

Article

Getting Started in the Scholarship of Teaching and Learning: A “How to” Guide for Science Academics

Susan L. Rowland^{†*}
Paula M. Myatt[‡]

From the [†]School of Chemistry and Molecular Biosciences Faculty of Science, University of Queensland, Brisbane, Australia, [‡]Teaching and Educational Development Institute, University of Queensland, Brisbane, Australia

Abstract

SoTL stands for the Scholarship of Teaching and Learning. The acronym, said “sottle” or “sote—all,” describes research that involves rigorous examination of teaching and learning by faculty who are actively involved in the educational process. The number of natural-science faculty engaged in SoTL is increasing, and their important work has broad implications for the measurement and improvement of college teaching and learning outcomes. The data show, however, that many faculty who conduct SoTL projects in science

departments begin their education research careers with no training in SoTL research methodologies, and find they are working alone, with few colleagues who can nurture (or even understand) their efforts. In this article we provide a guide intended to help natural-science faculty initiate SoTL projects while they negotiate the mechanics and politics of developing and maintaining a SoTL research program in a science department. © 2013 by The International Union of Biochemistry and Molecular Biology, 42(1):6–14, 2014

Keywords: integration of research into undergraduate teaching; mentoring; methods of science education research; teaching and learning techniques methods and approaches

Introduction

“There are professors on every campus who are looking closely at their students’ learning, redesigning their courses and programs, and coming together to share what they’ve learned with others. Broadly speaking, these are the faculty who are engaged in what is now widely called the scholarship of teaching and learning.”

This quote from Hutchings, Huber, and Ciccone [1] sums up the ethos and practice of the Scholarship of Teaching and Learning (SoTL). The examination of one’s own teaching is a hallmark of SoTL. Teaching and learning scholars can “treat their classrooms and programs as a source of interesting questions about learning; find ways to explore and shed light on these questions; use this evidence in designing and refining new activities, assignments, and assessments; and share what they’ve found with colleagues who can comment, critique, and build on new insights.” [2].

College faculty who are science-trained, but engaged in education research, are called Science Faculty with education specialties, or SFES [3]. Their numbers are increasing through both (i) migration of academics from “discipline based” research to SoTL work and (ii) specific hires of faculty with education specialties [1, 3–5]. A recent US-based study [3] shows that in the last decade more SFES have been hired than in all previous years combined. It also shows that fewer than 50% of these faculties have formal training in Science Education or SoTL research methodologies [3]. This means that many SFES are beginning their SoTL research careers with “only” a pure science background to support their education research.

SFES are being hired to both teach and conduct science education studies in fields such as biomedicine, physiology, biology, chemistry, biochemistry and molecular biology, and microbiology at a wide variety of tertiary institution types [3]. Despite their increasing numbers, many SFES find that their work is not strongly supported by colleagues, administrators, academic development structures, and extant promotion pathways [4–6]. SFES are also often working as the only education researcher in their department [3]. This isolation, combined with the lack of training in SoTL, may well be contributing factors to the high rates of disenchantment reported amongst these faculty [3].

*Address for correspondence to: School of Chemistry and Molecular Biosciences, University of Queensland, Brisbane, Australia. E-mail: s.rowland1@uq.edu.au.

Received 20 August 2013; Revised 27 September 2013;

DOI 10.1002/bmb.20748

Published online in Wiley Online Library
(wileyonlinelibrary.com)

The authors of this essay are natural scientists who, like many other SFES, have migrated from bench research to SoTL and academic development. One (Rowland) is a biochemist turned SFES, while the other (Myatt) is a microbiologist turned academic developer. In this article we provide a guide intended to help new SFES hires negotiate the start of their SoTL research careers, while also informing interested observers about the kinds of work done by SFES.

Why is this Guide Useful?

There are many resources available to help academics do SoTL, write up their work, and disseminate it. These will be discussed later in this article. This guide is intended to cover an area that is under-addressed in the literature—the mechanics and politics of getting started and continuing SoTL in a natural-science department. Because SoTL and its methodologies are quite alien to many natural scientists, the faculty member who is newly hired as an SFES, or who starts working in the SoTL sphere, can be an object of suspicion. In extreme cases the faculty member can be marginalized or discounted as a legitimate researcher; the requirement to do scholarly work can even be omitted from their position description [7]. There is evidence to suggest that SFES are less likely to be placed on the tenure track, particularly in the biologies [3]—one factor that may feed into this is the perceived (or actual) lack of “research” papers from SFES. There are, however, many opportunities for the SFES to have a research output in SoTL—both as investigators of their own teaching contexts, and as mentors to colleagues. This guide lays out a simple roadmap designed to help jump-start the research program of an SFES who has little or no training in SoTL. In addition, we identify barriers that we have found new SFES hires encounter with their research programs, and suggest potential ways forward.

We also intend this guide to be useful for the academic who wants to know “what SoTL is about” in the sciences. This audience includes academics curious about the work of their SFES colleagues and those who may even be considering implementing a science education study themselves. We hope this guide provides a structured framework and a clear, guided approach to a slightly foreign area of research.

We begin by addressing how a researcher chooses, structures, and begins a SoTL project, then move on to ways in which SoTL practice can be improved. We then address mechanisms for sharing SoTL outcomes and building a professional profile, and conclude with a discussion of “how to make SoTL work” as a career path in a science department.

Choosing and Structuring a SoTL Research Project

There are many excellent resources available that define and describe SoTL and its methodologies [8–10]. (Note: We will use the terms “SoTL” and “education research” interchangeably to describe discipline-based, scholarly examination of teaching and learning with an associated dissemination of findings.) There are some common SoTL

genres; and they are dealt with very effectively on this website [11]. Reading these resources provides an excellent grounding in SoTL theory and practice.

Perhaps the very first place to start engaging with SoTL, however, is to examine one’s own teaching, environment, and educational goals for SoTL opportunities. Pat Hutchings’s “Approaching the Scholarship of Teaching and Learning” [12] and Randy Bass’s “The Scholarship of Teaching: What’s the problem” [13] are both seminal texts that help the new SoTL practitioner examine the research potential of their own context.

Anyone who is a reflective, scholarly teacher is already implementing Action Research in their classroom [14]. SoTL doesn’t differ, in purpose, from Scholarly Teaching or iterative Action Research—all three activities aim to improve teaching and learning. The pragmatic difference between the three is that only SoTL involves dissemination of the findings for the benefit of the scholarly community at large. The academic difference is that while Scholarly Teaching and Action Research can be informal and somewhat ad-hoc, SoTL is expected to adhere to the standards of quality scholarship.

Glassick *et al.* [15] have defined quality works of scholarship as having “a common sequence of unfolding stages.” They are:

1. Clear goals
2. Adequate preparation
3. Appropriate methods
4. Significant results
5. Effective presentation
6. Reflective critique

In Fig. 1 we have mapped these stages onto a model SoTL project sequence. This model project is simple, and we have chosen this framework because it represents the important steps in an educational intervention (such as the introduction and evaluation of a new learning activity in a class). This is the type of SoTL activity one would expect a novice SoTL researcher to attempt. More experienced SFES might attempt holistic reviews of (and large-scale changes to) programs. This type of activity is not adequately addressed by the model we have shown here.

There are several items of note in this figure. A clear sequence of staged events runs from top to bottom, and critical items that should occur at each stage are shown. Importantly, later items cannot be attempted until the earlier ones have been completed. We will use the staged events in this diagram as a scaffold for the remainder of the essay.

Starting with an Idea

Developing a Research Question

As Randy Bass says [13], the very core of SoTL is to redefine the word “problem.” Something that is a “problem” in your teaching (or in the teaching of a peer) is not something to be sidelined, or avoided. Instead, it is an avenue for exploration—a “problem” is a research opportunity.

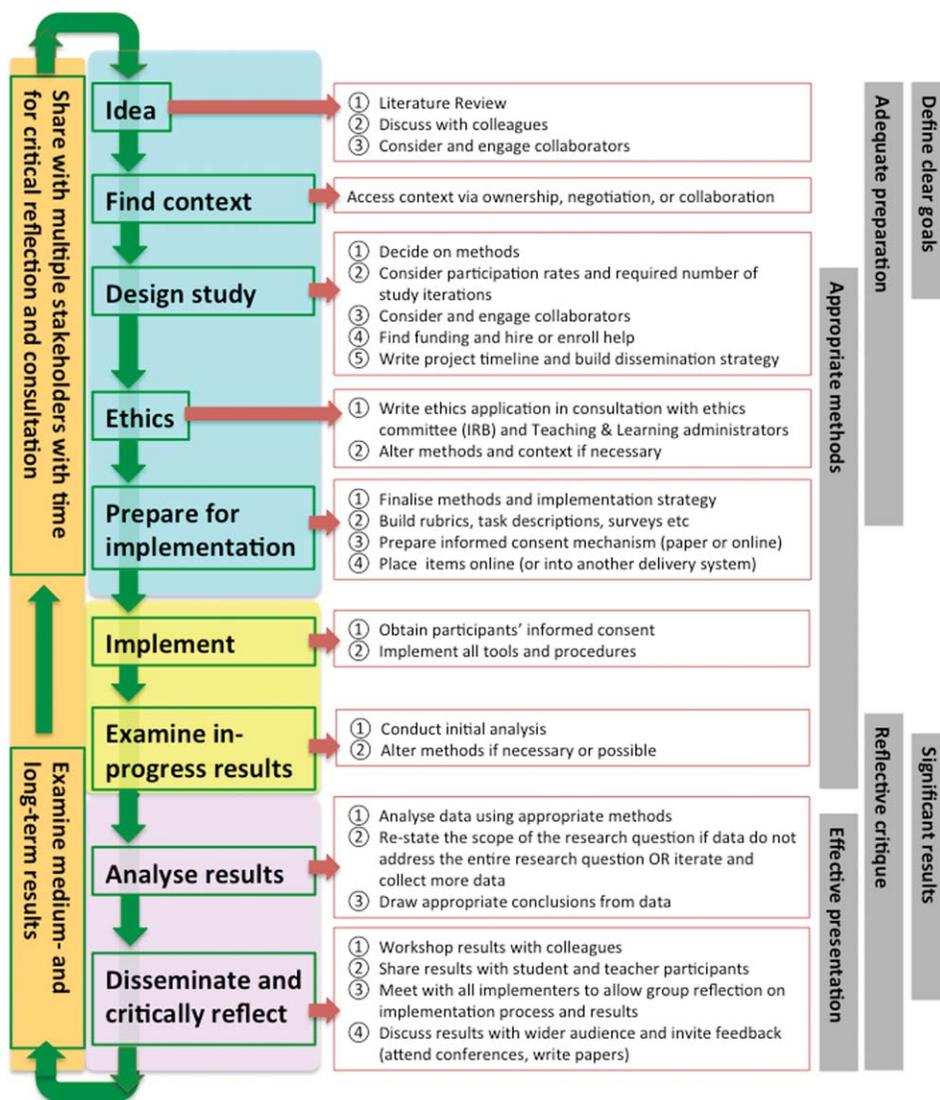


FIG 1

Stages and considerations in a model SoTL project. The sequence of staged events is shown in the green boxes and arrows. These stages can be grouped as “preimplementation” (blue highlight), “during implementation” (yellow highlight), and “postimplementation” (pink highlight). Activities that bridge the ends of iterations are shown with an orange highlight. These activities are not essential for an individual SoTL project, but they help with sustainability of initiatives and design of later SoTL projects. It is important to maintain contact with implementers and stakeholders and inform them of progress at all stages of the project. Other critical items that should be completed at each stage are shown in red boxes. The six criteria for quality scholarship are shown as grey boxes—they are aligned with the stages where they are most relevant, however they may extend over other sections of the project lifetime.

Careful “problematizing” of one’s practice allows the building of a solid, testable research question with clearly defined and measurable independent and dependent variables.

For example, let’s consider the “problem” of students in first year biology who are still not learning how to build a taxonomy, even though this has been taught in a lecture twice. One could problematize this issue and turn it into a research project, with a research question. Let’s also consider that an SFES would like to add clickers into the classroom in an effort to fix this learning deficit.

A weak research question about this “problem” might ask “Can I use clickers in my class to improve learning?” This question contains an independent and a dependent variable, but the context of the independent variable (“clickers in my class”) is poorly defined, while the dependent variable (“learning”) is so vague that it may not even be measurable. In addition, the overall question “Can I use clickers to achieve my outcome” is always going to yield the equivocal answer of “yes, probably, depending on variables x , y , and z .”

In contrast, a good question for the same study might be “Does including clicker questions with taxonomic-puzzle

content in an introductory biology module improve student ability to categorize animals using a taxonomic key?” Now we see what, exactly, is being included as the independent variable, and what is being measured as the dependent change. We can obtain a yes or no answer, and we can implement appropriate pre-post tests to measure the extent of the change.

It is possible to ask various types of SoTL research questions, depending on the institutional, curricular, or classroom context being addressed. At all stages it is helpful to keep the stakeholders in mind; students, employers, academics, the university, general staff, and the wider community are all stakeholders. From a political perspective, the SFES’s own students, department, and college or university are key stakeholders. The effects and value of educational initiatives for all of these parties are different. Their needs and viewpoints provide multiple avenues for exploration.

One should also consider when in the life of an educational intervention a question can be asked, and what types of questions are appropriate at each point of an intervention. A well-tested heuristic model for making this decision is shown in Fig. 2 [16].

Before the initiative begins there are important “context” questions to be investigated. These include discussions of why an initiative is important for various stakeholders, meta-analyses of previously published work to establish “best practice,” and an examination of critical factors that affect implementation.

During any initiative one can ask “process” questions. Often these relate to the mechanics of how the initiative is actually implemented, with particular emphasis on curriculum design and pedagogical approaches. Again, relating these processes to the needs and interests of the stakeholders, and hence demonstrating that the initiative has general value for practitioners, makes the work more publishable.

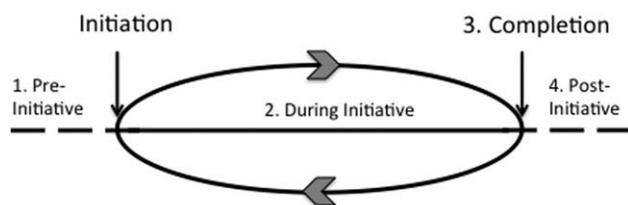


FIG 2

Heuristic model for the development of research questions associated with an educational initiative (adapted from Hubball and Clarke, 2010 [16]). The model depicts an educational initiative or intervention, flanked by pre- and postinitiative time periods. The intervention begins and ends at the initiation and completion points. The arrows on the oval indicate the iterative nature of the intervention, which may be repeated with or without variation. Particular types of questions are appropriate for each numbered point.

At completion of the initiative it is possible to ask “immediate-impact” questions related to the summative evaluation of the initiative. They may address learning gains, stakeholder satisfaction with the initiative, and things that could be improved in the next iteration. Beyond the immediate end of an initiative one can ask “long-term impact” questions, particularly those related to vertical integration, skill and knowledge retention, and graduate outcomes [16].

Conducting an Advance Literature Review

Any SoTL project must begin with a literature review. A researcher may find that their idea has already been tested, or more likely, the literature will yield related research that helps refine the study hypotheses and methodology. A literature review allows the researcher to examine journals that publish in their area of interest, and “find their place in the conversation.” The research can then be positioned so it is maximally important to the prospective audience. Some SoTL literature is listed under PubMed, however much of it is not. Google Scholar [17], ERIC [18], Web of Knowledge [19], and JSTOR [20] are the four primary online access points for education literature.

Finding a Context

Using Accessible Cohorts for Study

This may seem obvious, but it is still important. Whenever possible, academics should use their own teaching activities as the basis of their research. This practice saves time, and guarantees that any educational innovations or assessments will happen in a situation that the researcher can access and control.

Working on courses that are controlled by other faculty members can be difficult. It can be problematic to negotiate and oversee all the details of project implementation if someone else has responsibility for the class. Collaborators can suddenly withdraw their consent for work with their students, accidentally fail to implement the ethics compliance components of the investigation, or lose interest in a project because they become overwhelmed with other responsibilities. There is also a real danger of creating bad feeling between colleagues if a SoTL implementation goes poorly or the students respond negatively to the innovation, especially if the colleague was pushed into the implementation in the first place. We advise our readers to proceed with caution if they are innovating and doing SoTL on a course that they do not teach themselves.

Designing the Study

Structuring a Project Using Brown’s Questions

Brown’s Questions [21] provide a template for any project from start to finish. They force the researcher to focus their research question, simplify ideas, state goals and findings succinctly, and assess the value of the work. Addressing Brown’s questions during the initial project design makes it easier to decide which data should be collected so that a



pertinent and complete set of evidence is available at the end of the study. Brown's Questions will also help define the end-point in a study, so data collection can stop and writing can begin.

Perhaps the most important of Brown's questions is "What can you add to practice?" A researcher is best placed to answer this if they have a good knowledge of the literature and the currently-funded educational initiatives in their field.

Obtaining Project Funding and Hiring Help

It is very difficult for one, lone academic to do all the work required for good SoTL. New SFES should seek out funding, starting with their institutional grants system. We all do design and innovation as part of our regular course development, but the big additional time commitments come when we want to analyze the effectiveness of the innovation and publish our results. These time commitments are not usually "appreciated" by one's department, and it is very unusual to see them factored into an academic's workload. With this in mind, an undergraduate research assistant is a valuable hire. This student can help with literature searches, data analysis, statistical analysis, and digitization of ethics records (e.g., scanning the 1,200 informed consent forms from a freshman chemistry class).

Of course the amount of support money needed will depend on the size of the project. A large project will need a bigger grant and, if possible, a professional project officer, (who becomes the organizational heart of the study and is worth their weight in publications). Funding is also needed to cover travel costs for attending SoTL conferences, disseminating the findings of the research, and engaging new collaborators for the next project.

Ethics

Obtaining Ethics Clearance

An academic can do classroom Action Research for personal teaching and curriculum improvement without ethics approval, but ethics considerations are key to SoTL publication [22]. Generally, projects that lack an ethics clearance cannot be published or publicly presented.

Ethics approval is needed for the project "mechanics" (e.g., questions used in surveys, participant recruitment and compensation, data deidentification and storage) and most ethics review committees will also look closely at the project design to establish that it does not advantage or unfairly exclude particular groups of students. With this in mind, it is important to concede that it is almost impossible to conduct a "controlled" SoTL study, where students are equally matched, segregated into control and treatment groups, then assessed after they have (or have not) been subjected to an educational intervention. Obviously this kind of design has significant potential to advantage (or disadvantage) groups of students who have not been given a choice over their fate. This is unfair and unethical, and it has no place in good educational practice.

After ethics approval is granted, and before the study begins, it is essential to get informed consent from all study subjects (including students in regular classes being analyzed). Subjects who do not agree cannot be included in the study pool, but they must still be allowed to participate in the activity if it is part of their curriculum and/or likely to improve their learning.

The initial approval for a project can take some time to achieve. Before writing an application, we recommend that researchers call their ethics officer and discuss the project. This allows early flagging and resolution of issues. Other SoTL academics are usually happy to share their ethics applications; they can also give valuable advice on how to adhere to institutional and national ethics guidelines.

We strongly recommend that any researcher gains ethics approval BEFORE their study begins, rather than attempting to gain it retrospectively. Retroactive approval is occasionally granted, but it is only likely if the participants signed an informed consent at the time of data collection or the data were collected as part of normal classroom assessment (e.g., exam results, or enrolment demographics).

Implementing and Analysing

It is beyond the scope of this essay to describe all the possible options for implementation and analysis of SoTL projects. Clearly they will be context and question dependent. Instead, we can offer some advice about how to learn about the methods and options for SoTL studies.

Learning How to do SoTL Through Formal Training, Mentorship, and Collaboration

It is possible to clamber up the steep SoTL learning curve alone, but SoTL is much easier to master if one can take lessons. Most educational institutions offer courses in Teaching and Learning, including research-driven diplomas and higher degrees in Education. The completion of such a program by a faculty member tends to be seen very positively by science departments, and some tertiary education institutions are now mandating that new hires have (or quickly gain) a teaching qualification before they begin work in the classroom.

Most educational institutions also have an academic development team who help academics improve their practice as scholarly teachers and SoTL researchers. In our institution the team members also run teaching evaluations, administer teaching awards, and provide advice on learning technologies [23].

Professional societies also run SoTL programs. One wonderful place for faculty to be mentored in SoTL is the American Society for Microbiology (ASM) Biology scholars program [24]. Another program is the International Institute for SoTL Scholars and Mentors [25]. We also recommend the website of the Carnegie Foundation for the Advancement of Teaching [26] which maintains a valuable set of teaching publications under the "Resources" tab.

One should not mentally limit “mentoring” options to those bounded by the traditional notion of a single apprentice-expert pair. Successful academics have a constellation of mentors, including “publication” mentors (to help maintain a focus on writing and publishing) and “peer” mentors (who share challenges and support each other to success) [27]. In the past 5 years the science SoTL community has become increasingly organized and able to self-mentor through grant-funded organizations. In the USA and Australia the SEI (Science Education Initiative) [28], PULSE (Partnership for Undergraduate Life Sciences Education) [29], SABER (Society for the Advancement of Biology Education Research) [30], SaMnet (Science and Mathematics Network of Australian university educators) [31], CUBENET (Collaborative Universities Biomedical Education Network) [32], and VIBenet (Vision and Innovation in Biology Education network) [33] all recruit interested SoTL academics in the sciences, hold regular meetings, and post helpful documents on their websites. HERDSA (Higher Education Research and Development Society of Australasia) [34] is not a science-focused organization; however members of the HERDSA Fellows program [35] mentor new potential fellows as they document their SoTL work.

New SFES should seek collaborators with the relevant and complimentary skill-set to tackle their project. It’s common for SFES to feel isolated, as most of their departmental colleagues will not be versed in SoTL methodologies or language. Faculty in the arts, psychology, and education departments, however, probably do have expertise in assessment of learning, and their expertise is invaluable to the new SFES hire.

Collaboration can grow organically with co-workers, but it can also be achieved more formally through an action learning set [21] or a formal Community of Practice [36]. In SoTL, action learning sets are small groups of people who review one another’s work in a face-to-face forum on a regular basis. Communities of Practice are “groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly” [37]. In both cases group members become more expert as they spend time working towards a common goal of publication.

Learning How to Use Qualitative Methods and Accepting the Validity of Alternative Truths

Perhaps the most wrenching transition that a natural scientist will have to complete as they move into SoTL is the switch from a positivist, reductionist, and realist outlook to one that allows for context-constructed realities. This layman’s terms, this means we can no longer attempt to find the one final “truth” about a closely-studied and carefully controlled experimental situation. Instead, we must learn to evaluate a series of events wholistically, and accept that there are many truths, and many different lived experiences for the participants in any situation. These shifting

landscapes are often best investigated using qualitative methods, rather than empirical ones.

There are multiple reference texts that explain qualitative methods, the processes for applying them and, importantly, the different approaches to data analysis (we recommend [38–44] as a start). The hallmark of science education SoTL is a mixed-methods approach, where qualitative methods such as grounded theory, discourse and narrative analysis, ethnography, phenomenography, and classroom observation (see [45] for an elaboration) are combined with semi-empirical methods that generate discrete data sets. In some instances the research question is best served by correlating discrete data from a SoTL study (e.g., the scores on an exam) with categorical data from a study group (e.g., gender or minority status). In such cases statistics (especially factor analysis) is often used to extract the meaningful relationships between elements of the data.

Having a statistician as a collaborator is enormously valuable. Apart from the obvious benefit to the project’s data analysis, a statistician can evaluate whether a project is feasible and help design a better study from the ground up. For example, the size of a class and the likely participation rate for the cohort affect sample n . Attempts to show a statistically significant result from a study group with a small n will likely require data from more than one cohort, perhaps for a number of years. In this situation a mixed-methods approach that includes an ethnographic or phenomenological examination of the problem may produce a more rapid (and a more informative) publication.

Disseminating Research Results

Conferences

Dissemination is key in SoTL, and conference presentations are the “gold standard.” The International Society for the Scholarship of Teaching and Learning [46] was the first SoTL society. ISSOTL members are not just interested in science education, so their conferences have a diverse range of presentations. The work may not all be to the SFES scholar’s taste, but ISSOTL is an important conference and the diversity of the work is inspiring. Most of the other organizations listed under “Learning how to do SoTL” also run meetings on a regular basis.

A new SoTL researcher should not be daunted by applying for a talk or poster at one of these meetings. Other education researchers are usually very accommodating of speculative or incomplete work and their feedback is extremely helpful for formulating further studies or improving data analysis and presentation.

Journals and Other Publication Opportunities

Like science journals, SoTL journals are subject to rankings [46–49]. It is not always best to go for high-impact journals while establishing a publication record. Some SoTL journals can have long lead times (exceeding 4 years from acceptance to publication), and the papers that are accepted in high-impact journals tend to report studies that



are very well developed. Unfortunately, by the time the paper sees the light of day, the work can be very “old,” particularly when publications are needed to get grants and build a reputation for attracting collaborations. Ask editors about lead times, rejection rates, and online prepublication options (with a DOI) before submission, or consult the annotated lists of SoTL journals.

New readers of the SoTL literature may be bamboozled by some of the language of education research. Take heart, and don’t assume that published papers with complex language are filled with complex ideas—they might just be written unclearly! There is no need to use complex language to explain SoTL ideas and the new SoTL scholar would be wise to read and submit to journals that they understand and feel comfortable with, rather than choosing journals with a style far removed from their own voice.

Early career SFES can test the waters with publications in the journal run by their disciplinary body or local science education association. A publication here will probably be a quicker and easier addition to the CV. These fora are also a good place to meet and influence peers in one’s field. Regular publications in these journals may lead to invitations to be on the editorial board, to collaborate, or to present at conferences.

It’s also useful for new scholars to consider newsletters and non-peer-reviewed publications that are widely read in their field and/or published by their relevant professional society. Although they don’t have an “impact factor,” (so they don’t count towards formal publication outputs) they are quick to write, and a case can be made for their value as instances of community engagement and disciplinary service.

How to Make SoTL Work as a Research Stream

Building a SoTL Research Stream by Staking Out an “Academic Patch”

SoTL is time-consuming, and learning how to do it is also complex. Hence, it is important to set aside protected research time to properly plan, implement, and evaluate SoTL projects. In our experience, many science department colleagues get excited when they discover education research, and they begin to propose multiple new and interesting projects to their “local” SFES. This can become overwhelming, and at some point the researcher has to say “No” to running additional SoTL studies. We suggest three useful methods for justifying this refusal.

The first is to define a research focus. Once a researcher begins work in the SoTL field it is important that they define a theme for their work fairly quickly (within the first 3 years). This theme should be expressible in one sentence. For example, a researcher might work on “engaging undergraduate students with science through science communication” or “strategies to assess and improve critical thinking in graduate students” or

“structures of study programs that enhance minority participation and retention.”

In any of these cases the researcher has claimed an “area” or academic patch, and this process influences how they see themselves, and how others see their work [50]. SoTL researchers are entitled to say “No, I’m sorry but that project is not in my field of interest or expertise.” Of course, this does not mean that a SoTL researcher is entitled to shirk the normal responsibilities that come along with being part of an academic community—it simply means that, like any other academic, a SoTL researcher has their own research stream.

The second strategy for saying “no” is to offer to mentor the enthusiastic colleague in their SoTL endeavor, or to offer co-supervision of a research assistant or student who can make a significant contribution to the project. Mentoring activity is an excellent way to build collegiality and improve the skills and publication outputs of all parties. The SFES mentor should, however, take careful stock of how much time and expertise they can contribute to the project and clearly discuss these limits with their collaborator.

The third strategy for saying “no” is to offer to lead work on the project at a wider level, through service to the committee and governance structure of the college or university. SFES have an important role to play in the processes of curriculum and assessment design, and the best way to influence these activities is through official channels, rather than just as a personal endeavor.

Staying Current with the Conversation

Once a researcher enters the SoTL stream they quickly realize that the current is swift. There is a real danger that one can work on an outmoded idea or context, and get stuck in an unproductive or unpublishable research whirlpool. There are various methods for staying current with relevant SoTL fields. Most SoTL societies publish newsletters or produce regular electronic mailouts and listservs. The “Tomorrow’s Professor” listserv [51] posts twice a week and has an impressive archive of useful articles about teaching on its website. Subscribing to contents alerts for journals is also a must. Wiley and Springer Alerts are good places to start [52, 53].

The “areas of research” in SoTL [54] become more or less fashionable with time. They are heavily influenced by (i) the areas of strategic interest defined by local granting bodies; (ii) reports to the President (in the USA); and (iii) reports commissioned by bodies or groups that have power in the administration of science education (examples are the Australian Council of Deans of Sciences, The Australian Office of Learning and Teaching, the National Science Foundation, and the American Association for the Advancement of Science). It is important to read the publications from these sources and attend conferences where the authors and commissioners of these reports are keynote

speakers. Studies on problems that occupy the national education consciousness are more likely to get funded and published.

Supervising Research Students

The ability of an SFES to attract research students will differ, depending on the institutional environment and the general educational structure of the country. In the US, for example, where a PhD in SoTL can lead to a faculty position, it is relatively common to see graduate students completing education-related projects in science departments. In many other countries (including Australia) SFES positions are generally won only by candidates who hold a PhD gained at the bench or in the field, not by graduates in science education. This reality, combined with the relative “newness” of SoTL in science, means that higher-degree candidates in science education are unusual outside the US. One has to carefully consider whether a higher degree in SoTL is in the best interests of a student [6] and ask some tough questions. Why does the student want to do a SoTL project? Is it possible to combine the project with some wet-lab or field experience to increase the graduate’s employability? Does the potential student understand that their employment prospects will be different to the prospects for a student who does a bench or field project for their graduate work? Do course codes or programs of study that can accommodate the student already exist at the enrolling institution, or will a change in institutional policy be required for the student to enroll?

The SFES who wants to supervise a student may have to trailblaze. In this situation it is probably in the student’s best interest to find them a co-supervisor who has experience with education projects.

Assessing the Value of a Project and Justifying it to Colleagues and Superiors

Not every SoTL project is going to be a good one. It pays to be strategic and leave weak, overly difficult, or uninspiring projects for other pursuits that are more productive and which garner more support and attention.

Most universities and colleges (and their departments) publish strategic plans for Teaching and Learning. A politically-savvy SFES should read these documents and visibly align their work to them. Projects that are seen as valuable by those in power are more likely to be supported with time and money. Any project that is worth academic time should have clear value and novelty as a scholarly enterprise. The best projects also have clear benefits for the students involved, for the host institution, and for the education community at large.

Final Notes

SoTL is hard, time-consuming work that can be slow to yield papers. In addition, most education journals have low citation rates. This means the metrics that “count” in sci-

ence can be difficult for an SFES to fulfill, and we must look elsewhere for justification of our research streams.

Part of the “value” of SoTL is that it has far-reaching implications. It can affect and address academic and student behavior, educational design and assessment, professional development offerings, institutional structures, and educational policy—often far beyond the discipline itself. SoTL researchers who are poorly understood within their workplace may need to work harder to justify their research, promote the implications of their work, and maintain the rigor of their findings. They should always remember, however, that their research can produce rigorously analyzed data and provide powerful support for the use (or removal) of teaching activities and practices.

Researching the outcomes of teaching and learning is an essentially “scientific” process, which should come naturally to logical research scientists. In our experience, however, finding one’s own pathway in SoTL, and convincing skeptical colleagues that SoTL belongs in a science department, are not simple tasks.

SoTL takes time, money, dedication, and expertise, but in an era where universities are being asked to justify their curricula, their graduate outcomes, and even their own bricks-and-mortar existence, quality SoTL is essential. The work of SoTL researchers is an important weapon in the fight against funding cuts and deprofessionalization of the academic teaching workforce. Its ultimate value lies, however, in its power to help us build and maintain the best educational outcomes for all of our students, and hence for society at large [55].

References

- [1] Hutchings, P. Huber, M., and Ciccone, A. (2011) The scholarship of teaching and learning reconsidered: Institutional integration and impact, Jossey Bass, San Francisco.
- [2] Huber, M. and Hutchings, P. (2005) The advancement of learning: Building the teaching commons, Jossey-Bass, San Francisco.
- [3] Bush, S. Pelaez, N. Rudd, J. Stevens, M. Tanner, K. and Williams, K. (2013) Widespread distribution and unexpected variation among science faculty with education specialties (SFES) across the United States. *Proc. Natl. Acad. Sci. USA* 110, 7170–7175.
- [4] Bush, S. Pelaez, N. Rudd, J. Stevens, M. Tanner, K., and Williams, K. (2011) Investigation of science faculty with education specialties within the largest university system in the United States. *CBE Life Sci. Educ.* 10, 25–42.
- [5] Bush, S. Pelaez, N. Rudd, J. Stevens, M. Tanner, K., and Williams, K. (2008) The pipeline. Science faculty with education specialties. *Science* 322, 5909.
- [6] Rowland, S. (2012) Teaching-focused science academics supervising research students in science education: What’s the problem? *HERD* 31, 741–743.
- [7] Probert, B. (2013) Teaching-focused academic appointments in Australian universities: Recognition, specialisation, or stratification? In. Canberra, Australian Government and the Office for Learning and Teaching.
- [8] Scholarship of Teaching and Learning (SoTL). Available at: <http://fod.msu.edu/oir/scholarship-teaching-and-learning-sotl> Accessed on February 18, 2013.



- [9] Vanderbilt University Center for Teaching. Available at: <http://cft.vanderbilt.edu/teaching-guides/reflecting/sotl/> Accessed on 18 February, 2013.
- [10] SoTL: What is the Scholarship of Teaching & Learning (SoTL)? Available at: <http://www.fctl.ucf.edu/ResearchAndScholarship/SoTL> Accessed on 18 February, 2013.
- [11] How could i do scholarship of teaching and learning. Available at: <http://php.indiana.edu/%7Eenelson1/SOTLGenres.html> Accessed on 18 February, 2013.
- [12] Hutchings, P. (2000) Approaching the scholarship of teaching and learning. In: *Opening Lines: Approaches to the Scholarship of Teaching and Learning*. Menlo Park, CA., The Carnegie Foundation for the Advancement of Teaching, pp. 1–10.
- [13] Bass, R. (1999) The scholarship of teaching: What's the problem? *Invention: Creative Thinking About Learning and Teaching*. February, Vol 1, No 1.
- [14] Mettetal, G. (2001) The what, why and how of classroom action research. *J SoTL* 2, 6–13.
- [15] Glassick, C. Huber, M., and Maeroff, G. (1997) *Scholarship assessed: Evaluation of the professoriate*, Jossey-Bass Publishers, San Francisco.
- [16] Hubball, H. and Clarke, A. (2010) Diverse methodological approaches and considerations for SoTL in Higher Education. *CJSOTL* 1, 18. Available at: <http://www.cjsotl-rcacea.ca>.
- [17] Google Scholar. Available at: <http://scholar.google.com.au> Accessed on August 17, 2013.
- [18] ERIC—Education Resources Information Center. Available at: <http://eric.ed.gov> Accessed on August 17, 2013.
- [19] Web of Knowledge. Available at: <http://wokinfo.com> Accessed on September 28, 2013.
- [20] JSTOR. Available at: <http://www.jstor.org> Accessed on August 17, 2013.
- [21] Brown, R. (1994) Write right first time. *Literati Newslines*. 95, 1–8.
- [22] Hutchings, P. (2002) Ethics and aspiration in the scholarship of teaching and learning. In *Ethics of inquiry*, issue in the scholarship of teaching and learning. Carnegie Foundation for the Advancement of Teaching and Learning, Menlo Park, CA.
- [23] TEDI: Teaching and Educational Development Unit. Available at: <http://www.tedi.uq.edu.au> Accessed on September 27, 2013.
- [24] ASM Biology Scholars.org. Available at: <http://www.biologyscholars.org> Accessed on February 15, 2013.
- [25] International Institute for SoTL Scholars and Mentors. Available at: <http://www.imu.edu/resources/iissam.htm> (note that this website changes each year, depending on the conference location) Accessed on August 18, 2013.
- [26] Carnegie Foundation for the Advancement of Teaching. Available at: <http://www.carnegiefoundation.org/resources> Accessed on 15 February, 2013.
- [27] Debowski, S. (2013) Creating fertile learning spaces: Mentorship strategies to support academic success. *Proceedings of Research and Development in Higher Education: The Place of Learning and Teaching*, pp. 113–123.
- [28] SEI—The Science Education Initiative at the University of Colorado. Available at: <http://www.colorado.edu/sei/index.html> Accessed on 13 September, 2013.
- [29] PULSE Community. Available at: <http://www.pulsecommunity.org> Accessed on September 13, 2013.
- [30] SABER-Biology Education Research. Available at: <http://saber-biologyeducationresearch.wikispaces.com> Accessed on February 15, 2013.
- [31] SaMnet—Science and Mathematics network of Australian university educators. Available at: <http://samnetaustralia.blogspot.com> Accessed on September 13, 2013.
- [32] CUBENET Commons. Available at: <http://www.cubenet.org.au> Accessed on September 13, 2013.
- [33] VIBENet—Vision and Innovation in Biology Education. Available at: <https://sites.google.com/site/vibenet101/home> Accessed on 12 September, 2013.
- [34] Higher education research and development society of Australasia home page. Available at: <http://www.herdsa.org.au> Accessed on February 15, 2013.
- [35] HERDSA Fellowships. Available at: http://www.herdsa.org.au/?page_id=5 Accessed on September 15, 2013.
- [36] Lave, J. and Wenger, E. (1991) *Situated learning: Legitimate peripheral participation*, Cambridge University Press, Cambridge.
- [37] Communities of practice a brief introduction. Available at: <http://wenger-trayner.com/wp-content/uploads/2012/01/06-Brief-introduction-to-communities-of-practice.pdf> Accessed on February 15, 2013.
- [38] Leydens, J., Moskal, B., and Pavelich, M. (2004) Qualitative methods used in the assessment of engineering education. *J. Eng. Ed.* 931, 65–72.
- [39] Whitt, E. (1991) Artful science: A primer on qualitative research methods. *J. Coll. Stud. Dev.* 32, 406–415.
- [40] Creswell, J. (2007) *Qualitative inquiry and research design: choosing among five approaches*, 2nd ed., Sage Publications, Thousand Oaks, CA.
- [41] Patton, M. (2002) *Qualitative research and evaluation methods*, 3rd ed., Sage Publications, Thousand Oaks, CA.
- [42] Denzin, N. and Lincoln, Y., Eds. (2005) *The SAGE handbook of qualitative research*, 3rd ed., Sage Publications, Thousand Oaks, CA.
- [43] Bogdan, R. and Biklen, S. (2006) *Qualitative research in education: An introduction to theory and methods*, 5th ed., Pearson, New York.
- [44] Glaser, B. and Strauss, A. (1967) *The discovery of grounded theory: Strategies for qualitative research*, Aldine Publishing Company, Chicago.
- [45] Case, J. and Light, G. (2011) Emerging methodologies in engineering education research. *J. Eng. Educ.* 100, 186–210.
- [46] ISSOTL: International Society for the Scholarship of Teaching and Learning Available at: <http://www.issotl.org/sotl.html> Accessed on February 15, 2013.
- [47] Scholarship of Teaching and Learning (SoTL) Journals Available at: <http://ralresearch.creighton.edu/SoTL> Accessed on February 15, 2013.
- [48] Education: Scholarship of Teaching and Learning—Guides at Milner Library, Illinois State University. Available at: <http://ilstu.libguides.com/sotl> Accessed on February 15, 2013.
- [49] Towns, M. and Kraft, A. (2012) The 2010 rankings of chemical education and science education journals by faculty engaged in chemical education research. *J. Chem. Educ.* 1, 16–20.
- [50] Sadler, D. (1999) *Managing your academic career. Strategies for success*. Allen and Unwin, Sydney, Australia.
- [51] Tomorrow's Professor: Preparing for academic careers in science and engineering. Available at: <http://cis.stanford.edu/structure/tomprof/list-server.html> Accessed on 18 February, 2013.
- [52] Springer Alerts. Available at: <http://www.springer.com/alert?SGWID=0-103-0-0-0> Accessed on 18 February, 2013.
- [53] Wiley: Sign up for e-Alerts. Available at: <http://olabout.wiley.com/WileyCDA/Section/id-404511.html> Accessed on August 17, 2012.
- [54] Topics of Current Interest in the SoTL. Available at: <http://www.fctl.ucf.edu/ResearchAndScholarship/SoTL/whatsSOTL/sotltopics.php> Accessed on 18 February, 2013.
- [55] Singer, S. R., Nielsen, N. R., and Schweingruber, H. A. (2013) Discipline-based education research: Understanding and improving learning in undergraduate science and engineering, National Academy of Sciences, Washington, D.C.