see an increased use of SoTL in other aspects of SENCER's work, particularly those related to assessment and the collective understanding of what student learning in SENCER courses really encompassed.

Summer Institute SoTL Workshop

The overall design of the pre-institute SoTL workshop drew heavily from the SoTL residency that the American Society for Microbiology (ASM) had offered for several years. Spencer Benson (Biology, University of Maryland), a 2001 Carnegie Scholar and SENCER participant since 2002, had been involved in the development and implementation of the ASM program. Faculty interested in the pre-institute workshop were selected through an application process that made it clear that the workshop was intended to help participants develop and refine a project rooted in SoTL that inquired critically and reflectively into student learning. Workshop goals were to help participants:

- develop and explore a specific question they had about student learning
- identify evidence that could be gathered that would address the question
- develop their own understanding of the ethical issues involved
- learn where to find needed resources
- explore ways to make public their work.

Applicants were directed to a range of web based examples of SoTL projects completed by individual faculty members, many of them associated with various CASTL

programs. Questions on the workshop application asked interested faculty to describe their teaching responsibilities, their goal(s) for participating in the workshop, the aspect of teaching or student learning that the faculty member wanted to investigate, and the context and rationale for their question.

Accepted participants were asked to complete two assignments before the workshop. The first assignment asked them to read three articles:

1. The SoTL classic "The Scholarship of Teaching: What's the Problem?" (Bass, 1999)
2. "Defining the Scholarship of Teaching and Learning in Microbiology" (Benson, 2001)
3. "Why Should YOU Publish Your Best Teaching Ideas?" (Nelson, 2001)

After completing the readings, each faculty member was asked to write a brief (approximately one page) reflective piece addressing the following questions in relation to their proposed SoTL research question:

- How would you describe your "research problem(s)" to the SENCER group?
- What theme(s) based on your readings, resonate with your "problem" and/or your proposed approach to address your problem?
- Which of the 12 properties of SoTL proposed by Benson's article (2001) are particularly relevant to your project at this stage?
- Do you have any questions/concerns/comments that have evolved from your reading?
- What do you see as tangible products to be developed as a result of your Scholars experience within the next 12 months?
- What do you see yourself presenting at the follow-up session at next year's SSI?
- What will you need to develop these products?

The second assignment – based on an activity developed as part of the ASM program - asked participants to find five references relevant to their projects – two of these were to be found through an ERIC Search – and prepare an annotated bibliography for those works. The assignment instructions guided participants through the SoTL literature search process and introduced them to a wide range of resources including ERIC*,* PubMed and disciplinary education journals, PsycINFO, *Mountain Rise*, *Journal of Cognitive and Affective Learning*, SoTL case studies at the Carnegie Foundation website, the Peer Review of Teaching Project website (http://www.courseportfolio.org) , and the Visible Knowledge Project (https://digitalcommons.georgetown.edu/blogs/vkp/).

The workshop included four core elements:

- What's the problem: Framing the question
- Data – defining, collecting, analyzing
- Ethics and institutional review boards
- Existing literature and venues for going public

In between presentations focused on one of these core elements, participants had what was called "intellectual play time" where they could work individually or talk to another workshop participant or one of the facilitators. To help provide some structure for this, participants were gathered into small groups that provided a mechanism for peer feedback on projects as they developed through the workshop. Participants were also introduced to the KEEP Toolkit, a set of web based tools, as a way of presenting the main elements of their project. Developed by the Knowledge Media Lab at the Carnegie Foundation for the Advancement of Teaching, the KEEP Toolkit was designed to help teachers, students and institutions quickly create compact and engaging knowledge representations on the Web that integrated text, images, video, and hyperlinks. Freely available to all who wanted to use it, the KEEP Toolkit site maintained by the Carnegie Foundation closed in the fall of 2009 and the software moved to a new home within MERLOT (http://ww.merlot.org) where it was renamed the Content Builder.

Outcomes and Challenges

By some measures, both the pre-Institute workshop and the SoTL-focused session within the Summer Institute program appeared to be successful. Feedback from workshop participants in both 2007 and 2008 was positive, and several participants were able to present results of their projects as part of the "Inquiring Into Our Student's Learning" session at subsequent Summer Institutes. Turnout at the "Inquiring" sessions has been good – 20 to 25 people each year where attendance at SSI sessions can range from less than 10 to 40 people - and responses gathered as part of the Summer Institute evaluation have also been positive. Searching the session descriptions in the detailed SSI program since 2004 reveals the following: only one session made reference to SoTL in 2004 and 2005, two sessions made reference in 2006, and four sessions and one workshop made reference in 2007 and 2008. Clearly SoTL has a higher profile within SENCER than it did before NCSCE joined the CASTL Affiliate program.

Yet it has also become clear that the original goals of helping SENCER faculty develop scholarship of teaching and learning projects and connecting student learning in SENCER courses to broader questions of student learning in STEM courses face significant obstacles. Some of these could not have been foreseen at the time that NCSCE applied to the CASTL Affiliates program. The economic downturn that first became apparent in late 2007 and led to significant reduction in funds available to support faculty travel was probably a major factor in the 50% reduction in the number of applicants to the 2008 pre-Institute workshop. A second challenge was that faculty participating in SENCER were often leaders on their campus in other initiatives and so some found that unexpected demands from other commitments such as being appointed chair as part of an academic restructuring or a leadership roles in general education reform diminished the time that they had for their scholarship of teaching and learning projects. But these were not the only challenges encountered.

Something that was underestimated by the leadership team was the challenge of maintaining continuity in a program that was so geographically disperse. Of the 20 workshop participants in two summers, only two faculty came from the same institution. All of the other participants were attempting to carry out their individual scholarship of

teaching and learning projects by themselves on campuses with significantly different support mechanisms. In some cases, those institutions provided very positive and supportive environments for work in SoTL. In other cases, on-campus support was minimal or non-existent. The wide range of environments that faculty were working in as they engaged in SoTL posed a real challenge in terms of what the SENCER community itself needed to provide in the way of support.

Another unexpected obstacle to expanding the role of SoTL within SENCER was the resistance that many SENCER faculty felt from colleagues in their departments or institutions towards this approach of teaching STEM courses. While there have been a number of articles published calling for a change in the way that undergraduate STEM courses are taught (Feig, 2004; Handelsman et al, 2004; Alberts, 2005; Wieman, 2007; Labov et al., 2009), only recently has the nature of faculty resistance to these calls been explored in depth (Dancy and Henderson, 2008; Fairweather, 2008). Faculty teaching SENCER courses regularly describe the pressure they feel from colleagues to provide evidence that this approach works better than traditional approaches to science education. In many cases, the criterion for "working better" is improved mastery of content. Such pressures make it more difficult for SENCER faculty to pose questions related to student learning that seek to "make the invisible visible" (Bass and Eynon, 2009). As a result, the range of scholarship of teaching and learning projects that SENCER faculty feel they can invest time into are largely ones focused around some form of the question "does this approach work better?" While these questions are valid, they do not reflect the full range of questions that SoTL can pose (Shulman, 1999; Hutchings, 2000; Huber and Hutchings, 2005).

Future Directions

Where will NCSCE and SENCER go next in regards to supporting SoTL? One possibility currently being pursued is moving the workshop program to the regional Centers for Innovation. SENCER Centers for Innovations, established in 2008, are intended to be the core of what is hoped will become strong regional networks that offer faculty development and collaboration opportunities. As of early 2010, there were six centers based at Southern Connecticut State University, Rutgers University, the University of North Carolina at Asheville, Harold Washington College, Santa Clara University, and Texas Woman's University. Holding the workshops at the regional centers offers the potential advantages of reduced travel cost for attendees, ease of expanding the schedule to run an entire weekend, and the possibility of developing regional support networks that might work against the isolation that plagued many of the initial workshop participants.

In regards to the goal of connecting student learning in SENCER courses to broader questions of student learning in STEM courses nationally, that work may require a different approach to SoTL. Historically, much of this scholarship has been done by individual faculty working alone or in very small groups of two or three. Richard Gale (2007), in his essay "Points without limits: Individual Inquiry, Collaborative Investigation, and Collective Scholarship", points out that SoTL can also be done as a collaborative or collective activity. Up to this point SENCER has approached this issue of broader student learning in STEM courses as something that can be investigated as a series of

individual projects. But it may be that approaching this question as a collaborative or collective activity, with one senior member of the SENCER community providing leadership for the gathering and analysis of evidence from a number of faculty members within the community might be a more fruitful approach.

In some ways, the incorporation of more developed forms of SoTL into the teachings commons established by SENCER and NCSCE is in its early stages. Even so, the experience to this point makes clear that a growing number of faculty within SENCER are interested in approaching their classroom work in this way, and SoTL offers intriguing possibilities for exploring how students learn in SENCER courses and how these experiences affect student learning in subsequent courses. Hopefully what has been learned from the initial efforts described here will lay a foundation for the continued expansion and flourishing of SoTL within the SENCER community.

Acknowledgments

References

Alberts, B. (2005). A wakeup call for scientists. *Cell, 123*, 739-741.

Bass, R. 1999. The scholarship of teaching: What's the problem? *Inventio: Creative Thinking about Learning and Teaching, 1*. available at http://doit.gmu.edu//archives/feb98/randybass.htm

Bass, R. and Eynon, B. (2009) Capturing the Visible Evidence of Invisible Learning, in *"The Difference that Inquiry Makes: A Collaborative Case Study of Technology and Learning, from the Visible Knowledge Project,"* edited by Randy Bass and Bret Eynon, Academic Commons January 2009. Retrieved from http://www.academiccommons.org/files/BassEynonCapturing.pdf

Benson, S. (2001). Defining the Scholarship of Teaching and Learning in Microbiology. *Focus On Microbiology Education 7* (3), 1-6.

Dancy, M.H. and Henderson, J.C. (2008). Barriers and Promises in STEM Reform. Commissioned paper presented at NRC workshop on Evidence on Selected Promising Practices in Undergraduate Science, Technology, Engineering, and Mathematics (STEM) Education, Washington, DC. Retrieved from http://www7.nationalacademies.org/bose/Dancy_Henderson_CommissionedPaper.pdf.

Feig, A.L. (2004). Challenge your teaching. *Nature Structural and Molecular Biology*, *11*, 16-19.

Fairweather, J. (2008). Linking Evidence and Promising Practices in Science, Technology, Engineering, and Mathematics (STEM) Education: A Status Report. Commissioned paper presented at NRC workshop on Evidence on Selected Promising Practices in Undergraduate Science, Technology, Engineering, and Mathematics (STEM) Education, Washington, DC. Retrieved from http://www7.nationalacademies.org/bose/Fairweather_CommissionedPaper.pdf.

Handelsman, J., Ebert-May, D., Beichner, R., Bruns, P., Chang, A., DeHaan, R.L., Gentile,

J., Lauffer, S., Stewart, J., Tilghman, S.M., and Wood, W.B. (2004). Scientific teaching. *Science 304*, 521–522.

Huber, M. T., & Hutchings, P. (2005). *The advancement of learning: Building the teaching commons.* San Francisco, CA: Jossey-Bass.

Hutchings, P. (2000). *Opening lines: approaches to the scholarship of teaching and learning.* Menlo Park, CA: The Carnegie Foundation for the Advancement of Teaching.

Labov, J.B., Singer, S.R, George, M.D., Schweingruber, H.A., and Hilton, M.L. (2009). Effective Practices in Undergraduate STEM Education Part 1: Examining the Evidence. *CBE—Life Sciences Education 8,* 157–161.

Middlecamp, C.H., Jordan, T., Shachter, A.M., Lottridge, S., Oates, K.K. (2006). Chemistry, Society, and Civic Engagement (Part 1): The SENCER Project. *Journal of Chemical Education 83*, 1301-1307

Nelson, C. (2001). Why Should You Publish Your Best Teaching Ideas? *National Teaching and Learning Forum 10*(2), 10-11.

Project Kaleidoscope. (2002). *Report on Reports.* Retrieved from http://www.pkal.org/documents/ReportOnReports.cfm

Project Kaleidoscope. (2002). *Report on Reports II.* Retrieved from http://www.pkal.org/documents/ReportOnReportsII.cfm

Shulman, L. (1999). Taking learning seriously. *Change*, *31*(4), 37-44.

Wieman, C. (2007). Why not try a scientific approach to science education? *Change*, *39*(5), 9-15.