2010 Research Residency
Pre-Institute Assignments

BiologyScholars.org
center for undergraduate education

Team 6

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Assignment #1: Introductions

1) Describe your teaching responsibilities and the type of student you teach.

I am a non-tenure-track associate professor at the University of Arizona in Tucson and teach several different categories of courses. In the fall semester, I am course coordinator and teach one lecture section of ~350 students for our Introductory Biology course (cell/molecular biology) for life-science majors. I co-teach an undergraduate Biology Teaching Methods course for students in our secondary teacher preparation program during that same semester. During the spring and summer, I teach courses in science education pedagogy and biology for practicing secondary teachers. Over the past three years, I have transitioned these courses for teachers from in-person courses to online courses. I teach a graduate student "survival skills" class for minority PhD students in the biomedical sciences, and I supplement these teaching duties with advising of undergraduate biochemistry majors, science education majors, and biology teachers in our Natural Sciences MS program. Finally, I facilitate small-group learning in our medical school curriculum.

2) Describe what you would like to take home as a result of attending the SoTL Institute.

I hope to go through the backwards design process to re-vamp my teaching of Introductory Biology, focusing on providing a learning environment that promotes real student engagement in solving biological problems. I need help in designing assessments that will help us to determine whether these teaching strategies result in meaningful student understanding. I also need help in thinking about how to promote a teaching culture among our Introductory Biology team that values higher-order student learning.

3) Tell us about your interests outside of the classroom and a book that you have read recently.

As I am the mother of three young daughters (ages 9, 7, and 3) and the wife of a geologist who loves to do field work, most of my out-of-work activities center around my family. We all enjoy hiking, camping, photography, and our family's three dogs, and we are busy planning our two-

week family camping trip (stay tuned to find out if we can make it from Tucson to Yellowstone with a three-year-old). I am proud to say that I recently finished a work of fiction in less than a year. It was *The Adventures of Kavalier and Clay* by Michael Chabon. My last nonfiction effort was *The Omnivore's Dilemma* by Michael Pollan, and I am currently inching my way through his work *The Botany of Desire*. One of the joys of traveling to conferences is the availability of long blocks of time in which I can catch up on recreational reading.

Assignment #2: Reflections

1) How would you describe your "research problem(s)" to the Research Scholars group?

My research question is how to design assessment strategies that get at my desire to determine whether students in my Intro Biology course understand the content in a way that is deep and meaningful. What I mean by meaningful, which I realize is up for discussion, is that they can use the ideas and concepts they learn in this foundational class to help them solve meaningful biological questions, both in this class and in the classes they take next. I would like to use this assessment information in several ways: formatively, so that the students and I know at many points throughout the semester how they are doing in achieving this goal; but also summatively, so that I come away with an overall picture of how students understanding the material and therefore can use this information to make changes in my teaching.

2) What theme(s) based on your readings, resonate with your "problem" and/or your proposed approach to address your problem.

Several ideas from the reading assignments resonated with me. One got at the idea of "mastery." Is mastery of the material I teach in Introductory Biology even possible? If not, what should I be looking for? Another issue that I thought about was how students will use their understanding once they have completed the course: What types of deep understanding are necessary for students pursuing careers in medicine, pharmacy, nursing, wildlife management, biotechnology, and other career paths I cannot even imagine? And a third issue had to do with teaching to the learning goals I value the most. If I value deep learning, why do I not spend more time in class with the students promoting this type of learning actively?

3) Based on Pat Hutchings article, what taxonomy would you use to describe your research question and why?

Using the Hutchings taxonomy, I believe my research questions fall somewhere between the "what works" level (if meaningful understanding is what I am looking for, how do my students do on measures that assess that understanding, and then how do I reshape my practice accordingly?) and the "what is" level: how do students think about the concepts that are emphasized, and how can they use this information to solve meaningful problems?

4) Do you have any questions/concerns/comments that have evolved from your reading?

One question I came away with was how to learn more about students' attitudes and beliefs, as well as incoming knowledge, at the beginning of a class? How do those ideas, attitudes, and beliefs then shape their learning? Another issue I felt was extremely important was Hutchings' recommendation to share results not only with science education colleagues, but also disciplinary colleagues. Indeed, I feel this issue is one of the most important and often-neglected responsibilities we have. And, as Cindy Graham has already stated, the ideas about this research being iterative is one that I find extremely important. I never have heard anyone in the science research community say, "I have solved this problem and there is no more work to do." And yet, it does seem as if there is that expectation in educational research among colleagues: Is it fixed yet? Better communication is the best way to address this disconnect.

Assignment #4: Annotated Bibliography

I am interested generally in techniques that have been proven successful in improving learning outcomes in large (~300-400 student) Introductory Biology classes. However, I am also interested in the process of institutional change, because I am responsible not only for my own Introductory Biology teaching, but for coordinating a group of 5-8 other instructors. What evidence can I collect in my own section, or can I show them from other sites, that will promote their adoption of these best practices? Because I believe that evidence is the key, I am also looking at various approaches to assessment and how assessment data can be used to move institutions forward in teaching practice.

Some of the resources I have found useful thus far are:

1. Bond, L. *Toward Informative Assessment and a Culture of Evidence*. A report from the Carnegie Foundation for the Advancement of Teaching's Strengthening Pre-Collegiate Education in Community Colleges. Stanford, California: The Carnegie Foundation for the Advancement of Teaching, 2009.

This report describes the characteristics of the instructional change that happened over a series of years when 11 community colleges in California participated in the SPECC. The scope of the changes and the context in which these faculty and administrators are very different from what I am trying to accomplish, but I appreciate the way the change is described as one that makes participants more open to collecting and using evidence gathered from their own teaching.

2. Bonner, J. A Biology Course for the Less-Than-Prepared Prospective Biology Major. *Bioscene* 35 (1), 74-81 (2009).

This peer-reviewed article caught my eye because it discussed how faculty at the College of Notre Dame of Maryland set up a special section of Introductory Biology for incoming students who had low math scores. One of the correlations they noted, and that we have seen at our institution, is that students who have low math scores do not succeed as well in Introductory Biology. The author was involved in setting up a special section that allowed less-than-prepared students to explore the content in a more structured and less didactic way. Again, the setting in which this change occurred was quite different from our large research university, but the similarities in student demographics suggest that some of these strategies could be used to address the needs of our at-risk students.

3. Smith, M.K., W. B. Wood, and J. K. Knight. The Genetics Concept Assessment: A New Concept Inventory for Gauging Student Understanding of Genetics. *Cell Biology Education* 7: 422-430 (2008).

I am interested in putting together assessments that target conceptual understanding of the topics in Introductory Cell and Molecular Biology, and I appreciate the detail these authors put into describing how they created, validated, and used the 25 questions in this concept inventory. It was particularly striking that all the faculty involved in teaching were involved in identifying learning objectives and in identifying areas of student misconceptions. I also was drawn to the way the authors used the concept inventory questions in a pre-post design in their introductory classes, while delivering them again at the beginning of the genetics classes most student took immediately following-- a really nice way to look at how this type of assessment data can be used. I believe that I will be drawing largely on this and other concept inventories to create assessments for my own class.

4. Yerushalmi, E., C. Henderson, K. Heller, P. Heller, and V. Kuo. Physics faculty beliefs and values about the teaching and learning of problem solving. I. Mapping the common core. *Physical Review Special Topics- Physics Education Research* 3, 020109 (2007).

This article is less practice-based than most of the articles I am drawn to. It characterizes the beliefs of six physics instructors at one institution, drawing on course artifacts and instructor interviews centered around teaching a problems-based physics course. The outputs from the analysis were a set of concept maps representing the instructors' beliefs about various aspects of their teaching role, including what they believed about students and what experiences students need to succeed in their physics course. I do not anticipate doing research in this way on my own, but I appreciated the way the authors grouped their findings into emergent themes and then drew on evidence to substantiate the assertions. What struck me about their findings was that these six, randomly chosen instructors did have a common set of beliefs with respect to teaching, learning, and problem solving in physics. I am fairly sure that a similar approach would demonstrate that my fellow Introductory Biology instructors and I are quite divergent. Am I fooling myself about this? Should I do some work to answer this question definitively?

5. Klymkowsky, M. W., K. Garvin-Doxas; M. Zeilik. Bioliteracy and Teaching Efficacy: What Biologists Can Learn from Physicists. *Cell Biology Education* 2(3): 155-161 (2003).

This essay, the first in a series that describes these authors' work in developing a biology concept inventory, was particularly impressive because it discussed the important role that concept inventories played in redefining physics education, and because it discussed the fact that "bioliteracy" is critically important in the lives of citizens-- and that conceptual understanding is what is required, because the specifics change. This might be a good resource to use when advocating the use of these kinds of tools with my colleagues. The article also addresses the fact that one all-encompassing concept inventory for all of biology is difficult because of a lack of consensus about what should be taught, and it points out how astronomers have addressed this argument.

Jeffrey LaMack
Milwaukee School of Engineering, Milwaukee, WI

Assignment #1: Introductions

1) Describe your teaching responsibilities and the type of student you teach.

I mostly teach couses in the undergraduate biomedical engineering curriculum at Milwaukee School of Engineering. These include courses in the life sciences, as well as engineering, and they vary a bit each year. One of the more common undergrad classes is a freshman level Intro to Cell Biology and Genetics course. This course includes a lab, has about 18 students per section, and includes students majoring in Biomedical Engineering, Biomolecular Engineering, and Nursing. I also teach a physiology course to Biomedical Engineering juniors, about 15 students per section, lecture and lab. Some of the non-life sciences courses I teach are: Freshman Biomedical Engineering Design; Computing in Biomedical Engineering (computer programming); Thermodynamics; and Heat and Mass Transfer and Fluid Mechanics. Each course typically has 15-20 students per section. I also teach two graduate courses to students majoring in Perfusion and Cardiovascular Studies. These courses cover transport phenomena and mathematical modeling of biological systems.

2) Describe what you would like to take home as a result of attending the SoTL Institute.

My primary goal is to learn how to more effectively use learning objectives to aid in student learning in life science courses. I have found it difficult to find the right balance between being too prescriptive in telling students exactly what they need to know for exams and being too general. It appears as though different types and quantities of learning objectives might be appropriate for students at different academic levels, and possibly from different majors. I would like to learn how to take a more scientific approach in determining what is best for a given situation.

3) Tell us about your interests outside of the classroom and a book that you have read recently.

Last summer, I bought my first house, and this coming summer I will be getting married, so my most current pastimes include home repair, landscaping, and wedding planning. I am a big sports fan, and I enjoy playing golf and softball. My guilty pleasures include playing fantasy football and singing karaoke. The most recent book I read was Stephen Colbert's I Am America (And So Can You!).

Assignment #2: Reflections

1) How would you describe your "research problem(s)" to the Research Scholars group?

The research problem that I proposed involves optimizing learning objectives in life science courses. I believe in the use of learning objectives as a tool to communicate with students the expectations for a given course or topic within a course. However, I have been frustrated with the degree to which some students seem to become overly reliant on these learning objectives, viewing them as a comprehensive list of items to memorize. These students routinely become lost when they are asked a question about a topic in a context that deviates from a stated learning objective. I always strive to enable my students to learn topics (in cell biology and physiology) at a deeper level such that they might one day be able to apply this knowledge. I feel that perhaps there are better strategies that I might employ in the construction and dissemination of learning objectives to students; my goal is to discover such strategies and acquire evidence of their effectiveness.

2) What theme(s) based on your readings, resonate with your "problem" and/or your proposed approach to address your problem.

Being a newcomer to the field of scholarship of teaching and learning, I am largely naïve about accepted methodology. Since conducting a study across several sections of a course (perhaps with different instructors) seemed difficult and would introduce confounding variables, my first thought was to perform a study throughout a single course in which I experimented with providing different types of learning objectives for different topics and then assessing student knowledge on those topics with exam questions. However, I feared that I might not be able to reach solid statistical conclusions in such a small scale study and doubted the community would accept any less formal conclusions. I was pleasantly surprised to read Gwynn Maettetal's article on classroom action research which seemed to offer validity and potential acceptance of such a study.

3) Based on Pat Hutchings article, what taxonomy would you use to describe your research question and why?

I believe my research question falls primarily under the taxonomy of "what works", because it will involve exploring the effectiveness of a number of possible options. Segments of the research may also fit into the category of "what is", because I wish to evolve a new strategy for construction of learning objectives, yet I do not have a clear vision of which this strategy might be at this time. I am hoping that exploring "what works" will help me discover the "what is".

4) Do you have any questions/concerns/comments that have evolved from your reading?

In the first reading, when the author described how misperceptions and assumptions of students coming into a cultural history course impeded their ability to grasp big picture concepts in the class, I wondered if and how such phenomena might impact life science courses. The second reading made me reflect on what types of skills from my own discipline I might exploit in conducting educational research, since employing one's discipline appears to be a common thread among the various cases being described. Finally, in the same article, the discussion of continually changing one's strategies during the progression of a course (the "changing script" method) somewhat concerned me and made me wonder how long you should wait until you have enough evidence that something isn't working--is it not possible to be too impatient and erroneously conclude that a good idea is ineffective?

Assignment #4: Annotated Bibliography

My literature search for articles discussing learning (educational, instructional) objective specificity and effectiveness was not as straightforward as I would have thought. I learned that an abundance of sources described how to write good learning objectives in the 1960's through 1990's. Given the widespread use of learning objectives, I expected to encounter many recent studies regarding the effectiveness of learning objectives, but I had difficulty. I found ERIC to be the most helpful of the suggested databases, although I could not locate the majority of the references I would have liked to see. I used bibliographies to guide my search to some extent, although this was difficult since many of the articles I was starting with were rather old. One thing I did find to be helpful was conducting searches on the websites for specific journals, once I was able to identify these journals. Two journals that I found to be particularly useful were *CBE--Life Sciences Education* and *Journal of Research in Science Teaching*.

1. Mager, R. F. (1997). Preparing Instructional Objectives [electronic resource]: A Critical Tool in the Development of Effective Instruction (3rd ed.). Atlanta: CEP Press.

This electronic textbook is written by Robert Mager, who is credited with initiating the movement toward using learning objectives in general education. This book presents a foundation for writing effective learning (instructional) objectives. It focuses on the "do's and don'ts" of writing objectives and describes the essential elements of a good learning objective as: (1) the performance expected; (2) under what conditions; and (3) the criteria of acceptable performance. It stresses specificity as being generally favorable; however, the context of specificity is a little bit different than what I had in mind, seeming to contrast more with "vague" than "general". A section is devoted to how much detail to include in objectives. In it, Mager pushes for maximum detail, implying that leaving out detail and causing the student to study more than was necessary is betrayal or deception…I do not necessarily agree with this. The "under what conditions" part of the objective seems to be what I would like to manipulate in my research.

2. Naz, B.A. “Presentation on Instructional Objectives”. Institute of Education and Research. Gomal University, 2009.

This presentation is not peer-reviewed, but I found it to be a good introduction to the subject of instructional objectives, including references. The author distinguishes between “informational” and “instructional” objectives. The former does not include conditions and criteria (using Mager terminology).

3. Crowe, A., Dirks, C. & Wenderoth M. P. (2008). Biology in bloom: Implementing Bloom’s taxonomy to enhance student learning in biology. *CBE--Life Sciences Education, 7*, 368-381.

This peer-reviewed article describes a tool (Blooming Biology Tool, *BBT*) developed to assist faculty in college life science courses align their expectations and teaching methods, as well as to enhance student study habits. Emphasis is placed on matching course activities with learning goals (performance expectations). Discusses a masking that occurs when a higher Bloom’s level concept is provided ahead of time and then asked on a test--it becomes a recall level question in this case--this is aligned with my fear of providing too much detail in objectives. Authors also developed Bloom’s-based Learning Activities for Students (BLASt) to help students prepare at different levels (develop different study strategies). The strategy for a lecture course involved group activities centered around discussing the Bloom’s level of questions posed during the lecture (*“blooming”*). Metacognition (student’s being able to monitor their learning) was also emphasized. Providing data to students as to how they performed at each Bloom’s level throughout the course helped them make adjustments throughout the quarter (using the BLASt techniques). Overall, this paper presented a very thoughtful system for improving a biology course. However, results were anecdotal. I think I could use some of the concepts as a framework for my own research, but seeking evidence of its success.

4. Babin, P. (1987). Instructional Objectives. A publication of the Teaching Resources Service, University of Ottawa.

This monograph/teaching guide caught my attention, because it addresses a couple of issues in which I am specifically interested: (1) how precise instructional objectives should be and (2) consideration of differences among students when constructing objectives. Different viewpoints are addressed regarding these issues, but nothing is tested--only anecdotal evidence or opinion backs the viewpoints. States “if it has not been stated as an objective, it will not be on the exam.” I feel this is oversimplified in that there are different ways to state things in learning objectives. Specific concepts can be grouped and generalized, for example. Benefits of continually refining objectives are outlined.

5. Phillips, J.A. Instructional objectives in economics teaching: Philosophy, Effect, and Extent of Use. Source unknown.

Although the source of this paper is unknown (found full-text article in ERIC database), I am including it, because it includes content from the unique perspective of economics education. I find this interesting, because costs and benefits of instructional objectives are analyzed very thoroughly, as would be done by an economist. Instructional objectives are defined similarly to other sources, with the addition of providing a rationale for learning. The author argues for very explicit learning objectives, and even states that it is important to consider the order presentation of such objectives to students to ensure that concepts build from simple identification to complex application. The author states that literature is lacking of evidence of effects of instructional objectives (although this paper is probably from pre-1980. The author did cite one of his own papers in which he failed to demonstrate a significant gain as a result of the use of instructional objectives (citation provided). Note a few citations are provided pointing to studies in other disciplines that did find benefit of instructional objectives.

Susan Rowland
University of Queensland, St. Lucia, Queensland, Australia

Assignment #1: Introductions

1) Describe your teaching responsibilities and the type of student you teach.

My name is Susan Rowland, and I am a teaching-focused academic at the University of Queensland (UQ) in Brisbane, Australia. I work in the School of Chemistry and Molecular Biosciences (SCMB), where we have about 62 full-time faculty, but only two teaching-focused faculty. The role of the teaching focused faculty is to research and improve teaching and learning in the school. The introduction of tenured teaching-focused faculty is a new initiative at UQ (one of the eight large T&R Universities in Australia), and we are being strongly supported by the University.

I am coordinator of the Biochemistry and Molecular Biology Major at UQ, and I teach first year (freshman) Biology (~1200 students), our large second year (sophomore) Biochemistry and Molecular Biology course (~500 students), our even larger second year Genetics course (~600 students), and a small molecular biology masters by coursework cohort (~40 students).

Other than the masters students, most of my students do not want to be scientists. About 30% of my UG students want to pursue a career in science, but the remainder have many other goals, including medicine, nutrition, engineering, teaching, IT, law, and food science. Their study programs have many different entry requirements, and consequently the cohorts are mixed-ability.

2) Describe what you would like to take home as a result of attending the SoTL Institute.

My proposed project is to develop high-value assessment for my mixed-learner cohorts, so that students perceive their assessment items as being of more benefit to them than just a marks-getting exercise. I hope this will make them more willing to engage with the subject matter in our courses. I would also like to have a better grasp of how to design, implement, assess, write-up, and publish sound SOTL projects.

3) Tell us about your interests outside of the classroom and a book that you have read recently.

I work full-time, and I don't have a lot of time for hobbies, but I am lucky to have a wonderful family – my husband Glenn who is also an academic, and our two children Gemma (aged 8) and Aidan (aged 6). We enjoy doing things together like traveling, going swimming, hiking, camping, taking photos, gardening, and cooking. I volunteer in my kids classrooms. We have a cat, James, and 7 guinea pigs (all pound rescues) who keep us busy. My daughter likes to help me with scrapbooking.

I recently read "Alex and Me" by Irene Pepperberg (http://www.alexfoundation.org/Alex_and_me.html) about Alex the African Grey parrot. I believe our pets talk too, but the guinea pigs are more limited than James the cat. I always read the New Yorker because we lived in the US for 11 years in CT, and I still need my American news fix.

Assignment #2: Reflections

1) How would you describe your "research problem(s)" to the Research Scholars group?

The primary research problem I have chosen to work on this year is the engagement of our "non-science" and "non-major" students with the content and concepts of a large, mandatory Biochemistry and Molecular Biology course (BIOC2000). BIOC2000 is designed and taught by scientists who love science as a pure discipline. Consequently the course is "science-centric" and is also "ego-centric", in that we believe the content is interesting and worthwhile. Many of our students struggle with that idea, as they don't see it as relevant to their career and learning goals. Also, we tend to assess the course using classical "science" activities – prac reports, final exams, and sometimes poster presentations
from primary literature.

So, how do we provide learning, assessment, and extension activities that engage these disaffected students and help them learn concepts and ideas from "our" discipline that will ultimately be relevant to their needs?

2) What theme(s) based on your readings, resonate with your "problem" and/or your proposed approach to address your problem.

I think the question of conceptual understanding is relevant here. I am already doing a study with the class this year that looks at their changing mastery of "big ideas" in biochemistry, but I have not specifically looked at their ability to translate (or map) their understanding of concepts in biochem to similar understandings in medicine, nutrition, and engineering.

Also the question of "affective" learning is important. What "knowings" can students get from this course and associated activities that will be useful to them later? These don't just have to be biochem and molecular biology content-related. They could be skills in reading and comprehension, dealing with ambiguity, reasoning, and communication. They are actually all embedded (deliberately) in the course material and assessment items, but most of the students don't appreciate this, or they just bypass them because they are sure they will not be assessed. They are actually assessed, and this is laid out in the marking criteria, but the students still don't "get it".

Neither of these things is currently a stated learning objective of the course and I am realizing that they should be if I want them to be important (even though the students never read the learning objectives).

3) Based on Pat Hutchings article, what taxonomy would you use to describe your research question and why?

I would class the first stage of analysis of this problem as a "what is?" question. Specifically, what is the student experience of the course? What are their perceptions of the assessment and learning activities? What are they getting out of the course other than "marks"?

The next section of the analysis is a "what could be?" question. How can we make the course more relevant to the diverse needs of the cohort? How can we make the embedded *implicit* skill-learning *explicit*? What sort of assessment items and learning activities can we give the students that will make them more able to engage with the material and ideas? Would the students like a choice of assessment items? If so, what would they like to choose from? I think their ideas and suggestions would be very interesting here.

The final section is a “what works?” question. By introducing new assessment items and modified learning activities into the course, have we improved things? Do students see increased value in the course? Are students more aware of the affective learning they are doing? Do students gain a better grasp of the core concepts and material with the new learning and assessment items? Of course, this is an action learning cycle, so by the end I will end up starting all over again, but I hope things will be “better”!

Assignment #4: Annotated Bibliography

Preamble:

I have been writing a start-up grant in conjunction with my Biology Scholars Research residency. I wrote it on my residency project - I figured it would be a good idea to have some funding to do this work. I assembled quite a lot of useful resources as I wrote the grant, and I also started to think quite differently about the project. My initial project was focussed on the introduction of new, better, more engaging assessment items for UG science students. I was also keen on getting them to see the value of each assessment item while reducing their perception of "risk" in attempting something new. The more I read, however, the more I started to wonder "Are the students even ready for lots of new, better, more exciting assessment items?" and more to the point "Are the lofty goals I had in mind achieveable, given the risk-averse nature of the undergraduate student." I have decided to scale down a bit, and first work out how ready our students are for empowered assessment. After that, I will know how far to push the envelope on assessment choice without creating a volcano of disquiet amongst the students.

In my grant application I say: "I propose three questions that I believe are important for the improvement of BIOC2000 and of other generalist undergraduate courses in the Faculty of Science at UQ. Firstly, other than grades, what do the students want from their second year biochemistry and molecular biology course experience? Secondly, although we consistently test students with “science centric” methods, are students receptive to the idea of altering assessment regimes to provide student-empowering mixed-ability learning opportunities while maintaining academic rigour and minimizing “costs”? Lastly, what ideas do students have for new assessment items that they see as relevant and valuable to them?"

Useful References:

1) Francis, R.A. (2008) An investigation into the receptivity of undergraduate students to assessment empowerment.", Assessment and Evaluation in Higher Education, 33:5,547-557.

This is a really nice paper that gives a working model (including survey questions and methodology) to assess student receptivity to empowered assessment. I found its discussion of "empowerment" very useful. It incorporated philosophical ideas about motivation that I hadn't considered before. It also talks about power structures in education, and defines three important factors that define student interest in taking risk:

(1) *the role of the lecturer and confidence in the lecturer as assessor,*

(2) *their personal understanding of the assessment process and criteria* to which they are currently subjected, and (3) *the potential for empowerment to take place at the community rather than the individual level.*

Abstract quote: "This paper presents the results of a pilot study into the receptivity of first- and third-year undergraduate geography students to various mechanisms and concepts associated with assessment empowerment. Some receptivity to empowerment relating to choice of assessment was observed in first-year students but the greatest receptivity was found in third-years, at both individual and community empowerment levels. Third-year students displayed an increased desire for assessment choice, criteria choice and community empowerment, and decreasing confidence in the lecturer as assessor. Based on these initial results, a methodology for incorporating assessment empowerment into undergraduate teaching is outlined."

2) Patall, E.A., Cooper, H., Civey Robinson, J. (2008) "The Effects of choice on intrinsic motivation and related outcomes: a meta-analysis of research findings.". Psychological Bulletin, 134:2,270-300

I found this article helpful, because it describes a meta-analysis in which the authors attempt to quantify the effects of activity choice on intrinsic motivation, effort, task performance, and perceived competence displayed by the choosers. This is valuable, because there are so many papers floating around in which the effect of choice is tested on either a very small group, or in a very specialised scenario, and it becomes difficult to determine how effective such a choice might be in your own educational situation. I am interested in providing assessment choice to students, but I would like to do it in a manner that does not increase their stress and decrease their motivation. The authors provide an illuminating introduction in which they discuss self-determination theory, the idea of learned helplessness, and the variables associated with choice. These variables include (i) type of choice, (ii) number of choice options, (iii) the presence of an external (extrinsic) reward for choosing, (iv) the presence of a control group who did not get a choice, and (v) the presence of pressure to choose a particular option. The findings of the study were rather disappointing. Mostly there seemed to be no effect of choice on any of the outcomes tested. The authors were, however, able to determine that there is a significant effect associated with the number of choice options available. Two to four options produces the highest levels of satisfaction. Below this (obviously) is no choice, and above this the choice becomes too stressful and takes too much time. If anyone is good at statistical analysis methods, I would like to talk to them about this paper, because I don't understand some of the terms they used in their stats. What, for example, are "yoked" studies?

3) Aldous, C. (2006) Engaging Pedagogies in Mathematics and Science Education: Some Key Ideas, Issues and Implications for Research and Teaching in South Australia. AARE Conference papers, 2006. ISSN 1324-9339 web: http://www.aare.edu.au/06pap/ald06755.pdf

This paper provides an insightful analysis of different ways to think about, or contextualise, science education. I found it full of wise advice and thought-provoking questions. Aldous discusses six important ideas:

> i) equity in science education: the idea that everyone should be given access to science training, and everyone can learn science (not just the "smart" kids),
>
> (ii) science as a form of service to humanity and (iii) science awareness as a basic form of literacy: although governments see scientists and scientific literacy as essential for the health of a society, students often see it as "too hard", or "irrelevant", or "not a secure job", or just outside their realm of experience and interest. Science is hard, and it does not present a secure career trajectory. So how do we encourage students to go into it? Students these days are not as "noble" as they once were, so the idea of chasing an elusive research goal for the sake of possible glory or contribution to the planet is not appealing to many of them. The simple answer is probably financial incentives. If scientists made more money, they would probably be more socially admired.

(iv) dimensions of knowledge: How do we define scientific understanding. Is it processes, content, or context? How does this impact on our course design and assessment objectives and tools? How does this affect national curriculum design for specific science disciplines?

(v) Affective and cognitive responses to maths and science: we tend to focus on the cognitive response to science and maths, rather than fostering an affective response as well. When was the last time you sold science as intrigue, mystery, and wonder, or maths as beauty, elegance, or aesthetics? To me, this is one of the reasons I got into science. The experiments were so beautifully thought out and that fascinated me on an aesthetic level. Do we help our students see that on a daily basis, and harness that excitement to drive the students' interest?

(vi) the connection between maths, science, and technology: do we do enough to promote to students that idea that the technology and problems they engage with in daily life are very often solved using science? If not, how do we do it?

4) Seymour, E. & Hewitt, N.M. (1997) "Talking About Leaving. Why Undergraduates Leave the Sciences." Westview Press, CO.

Seymour and Hewitt and sociologists at U.Colorado. They have culled over 600 hours of interviews with undergraduates from STEM disciplines in which they discuss the factors that affected retention in science, maths, and engineering (SME) courses. I am reading this book at the moment, and it is an eye-opener about the way in which traditional fire-hose teaching methods for SME subjects affects students. The two major reasons for leaving science are cited as (i) "Loss of interest in the subject matter" (or increasing interest in a different field of study) and (ii) Poor teaching by SME faculty. Obviously we can't change the subject matter - science is science, but we can give students the choice of constructing assessment and learning opportunities around topics that interest them.

5) Perdigones, A. Garcia, J.L., Valino, V., & Raposo, C. (2009) "Assessing heterogeneous student bodies using a methodology that encourages the acquisition of skills valued by employers', Assessment and Evaluation in Higher Education, 34:4, 389-400. and

6) Peat, M., Taylor, C.E., & Franklin S. (2005) 'Re-engineering of undergraduate science curricula to emphasise development of lifelong learning skills', Innovations in Education and Teaching International, 42: 2, 135-146

Both these papers focus on the development of generic skills in undergraduate students. This is something I am struggling with when talking to colleagues who co-teach courses with me. They are often still in the mindset of teaching content only, and assessing content memorisation rather than application of material in real-world scenarios. My colleagues are also unwilling to set assessment items that are aligned with content. They prefer to rely on the final exam, with bad results. Both of these articles gave me inspiration about ways to approach generic skills development in our students while reinforcing content mastery as well. Article (6) is by a lecturer who taught me when I was an undergraduate (Mary Peat). It's exciting to see that she is still an interested and innovative teacher. Article (6) also describes many of the general issues we experience in Australian universities, using the University of Sydney as a case-study.

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Assignment #1: Introductions

1) Describe your teaching responsibilities and the type of student you teach.

I currently teach three courses: Introduction to Microbiology; Molecules, Cells, and Organisms; and Cell Biology. The Intro. micro class is designed for non-majors, primarily nursing students, but some students take it to fulfill their science requirements. The class typically has about 55 students that all meet in lecture together and then as three separate lab sections which meet twice a week. Cell Biology is an upper level biology class for majors. I currently have 31 students in the class; we have lecture twice a week (1hr 45min) and two lab sections that each meet once a week (~4 hr). At PLU, students can start taking upper level courses once they finish "the core" and so there is a mix of students in there--for some this is their 1st upper level class while others will be graduating this semester. Molecules, Cells, and Organisms is the 1st class in our core sequence. I have 45 students that meet 3 times a week for lecture and in 2 separate lab sections per week. This is an interesting mix of students as well--overall they are suffering the "shell shock" of starting college, and some of them are really not prepared for college level courses. They also come to us with a wide range of background in science--some had lots of AP science, while others really didn't have science at all or had it taught by a non-science professional (e.g. the choir teacher).

2) Describe what you would like to take home as a result of attending the SoTL Institute.

My biggest goal is to learn strategies that will help me become successful in creating quantifiable methods for evaluating my teaching and my student's learning. Over the past year, I feel like I've made some strides in moving toward a truly learner-centered classroom, but I don't feel like I have the best grasp on really assessing their learning in a way that helps me continue to improve as a teacher.

3) Tell us about your interests outside of the classroom and a book that you have read recently.

I love to go camping, hiking, and backpacking whenever I get the chance. I also love to watch movies (particularly film noir) and read. I have recently re-read *To Kill and Mockingbird* and *The Omnivore's Dilemma*. I've just started *The Immortal Life of Henrietta Lacks*.

Assignment #2: Reflections

1) How would you describe your "research problem(s)" to the Research Scholars group?

We have recently revised our "core" curriculum for Biology majors. Our previous core consisted of 3 semesters, with class sizes of approximately 150 students team-taught by 2-3 professors in a mostly traditional lecture style format. Our new core is 2 semesters long, with class sizes of 45 taught by a single instructor. We have also moved to a more learner-centered approach in the classes, the level of which varies with instructor. In my class, I implemented learning groups throughout the semester and also included a self-assessment component. As you might imagine, some students did not engage in their learning groups, and I also feel like I did not use the self-assessment component in the most effective way. This led me to my area of interest, which is to determine the impact of learning groups on student learning and how self-assessment can be used to increase student metacognition, engagement, and learning. As part of this investigation, I am also interested in identifying effective indicators of student learning.

2) What theme(s) based on your readings, resonate with your "problem" and/or your proposed approach to address your problem.

There were a few themes that resonated with me--first of all, the idea of mastery and the demonstration of understanding. I found myself identifying with many of the ideas in Bass's article particularly in regard to what I consider mastery and understanding and how I know that students have reached the level I want them to. Furthermore, I found myself thinking more and more about if my teaching is effectively allowing them to achieve the levels that I feel are appropriate.
The second theme that struck a chord with me was the idea that SoTL is about informing my decision making about how to make changes to enhance student learning. This is something that is perhaps naturally part of my commitment to SoTL, but the fact that this needs to be deliberate and purposeful was really driven home.
Lastly, I was again reminded of the dynamic nature of SoTL. I think that sometimes it is hard for colleagues to appreciate that because the goal is to exact change; one really does need to look at a course plan as a "changing script". It is a process that requires constant adjustment *while* you're teaching the class. I think this is sometimes also hard for students to appreciate, as they often see deviations from the initial course schedule as a weakness.

3) Based on Pat Hutchings article, what taxonomy would you use to describe your research question and why?

I feel like my questions actually fall into three taxa, the "what works", "what is" and the "visions of the possible". In regard to "what works" I want to determine if the learning groups and self-assessment are effective approaches in the core class I teach. In regard to the other two taxa, I find myself thinking about what I envision the learning groups and self-assessment bringing to the classroom. I envision responsible students that come to class ready to engage with their group and class at a level beyond simple acquisition of knowledge/facts. I see students that are reflecting on their own learning constantly, able to thereby identify how they learn and what their strengths and weaknesses as a learner. In turn, this increased self-awareness strengthens their engagement with their group/class, thereby creating a richer experience for all.

4) Do you have any questions/concerns/comments that have evolved from your reading?

One concern I have is that my question(s) are too broad in focus right now. I feel like I might need to narrow my focus in order to be effective in answering my questions. I am also continuing to question how I will be able to develop quantifiable methods to answer my questions.

Assignment #4: Annotated Bibliography

My interest lies in determining how to use self-assessment as an effective tool for increasing metacognition and learning, particularly in our introductory biology series (which is taken by first-year students).

Andrade H, and Valtcheva,A, "Promoting Learning and Achievement Through Self-Assessment", Theory Into Practice 48:12-19, 2009.

This paper focuses on the use of criteria-referenced self-assessment as a key element of formative assessment where "students reflect on the quality of their work, judge the degree to which it reflects explicitly stated goals or criteria, and revise accordingly." The authors state that certain conditions including modeling, cueing, direct instruction, and practice are necessary for effective self assessment. Furthermore, student engagement in the process can be increased by following three steps: i) articulate expectations; ii) performing self-assessment; and iii) revising

(using feedback from self-assessment). Prior research on criteria-referenced self-assessment in writing and mathematics indicates both quantitative and qualitative improvements in student work and attitudes.

This article is relevant to my area of interest because it quite simply and clearly points out basic considerations for effectively using self-assessment in a course. In addition, the article reinforced the need to have revision and clearly defined criteria as essential components of the self-assessment process.

McMillan JH, and Hearn J, "Student Self-Assessment: The Key to Stronger Student Motivation and Higher Achievement", educational HORIZONS 87(1):40-49, 2008.

The authors begin by defining and describing the "student self-assessment cycle", which includes the components of self-monitoring, self-judgment, and identifying and implementing correctives. This cycle allows students to not only judge their own work, but to improve it by identifying "discrepancies between current and desired performance." This article reinforces the importance of criteria as mentioned in the Andrade and Valtcheva article discussed above. In addition, McMillan and Hearn emphasize the role of the student in the process of designing self-assessment as research indicates that when students are involved in criteria and goal setting student achievement increases. One area of the paper that I found particularly useful was the discussion of Rolheiser's four stages of teaching student self-assessment, which serves as a "growth scheme" for both the teacher and the student. This article also was relevant to my research because it made me think about how I've been using self-assessment in my classroom up until this point, which is primarily reflective in nature. I'm beginning to see how I'm missing some important components needed to make self-assessment more effective for my students.

Young A, and Fry JD, "Metacognitive awareness and academic achievement in college students", Journal of the Scholarship of Teaching and Learning 8(2):1-10, 2008.

Metacognition can be broken down into metacognitive knowledge (what we know about our cognitive processes) and metacognitive regulation (activities we use to facilitate our learning). In the present study, the researches wanted to determine if there was a correlation between metacognition and "broad based measures" of academic achievement. These include metrics such as GPA and end-of-course grades rather than single measures such as individual test or assignment scores. After providing a review of past studies that used the metacognitive awareness inventory (MAI) in a variety of ways, the authors present their own findings. In summary, they found strong correlation between the MAI and broad measures and no significant correlation between the MAI and a single-event test score. My main interest in this article was to learn more about the MAI as a tool for assessing student metacognition. I did learn more about this tool as well as others that could be helpful to me in the future. In addition, I gained some insight as to what types of metrics might actually be helpful to me as I try to evaluate student metacognition and its relationship to student learning gains.

Nordell SE, "Learning How to Learn: A Model for Teaching Students Learning Strategies", Bioscene: journal of college biology teaching 35(1):35-43, 2009.

Many students find it difficult to make the transition from high school to college academics. To address this issue, many schools provide students with some form of study skills workshop in order to help better prepare them for success. I was particularly interested in Nordell's study because it focuses on not only teaching students study skills, but helping them to be better at self-assessing and identifying their study strengths and weaknesses. This paper presents a relatively detailed explanation of the workshop used in the department of Biology at St. Louis University; the main topic areas of the workshop are self-assessment of learning techniques and study skills strategies. Results (based on exams before and after the workshop) indicated that

those students who attended the workshop performed significantly better on exam 2. Consistent with what I see at my own institution, the workshop was attended primarily by students that were already doing well in their biology course. This brings up the question of whether low-achieving students don't attend such a workshop due to their inability to self-assess and recognize that they are in need of help. This article unfortunately didn't really address this question. However, the concrete examples provided in the article have given me solid ideas for techniques to help increase student metacognition in my classes.

Walser TM, "An Action Research Study of Student Self-Assessment in Higher Education", Innovations in Higher Education 34:299-306, 2009.

In this study, Walser implemented self-assessment as an instructional tool to "give students responsibility for monitoring and attaining progress and as a way of encouraging students to develop reflection as a personal trait." In contrast to many studies I have seen where self-assessment is used *throughout* an entire course, Walser used self-assessment at three specific points in the semester (beginning, middle, end). The majority of students reported that the self-assessment activities were an effective instructional method and that the activities helped them to reflect on their own performance. Walser reports that the activities provided her with useful feedback about the course and also strengthened relationships with students. This study is of interest to me because it presents a way of using self-assessment that is distinct from how I've used it in the past and how I've envisioned using it in the future. This paper also provided some useful insights into student perceptions of self-assessment and its use to their current and future learning.