

**Diffusion of SENCER:  
Leading Change on Campus**

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**A SENCER BACKGROUNDER  
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## **Introduction**

“Some may consider it an ‘inconvenient truth’ that science education within our hallowed halls does not reach the average student. Science requirements within general education programs are viewed with disdain, and student enrollment is often governed by the need to ‘get the requirement out of the way.’ However, campuses associated with the SENCER dissemination project are finding it possible to change students’ attitudes regarding science requirements. Doing so requires moving away from the traditional pedagogical approaches many faculty emulate from their own education and toward those approaches which truly engage students in scientific understanding of the world around them. SENCERizing a campus requires a commitment from faculty and administration. This discussion presents effective actions put into place at a comprehensive, urban campus to encourage the infusion of the SENCER approach in the science classroom and to revolutionize science teaching from the general education classroom to the major.”

This was my presentation abstract for the 2008 SENCER Summer Institute. The 2007 abstract is similar. When David Burns first asked that I write these presentations as a backgrounder, he suggested I read over Terry McGuire’s backgrounder “Reinventing Myself as a Professor: The Catalytic Role of SENCER.” [McGuire] McGuire cautions that his paper is not a “how-to” narrative (although it provides sound advice for anyone looking to reinvent themselves in the classroom). Such is the case with this backgrounder. I would not necessarily market this as a guide for leading change on campus. While it may appear that I had a plan that was carefully executed, the truth

follows Lord Polonius' comment "Though this be madness, yet there is method in it."  
[Shakespeare] Only in retrospect and through some research into the study of change leadership does an actual "method" emerge that brings the SENCER ideals to the science classrooms<sup>1</sup> at Southern Connecticut State University (SCSU). I invite you on a reflective journey of our SENCER efforts to date. While I believe we have made great progress, much still needs to be done.

### **Science Education at SCSU**

Southern Connecticut State University, one of four institutions governed by the Board of Trustees for the Connecticut State University system, is a comprehensive metropolitan public university offering degrees in 40 undergraduate programs and 46 graduate programs. Southern also offers a sixth year diploma in several special areas and a doctorate of education. Current full-time and part-time enrollment is 13,000. Undergraduate degrees in physical anthropology, biology, chemistry, earth science, mathematics, and physics are offered through the School of Arts & Sciences. In addition, we offer minors in environmental studies and marine studies, as well as graduate degrees in biology, chemistry and science education. All secondary education programs are housed within the respective departments in Arts & Sciences. We have a total of 61 faculty members in mathematics and the sciences and a current count of 878 undergraduate and graduate majors, with 49% of these majors being women and

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<sup>1</sup> Many alumni of SENCER refer to the incorporation of the SENCER approach in courses as SENCERizing the courses.

members of under-represented groups. The majority of science students major in biology. Our acceptance rate into medical schools is approximately 67% and our acceptance rate into Ph.D. programs is approximately 90%. In spring of 2007, the Board of Trustees approved the establishment of the Center for Coastal and Marine Studies and the Center for Excellence in Mathematics and Science at SCSU. Faculty are actively involved in research and often include undergraduate and graduate students in their projects.

The current general education program at SCSU is a traditional program with requirements distributed among disciplinary lines. Students are required to complete three to four credits in Natural Science A (biology and earth science) and three to four credits in Natural Science B (chemistry and physics). We have a large nursing program which requires 24 credits in biology, chemistry and physics. All science classes match Carl Wieman's description of a traditional science class [Wieman] - a professor stands in front of a large passive group of students who are copiously taking notes. The students go home and work end-of-chapter problems in their textbook and take exams that closely resemble those problems. The students complete laboratory exercises and may connect the experimental results to the lecture's content (depending upon the laboratory instructor).

Attempts to discuss pedagogy with the science faculty are met with mixed reviews. Faculty in the Physics Department are very involved in science education and well-versed in issues pertaining to student learning. At the other end of the spectrum, we

have faculty very clearly express their satisfaction with Wieman's science classroom description.

“I provide the most up-to-date material relevant to my discipline. I do not believe in ‘outcome’ based learning as you understand it. I run my courses following the disciplines of the people who trained me. So far I think that I have been pretty successful. If you have complaints from students concerning my professional competence, please put them in writing so that I can adequately address them. Lastly, I am not interested in the ‘Scholarship of Teaching and Learning’ and will answer no questions concerning it.” In other words, if it worked for me, it will work for my students. Granted, many faculty employing traditional teaching methods in the classroom have a loyal following of students, particularly in the major. And, very rarely do I receive student complaints regarding any science faculty.

### **My Background**

I joined the chemistry faculty at SCSU in the fall of 1987. I taught General Chemistry and upper-level and graduate courses in Inorganic Chemistry. I was well-liked by students and made many efforts within my traditional classroom to connect the topics to my students' lives. By the fall of 1997, I felt that all my courses needed major revision and was looking for ways to improve my students' learning. During the winter break, I began implementing a different laboratory curriculum for the senior-level inorganic course and was exploring the possibility of working with a publisher to revise an out-of-print inorganic chemistry textbook.

The spring 1998 semester took a very different turn. At that time, I was in my fourth year of chairing the chemistry department, and had been elected chair of the newly founded Undergraduate Curriculum Forum. I was excited about this new leadership role, particularly given the need to restart (for a third time) efforts to revise our general

education program. In retrospect, I was flattered by the confidence of my colleagues' vote, and I think I was enticed with the possibility of leading change in a curriculum that was outdated and whose requirements often were associated with the phrase "get it out of the way." However, before the start of the semester, an interesting game of musical chairs was played in the administration. The Dean of Arts & Sciences assumed the position of Interim Vice President for Academic Affairs. I was offered the position of Interim Dean for the School of Arts & Sciences.

I decided to accept the position, in part, because my career goals included the possibility of moving into the administration, and I was handed the opportunity of doing so with an incredible safety net. I could try my hand at leading the largest school on campus, and if I found it didn't suit me (or I didn't suit it) I could easily return to the faculty without any embarrassment. I quickly learned that my time in the position would be much longer than the six months initially indicated and that I actually enjoyed the work of the dean, challenges and minutia included. My predecessor (now the Vice President) encouraged my enthusiasm, reminding me that "there were no interim decisions, only interim positions." Recognizing that I would remain in this role for awhile and that I would apply for the position when a search was initiated, I decided to make the most of my time. I had the choice of maintaining the status quo within the school or leading the school in a new direction. I chose the latter.

SCSU was in the third year of a ten-year strategic plan which called for the creation of an Academic Strategic Plan. Many meetings were spent discussing visions and missions, initiatives, action steps, and timelines. Schools were instructed to emulate

the process, which led to the realization that the School of Arts & Sciences had no stated vision or mission. Searching for the common thread tying all departments and programs together, I started down the path that would lead me to SENCER. I was beginning what would ultimately become one of my primary advocacies – promotion of liberal education as the foundation of any university education. In the process, I articulated the common goal, our commitment to liberal education, for the School of Arts & Sciences.

In 2001, I was appointed dean of the school. I continued advancing the agenda I set two years earlier, promoting the value of liberal education and the role of Arts & Sciences in providing that education. I became the university's lead representative to the Association of American Colleges and Universities and began attending the national meetings and Network for Academic Renewal working conferences.

### **SENCER 2004 and Beyond**

I first heard of SENCER while attending the 2002 national AAC&U meeting. We were making progress in reforming the general education program and I thought it helpful to have a team of faculty and administrators attend this meeting in Washington, D.C. Jim Tait, co-chair of the Gen. Ed. Task Force and a science faculty member, spoke with Amy Schacter about SENCER and brought it to my attention.

Over the next two years, our involvement with AAC&U continued, and I was reminded of SENCER at each meeting I attended. By 2004, I actually took the time to learn about this initiative at the AAC&U national meeting and suggested to Jim Tait that we send a team to the summer institute. I was concerned that we would continue to have

watered-down versions of science majors' courses offered as general education requirements and felt a need to incorporate a new approach to teaching science to nonmajors, one that could improve the scientific literacy of our students. I was extremely dissatisfied with the status quo and wanted change. We were also planning on attending the AAC&U General Education Institute that summer. Jim felt we weren't ready to get into the details of the course requirements for the science portion of our new general education program and thought we should wait one more year.

Our Honors College Director, Terese Gemme, was also a member of the Gen. Ed. Task Force. The Honors College program, like our general education program, was virtually unchanged from its inception in mid-1980. We were struggling with the delivery of its science requirement, "The Idea of Nature." This course compares ancient and modern science, and examines the role of experimentation and the concepts and meanings of science. For many years, it was offered with both a lecture and laboratory component. Up until the fall 2002 semester, the course was team-taught by faculty in the biology and philosophy departments. Since that time, the course has been taught by faculty in the Philosophy or Anthropology Departments. Unfortunately, the laboratory component is no longer offered and the content has veered into the domain of the philosophy of science.

Terese and I met to discuss the program's science requirement shortly after I proposed attending the SENCER Summer Institute to Jim Tait. I shared my information about SENCER with Terese, who eagerly embraced the idea of attending the summer institute as an advance team. Our goal was to implement some of the SENCER approach



in an Honors College course in the spring 2005 semester. From the standpoint of E. M. Rogers' "Diffusion of Innovation" [Rogers, pp. 252-280] change leadership theory, Terese, unknowingly, was taking on the role of an "innovator," uncomfortable with the status quo and eager to try new things. I became the "change agent," the individual attempting to influence the decision to bring the SENCER innovation to SCSU.

### **Diffusion of SENCER: The Method**

My original approach to writing this backgrounder was to incorporate a well-researched discourse expounding upon the virtues of SENCER. I first turned to the "Handbook of the Undergraduate Curriculum: A Comprehensive Guide to Purposes, Structures, Practices, and Change" [Gaff, Ratcliff] and found such a discourse in chapter 13, which outlines the need for curricular reform projects in the sciences. Gene Wubbels and Joan Girgus call for the development of science courses "that focus on understanding science through a primary lens of real-world problems or other contexts, usually with a multidisciplinary or interdisciplinary stance." [Wubbels, Girgus]. I also found, in Chapter 31, "Strategies for Change," a very concise summary of E. M. Rogers' "Diffusion of Innovation" theory and its application to higher education [Lindquist]. I was surprised to learn that our efforts at changing the pedagogical approaches in teaching science fell in step with a marketing theory first published in 1962. I'll briefly describe this theory for those of you who may want to use this backgrounder as a "how-to" guide.

Diffusion of an innovation is the process by which an individual or organization decides to adopt (or reject) a new idea, practice or object. E. M. Rogers, *et.al.*, describes

this decision-making process as moving from learning of the innovation to forming an attitude about the innovation to adopting the innovation. Once the innovation is adopted and implemented, efforts are made to confirm that the decision to adopt was correct. Usually, an individual identifies a need before learning of an innovation; however, it is not uncommon for an individual or organization to learn of an innovation and then match that innovation to a problem. The innovation must provide a relative advantage to the adopter and be compatible with the social system's values. [Rogers, pp. 10-11, 34-36]

Individuals in the diffusion process are categorized by the role they assume in communicating or adopting the innovation. These roles come under the headings of change agents, innovators, early adopters (which includes opinion leaders), early majority, later majority, and laggards. The change agent is the individual who identifies a need and recommends an innovation to meet that need. The change agent tries to influence the adoption of the innovation and facilitates the exchange of information between those considering the innovation and those who created the innovation. In addition to creating the intent to change, the change agent works to have the intent transformed into action. The change agent's success depends upon the credibility of the change agent and the compatibility of the innovation with the need for change. [Rogers, pp. 335-352]

An innovator is a daring individual, willing to take risks and connected to networks outside the social system. This individual is uncomfortable with the status quo, less resistant to change, and eager to try new ideas. Usually, the innovator does not belong to the group identified as needing the innovation and, therefore, may not be

respected by the group members. [Rogers, p. 263] The innovator is the first to adopt an innovation and can increase the group's awareness of the innovation. However, the innovator usually does not convince others to adopt. Opinion leaders, who are innovative but not innovators, have a unique and influential position within the group. These individuals usually have greater contact with the change agent and are more actively involved in the social system. If the opinion leader becomes too innovative (deviates too much from the system's norms), she will lose her credibility with the group. [Rogers, pp. 293-296]

Most often, opinion leaders are found among the early adopters of an innovation. These individuals are more integrated into the group's social system, are considered role models, and are highly respected by their peers. Early adopters decrease the uncertainty of an innovation by providing a subjective evaluation. The early majority are more deliberate group members and the most numerous, approximately 1/3 of all the adopters. These individuals are an important link in the diffusion process; however, they are not opinion leaders. They "follow with deliberate willingness in adopting innovations." [Rogers, p. 264]

The late majority are very skeptical of innovation and will only adopt as a response to increased pressure from their peers and when the innovation's uncertainty is removed. By the time the late majority adopt the innovation, the innovation is considered part of the system's norms. Laggards, perhaps more kindly referred to as traditionalists in a higher education setting, have the past as their point of reference. These individuals are very suspicious of innovations and change agents and partake in very lengthy

decision making processes. Before finally agreeing to accept an innovation, these traditionalists must have substantial evidence that the innovation will not fail. [Rogers, p. 265]

Adopting innovation requires carefully delivering the new idea. Faculty are more willing to listen to new ideas that are well researched and backed by impressive evidence. Other attributes that aid the adoption include simplicity, low risk, low uncertainty, the relative advantages to the adopters, compatibility with the institution's values, the ability to adopt in part or in some easy sequence, and the ability to observe or pilot the idea before wholesale adoption. The opinion leader plays a crucial role in the process of delivering the idea to the faculty. The most persuasive opinion leaders are "those whose expertise, experience, or social role establishes them as credible sources of information." [Lindquist] Given the long-standing tradition of shared governance in higher education, it is best to have the opinion leaders come from the faculty. Therefore, the dean or chairperson's role is one of the change agent, to identify the opinion leaders and have them carry the message to the faculty.

The adoption of SENCER at SCSU has moved from the innovator stage through the early adopter stage. We are progressing through the early majority stage, although the rate of adoption has been slowed by the current budget crisis. We are fortunate to have opinion leaders in influential positions who are well-respected by their peers and whose innovativeness is nonetheless slightly outside the system's norms.

## **Transitioning Through the Process**

### *The Plan*

How did we diffuse the SENCER ideal from the innovators to the early majorities? We started with a plan. Keep in mind, we initially attended the summer institute in hopes of revising the science offerings in the Honors College. However, concurrent with our need to revise that curriculum was the NEASC (Northeast Association of Schools and Colleges) requirement that we revise our general education program. Therefore, we decided to pilot SENCER science courses in the Honors College (a very interdisciplinary, team-taught curriculum well suited to the SENCER ideals) with the intention of using the experiences from the pilot to inform the science requirement (labeled as the Natural World requirement) in our new Liberal Education Program. Implementation of this plan was made easier given that one of the identified opinion leaders was Jim Tait, the chair of the Gen. Ed. Task Force and a science faculty member.

Upon our return to campus in 2004, Terese and I enlisted Vince Breslin, a faculty member in our Science Education/Environmental Studies Department and a member of the Honors College faculty, to create a science course for the Honors College. During the fall 2004 semester, Vince and I collaborated on developing a course entitled “Issues in Science and Society: The Environmental Impact of Energy Use in Connecticut.” We kept Barbara Tewksbury’s guide to designing a SENCER course close by and referred to it often. Vince taught the course the following spring. (I was along for the ride, but had a minimal role in the delivery.) Vince became an early adopter of the SENCER innovation and was the most visible opinion leader on campus. Terese’s role as an innovator

continued as she worked to implement the goals of our SENCER mini-grant and incorporate the new science course into the Honors College program. In my capacity as a change agent, I submitted a proposal to SENCER to have a team attend the 2005 Summer Institute. Members of that team included Jim Tait, Vince Breslin, Christine Broadbridge, Terese Gemme, and me. The following year, Vince and Jim revised the Honors College course, changing the topic from “The Environmental Impact of Energy Use in Connecticut” to “Science on the Connecticut Coast: Investigations of an Urbanized Shoreline.” This particular course is now a regular offering in the Honors College curriculum and was accepted as a SENCER model course in 2007.

After attending the 2005 SENCER Summer Institute, we transitioned from the pilot program in the Honors College to the Natural World requirement in the revised general education program. The original description of the Natural World requirement was written by Jim Tait. As chair of the Gen. Ed. Task Force, he had already been identified by the faculty as a colleague whose knowledge and expertise of curricular matters was well-respected by his peers. Jim formulated the purpose and experience of this area of knowledge as “to familiarize students with science as a method of inquiry and to raise their awareness of the role science plays in the world. The ability to accurately and objectively articulate the scientific underpinnings of important complex issues is essential in a society that increasingly depends on science and technology.” [Tait, *et.al.*] A key element for all courses offered under this heading is “Relevance to Contemporary Societal Issues – Understanding the scientific components of some important world issues (for example, biodiversity loss, genetic engineering, global climate change, land

use and planning, resource depletion, or energy concerns.)” [Tait, *et.al.*] This language sealed Jim’s role as a SENCER opinion leader on campus.

The “opinion leaders” began speaking with their colleagues in the sciences, and held meetings in which the purpose and key elements of the Natural World requirement were discussed. The only concerns publicly voiced about the key elements for the Natural World requirements were the logistical and budgetary problems of requiring that all courses contain a significant laboratory or field experience. The SENCER aspects were not questioned.

#### *Faculty Development: Easing into the Early Majority*

Given Jim Tait’s position on the Gen. Ed. Task Force, it was relatively easy to shape the purpose and key elements of the Natural World requirement around SENCER. However, we needed buy-in from the science faculty to have the proposal accepted and move forward to a faculty referendum. This required that we move from the “early adopters” stage to the “early majority” stage. Faculty development played a large role in this transition. Continuing in her role as an innovator, Terese Gemme arranged to have David Burns visit our campus in the spring of 2006 to talk to faculty, students, and administrators about SENCER. In the process, he discovered that we actually had a true innovator of SENCER, an individual who incorporated SENCER ideals long before he was aware of the SENCER project. Terry Bynum regularly offers the course “Computer Ethics” which examines “the application of moral theories to ethical problems created, aggravated or transformed by computer technology.” [SCSU]. David Burns invited

Terry to submit this course for inclusion in the SENCER National Model Series. The course was chosen for inclusion in the series in 2006. We now have SENCER diffused through a small corner in the Philosophy Department.

Resources were made available for faculty to attend the SENCER regional meetings in Springfield, MA and the 2007 Summer Institute in Portland, ME. We even brought the 2008 regional meeting to SCSU to accommodate those individuals reluctant to travel. I would venture to say that a majority of the science faculty is aware of SENCER, and a good number can actually provide a description of the program. And, like Terry McGuire, some are looking at their courses and attempting to change/add one or two concepts/activities that embrace the SENCER ideals. Our fourth team is attending the 2009 Summer Institute and includes the dean for the School of Health and Human Services. I intend to have an additional change agent on campus working with individuals in our Public Health and Exercise Science departments to create SENCER courses for our Mind and Body area of knowledge in the Liberal Education Program. As a change agent, I am facilitating these faculty development opportunities by providing the needed resources. SENCER is the change agency as defined by Rogers, and my role as change agent is to link the change agency to the faculty. [Rogers, p. 335] The best opinion leaders in delivering the SENCER message are found at the summer institutes, and my goal is to have 75% of the science and mathematics faculty become alumni of these institutes.

The department chairpersons should be a member of either the early adopter or early majority group, particularly given their day-to-day interaction with their colleagues



and influence with tenure-track faculty. After the 2005 Summer Institute, Jim Tait was speaking with one such chairperson, describing one of the model courses. The response was less than flattering, and no amount of persuasion on Jim's part could lead the faculty member to look at the SENCER website. As a result, no one else in the department would consider this approach in developing their courses.

I invited this individual to attend the 2007 summer institute. During our stay in Portland, he would occasionally comment, "I could see us using this in some gen ed courses." A year later, he assisted a new faculty member in developing two SENCER courses which will meet the Natural World course requirements. The early or late majority may be more readily influenced to adopt when provided the opportunity to witness the innovation's impact on others.

In many ways, the department chairperson is an opinion leader, and as such, it is necessary to have buy-in from these individuals early on in the process. Nevertheless, if the department chairperson is unwilling to accept SENCER, it may be possible to identify another leader in the department. Four of the five science chairpersons have attended either the regional meetings or summer institutes. The one who has yet to attend is very supportive of SENCER and encourages new faculty to offer courses which address capacious, complex social issues. In addition, he reinstated a course whose catalog description is aligned with the SENCER ideals.

### Strategic Hires

Moving from the early adopter stage to the early majority stage can also be facilitated through strategic hires. New faculty will fall on either side of the dividing line in this process. They may bring traditional approaches learned from either their undergraduate or graduate education or they may be easily influenced by the opinion leaders in their department (another reason to have buy-in from the department chairperson). The dean can help in this regard by shifting into the role of either an innovator or opinion leader. The interview with the candidate provides an excellent opportunity to share my opinion regarding SENCER. (On a few occasions, the impact of SENCER has been illustrated by the candidate initiating the discussion.) Each interview is followed by a conversation with the department chairperson and/or the search committee chairperson in which I indicate whether I consider the candidate a viable candidate. My opinions are often determined by the candidate's reaction to the SENCER description and her response to questions regarding her pedagogical approach. During hiring negotiations, I continue referencing SENCER, offering the candidate the opportunity to attend the summer institute and articulating my expectation that SENCER becomes a part of his course development efforts.

There is a cautionary note to consider when involving new tenure-track faculty in an innovative process. The department must have an early adopter or early majority faculty member in the department support the new faculty member. Additionally, this individual needs to have the "how-to knowledge" necessary to implement SENCER

successfully. If done incorrectly, the late adopters and traditionalists will have the evidence needed to reject the innovation.

### Rewards/Support Systems

If new faculty members come into a department consisting primarily of the late majority or traditionalists, they need to know that their efforts to bring SENCER into the curriculum will be well rewarded. I will often include comments in yearly evaluations about the positive impact such efforts have on student learning, and if need be, take others to task for devaluing such efforts. Evidence of quality in teaching is the top criterion for evaluation of faculty for renewal, promotion, tenure and professional assessment. Letting faculty know that the administration notes and values their efforts in SENCERizing the curriculum and considers such efforts evidence of quality provides continued motivation to young faculty navigating the tenure process. (However, depending upon the departmental culture, it is sometimes prudent to advise tenure-track faculty that the diffusion of SENCER may need to take longer than seven years.)

Other forms of support come from funding field trips/experiences in SENCER courses, poster presentations of class results, and invited presentations at SENCER venues. For some, moving from the traditionalist position to the late majority may be a result of wanting the same resource support received by the early adopters and early majority.

Rewarding faculty for their innovative pedagogy can motivate them to experiment with an innovation. In 2007, Vince Breslin was nominated for the J. Philip Smith

Outstanding Teaching Award. Nominations come from faculty and students, and the nominee is expected to submit a portfolio demonstrating his/her innovations and quality in the classroom. There is no formal role for the dean. On occasion, nominees have requested that I write a letter of support. I normally decline, not wanting to create an atmosphere of favoritism. However, Jim Tait requested I write a letter of support for Vince, which I willingly did. Given Vince's acumen in the classroom, I seriously doubt my letter had much to do with him receiving the reward. However, I wanted to send a message to all the faculty in the sciences that emphasized the value I place on incorporating SENCER in our science curriculum. The early and late majority need the evidence that this innovation is well supported and valued before they are willing to spend time and energy revising existing courses or proposing new ones.

### **The Challenge: The Late Majority and The Traditionalists**

Some would argue that attempting to get all traditionalists on board is a waste of time. Individuals such as the one who runs his courses following the pedagogy of those who trained him probably will never engage in learning about SENCER. For the time being, his students are very happy with his courses and believe they learn a great deal. If, over time, the students begin to experience a new way of learning, their satisfaction with his course may diminish. It will be interesting to observe his response if students become dissatisfied or frustrated with his pedagogy.

The late majority and traditionalists can be forced to change. If we remove the current choice to continue teaching the traditional class by periodically reviewing the

alignment of courses with the purpose and key elements of the Natural World requirement, faculty will be forced to either change the pedagogical approach of their courses or not teach in the general education program. Such draconian measures may force faculty to become extremely late adopters. However, I would never advocate such measures and advise that careful consideration be given before taking a similar approach. Students are not well served when faculty are forced to adopt course content or pedagogies that they consider of little value.

It may be best, as David Burns has so wisely suggested, to follow the advice for facilitating change offered by the political theorist Michael Oakeshott in his essay “On Being Conservative.”

“[A] man of conservative temperament draws some appropriate conclusions. First, innovation entails certain loss and possible gain, therefore, the onus of proof, to show that the proposed change may be on the whole expected to be beneficial, rests on the would-be innovator. Secondly, he believes that the more closely the innovation resembles growth (that is, the more clearly it is intimated in and not merely imposed upon the situation) the less likely it is to result in a preponderance of loss. Thirdly, he thinks that an innovation which is in response to some specific defect, one designed to redress some specific disequilibrium, is more desirable than one that springs from a notion of generally improved condition of human circumstances, and is far more desirable than one generated by a vision of perfection. Fourthly, he favors a slow rather than a rapid pace, and pauses to observe current consequences and make appropriate adjustments. And lastly, he believes occasion to be important: and, all other things being equal, he considers the most favorable occasion for innovation to be when the projected change is most likely to be limited to what is intended and least likely to be corrupted by undesired and unmanageable consequences.” [Oakeshott]

One characteristic attributed to both the late majority and the traditionalists is a conservative nature, one in which the need for change is unrecognized. To change

requires a loss of that which is comfortable and a gain of that which is anxiety ridden. The “onus of proof” then lies with the change agent, the innovators, opinion leaders, etc. to show that the change is indeed beneficial. Such proof may come from the inclusion of assessment instruments, such as the SALG, which demonstrates the amount of learning occurring in the classroom. Scientists do understand and appreciate the value of data. If we can provide data that demonstrates the difference between the learning in a traditional course vs. the learning in a SENCER course, we may find that some traditionalists will begin to believe that SENCER is “in response to a specific defect,” the decrease in scientific literacy, and that the SENCER approach “resembles growth” in his ability to increase student learning. As a consequence, this innovation is “less likely to result in a preponderance of loss” with the students’ satisfaction with the course. Finally, providing faculty the opportunity to incorporate change at their own pace is advantageous. The ebb and flow of change allows the later majority and traditionalists to observe what does and does not work well in the classroom and to determine which strategies are best “limited to what is intended.”

### **SENCER Across the Curriculum**

At this point in time, we offer two SENCER courses on a regular basis, both of which are model courses. Faculty in the Biology and Science Education/Environmental Studies departments are collaborating on an additional SENCER course, and biology and chemistry courses in the current General Education Program were revised to incorporate the SENCER approach. During the fall 2009

semester, we will implement use of the SALG in at least one of the SENCER courses. The most exciting development in terms of SENCER on campus is the work of Susan Cusato, chairperson of the Science Education/Environmental Studies department, and Lara Smetana, Assistant Professor of Education. They plan to implement a concentration in Elementary Science Education for our M.S. in Science Education program in which all science content courses will incorporate SENCER. We anticipate that this degree will be very popular among elementary and middle school principals, given the recent inclusion of science on the Connecticut Mastery Test.

Teaching to science through complex, capacious social issues is not limited to the science classroom. SENCER can find a very comfortable home in critical thinking courses and first-year experience programs. SCSU developed an inquiry seminar for our entering freshmen that focuses on the role of higher education and the mission of SCSU to empower every undergraduate student with “the knowledge, skills, and perspectives essential for active participation and impassioned, ethical leadership in our rapidly changing global society.” [SCSU Mission Statement] In addition, this seminar highlights our commitment to community service, civic engagement and social responsibility and the integration of this commitment in the learning experiences of our students. SENCER courses can be readily adapted to meet the inquiry seminar’s requirements, and the summer institutes are replete with examples of civic engagement and social responsibility that can be used as learning experiences for our students. In fall of 2008, I taught one of these seminars centered on the goal of demonstrating the value of a liberal education when faced with an unstructured problem. The unstructured problem

featured in this seminar came directly from Brian Hagenbuch's 2007 summer institute workshop on the buffalo wars. This coming fall, my seminar will focus on the unstructured problem of flu pandemics. This topic was inspired by a conversation with David Burns in 2005 as the fear of the bird flu was diminishing. David worried that few universities he knew about seized the opportunity of this grand teachable moment by incorporating this complex, capacious social issue into their curriculum. I am now taking on the role of an innovator in this course. It is quite possible that future SCSU teams attending the summer institutes will consist of faculty dedicated to teaching the inquiry seminar from all disciplines in the arts and sciences.

### **Beyond SCSU: The “How To” Guide**

A faculty member from a neighboring institution asked me “How do I convince my dean to embrace SENCER?” Another faculty member attending the 2007 institute asked what she could do to support her dean. The answer to both questions is the same – become a change agent. A dean or provost may not necessarily be focused on the issue of scientific learning or the status of the science courses in the general education requirement. A change agent determines the needs and recommends innovations to meet those needs. You can determine those needs through data gathered from the administration of the SALG in your own courses and your colleagues' courses. You can take advantage of the regional SENCER Centers for Innovation and request that a member of the leadership council visit your campus to meet with key administrators. The



SENCER fellows are willing to assume the role of change agents and work with campus innovators to convince the early adopters, early and late majority, and even a few traditionalists to embrace SENCER. By taking into consideration the characteristics attributed to the different roles in the diffusion process, you can identify the opinion leaders among your colleagues. If possible, work to find the resources necessary to bring a team of innovators, opinion leaders, and the dean to the summer institute.

If the dean starts out as the change agent on campus, the best support you can provide is to take a strong leadership role in the process. You can lighten the workload for the dean by becoming the change agent and working to identify faculty as innovators and opinion leaders. As the change agent, you can diffuse SENCER through the curricular process by arranging SENCER meetings on campus, attending regional meetings, and proposing summer institute teams. Above all, you can begin to bring the SENCER ideals into your own teaching, so that you can point to real examples of improved learning when you are speaking with your colleagues. Your students will themselves become advocates for change.

The work of a change agent, innovator, or opinion leader can be overwhelming, particularly when the goal is to diffuse the innovation through a department or a school or a university. When it is the dean's role to be the change agent attempting to lead the school towards accomplishing the truly important, the viability of the change is dependent on the dean's ability to devote attention the reform. Unfortunately, we deans spend our days with our attention unequally divided between the merely urgent (managing the school) and the truly important (leading the school). We are concerned

with budgets, enrollments, student issues, the angry parent on the phone, and answering to our stakeholders. We constantly find ourselves putting out small brush fires created by the institution's bureaucracy and the political nature of our profession. These are the issues that keep us awake at night, the merely urgent tasks of managing the school. As a consequence, partners in the process are critical for the success of the process.

Keep in mind that all of us were once classroom teachers. We chose the academy as our profession because of our commitment to the furthering and creation of knowledge. We want our students to be deeply engaged in their learning, to have the highest quality education possible, to appreciate the ideals of a liberal education, and to truly be on the path of the intentional life-long learner. If we could have total control over the division of our labor, these are the issues with which we would occupy our time for these are the truly important. We need as much support and help as possible to diffuse SENCER across the school, for diffusion of SENCER focuses the faculty on these truly important issues and can eventually reach into every corner of the school. By adding your voice to this effort, we can make science education model the very best of what we know about how people learn.

### **Epilogue: Diffusion of SENCER and Reinvention**

Diffusion scholars recognize that adoption of an innovation is frequently accompanied by re-invention of the innovation to better match the needs of the adopter. "Potential adopters become active participants in the adoption and diffusion process, struggling to give their own unique meaning to the innovation." [Rogers, p. 179] In the

opening paragraphs of this backgrounder, I made reference to Terry McGuire's backgrounder "Reinventing Myself as a Professor: The Catalytic Role of SENCER." [McGuire] Re-reading Terry's backgrounder after writing my own, I realize that Terry re-invented SENCER to give his own "unique meaning to the innovation." SENCER reciprocated, reinventing Terry in the process. While I have yet to find research supporting the idea, I suspect that this dynamic relationship, re-invention of both the innovation and the adopter, is common. I, too, have been reinvented by the SENCER innovation. During the spring of 1996, I attended a meeting with the dean of Arts & Sciences and the dean of Education. We were discussing the recent state mandate that all of our certification students be taught the use of technology in the classroom. At one point during the meeting, a very frustrated dean of Education shouted, "You people in Arts & Sciences just don't get that no one learns by being talked to." The chairperson of the Chemistry department shot back with, "I beg to differ! Everyone sitting in this room learned by being talked to!" I was that chairperson, and by the spring of 1998, I was the dean of Arts & Sciences and working with the very same dean of Education to convince the Connecticut State Department of Education that SCSU should be reaccredited to offer initial teacher certification. I learned a great deal from that education dean, and he prepared me well for the moment when I walked into the Recital Hall at Santa Clara University and listened to José Mestre present a plenary lecture on "Using Learning Research to Transform the Way We Teach Science." Susan Cusato has often told me I should not diminish my own transformation from an elitist chemist who believed that understanding concept and theory were all that matter in the classroom to a science

educator, embracing all learning styles and attempting to engage those learning styles when I teach. José Mestre's lecture was a turning point for me. As I interacted with his pedagogy and connected that pedagogy to teaching and learning, I realized that SENCER, at its very core, is about teaching that matters, that makes a difference. I began to understand my own learning style and the learning styles of my children. I became excited about the possibility of teaching and wanted, for the first time in my career, to teach the non-science major. SENCER gave me the confidence to tackle the freshmen inquiry seminar. Instead of delivering a course from a textbook, I now know how to create a course starting with a goal. I look forward to each summer institute knowing that I will bring back to Connecticut something that can be put to use, whether it is the incorporation of some innovative use of technology (such as the use of personal response systems (clickers) in the classroom), or a complex, capacious social issue as a discussion topic in the inquiry seminar. Even though I currently do not have the opportunity to teach chemistry, the diffusion of SENCER provides me with the opportunity to impact the learning of chemistry. SENCER has provided me a forum for discussing the teaching of science and the importance of using the science of teaching in the process.

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