
TEAM #2

TEAM LIST:

David Dunbar
Carol Hurney
Bethany Stone
Didem Vardar-Ulu

TEAM FACILITATOR:

Alix Darden

David Dunbar

Cabrini College, Radnor, PA

Assignment #1: Introductions

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

My primary teaching responsibilities at Cabrini College in with science majors are genetics, Cell & Molecular Biology, Developmental Biology and a Senior Seminar Capstone course. The courses I teach outside the major are a team-taught Forensic Science course, Human Genetics and Environmental Psychology. Environmental Psychology is an interdisciplinary Honor's course co-taught by myself and a psychology professor.

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

Some of the things I would like to take home from the workshops are assessment pieces to assess interdisciplinary taught courses, a non-lecture workshop model to use in my content heavy Cell & Molecular Biology course, ways to imbed more original research in the laboratory components of some of the courses I teach. Also, I would like to offer more writing assignments in my courses and the best practices in the use of "clicker" student response technology.

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

My real passion outside the classroom is fly fishing. As for some of the books I have read recently are "Break Through" by Ted Nordhaus and Michael Shellenberger.

Assignment #2: Reflections

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

A colleague (Melissa Terlecki) and I are constructing an interdisciplinary approach that integrates the science and social science of watersheds to develop a watershed citizenship course that is both rigorous and accessible to non-major/pre-major

students. Our desire is that our interdisciplinary approach will provide multiple access points for students with diverse learning styles and interests. We anticipate that this approach will foster scientific engagement in non-majors, and encourage research interests in other students to become science majors. Recognizing that “learning is an active search for meaning by the learner—constructing knowledge rather than passively receiving it, shaping as well as being shaped by experiences” (Joint Task Force on Student Learning, 1998a), our course will take on a learner-centered approach to assessment. This paradigm calls for assessment to be both integral to teaching—that is, through ongoing formative and summative assessment practices where faculty will both monitor and promote learning (Huba and Freed, 2000)—and to course design and evaluation (Palomba and Banta, 1999). The Director of the Cabrini College Center for Teaching & Learning at Cabrini College, Lisa A. Ratmansky, will work collaboratively with us to develop and sustain formative and summative assessment for our team-taught course.

As the watershed citizenship course deploys a “problem-based” interdisciplinary approach to community-based research, bringing together biological and social science perspectives on specific environmental issues of import to communities, the evaluation of the learning outcomes will require a careful look at how students apply their knowledge in active, engaged and contributory ways (Sternberg, 2008) as well as what their attitudes towards becoming citizen scientists who steward the environment.

In order to capture changes in awareness, students will be asked to reflect on their beliefs about environmental stewardship throughout the semester. Combining assessment tools designed by Dr. Terlecki as a model for pre- and post-testing students knowledge, attitudes and awareness combined with a portfolio system of assessment (for which students compile all the work they complete sequentially so that changes in their skills, competencies, content knowledge and awareness can be evaluated) will offer both a quantitative and a qualitative form of formative and summative evaluation. Likewise, to enhance and structure evaluation of the courses themselves, a course portfolio will be created jointly by the faculty. These portfolios will follow from Lee S. Shulman’s call, for faculty to see their teaching as a site for research and scholarship of discovery. The course portfolios serve as ongoing investigations of a course (or in this case, courses) permitting growth in a myriad of related realms: the critical review of course content, design and evaluation and the exchange and use by other members of one’s team, and more broadly of one’s scholarly community (Shulman, 1998).

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

3) Which of the 12 properties of SoTL in microbiology education proposed by S. Benson’s article are particularly relevant to your project at this stage?

Based on the above, the properties of SoTL proposed by the Benson article that are most relevant to our interdisciplinary model at this stage are properties #1, 10, 11 & 12.

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

5) What do you see as tangible products to be developed as a result of your Scholars experience within the next 12 months?

Dr. Terlecki and I are working on an assessment piece to evaluate our unique interdisciplinary course with the hopes of publishing our results in a prestigious pedagogical journal such as the Journal of Excellence in College Teaching.

6) What do you see yourself presenting at the follow-up session at ASMCUE 2009?

I trust that at the follow-up session at ASMCUE in spring 2009, we will have our work already submitted to a journal for peer-review. I also trust that we will be presenting our interdisciplinary model at appropriate education conferences.

7) What will you need to develop these products?

Assignment #3: Annotations

In assembling a beginning annotated bibliography, I am focusing on articles involving interdisciplinary team-taught courses. This approach stems from a an interdisciplinary course a colleague of mine (Melissa Terlecki) and I are constructing that integrates the science and social science of watershed ecology to develop a watershed citizenship course that is both rigorous and accessible to non-major/pre-major students. Our desire is that our interdisciplinary approach will provide multiple access points for students with diverse learning styles and interests. We anticipate that this approach will foster scientific engagement in non-majors, and encourage research interests in other students to become science majors. We presented our work as a panel presentation at the 2008 Council for Undergraduate Research (CUR) meeting and received some valuable feedback.

1. Husic D, Navigating Through Interdisciplinary Pitfalls and Pathways to Success CUR Quarterly 26(4): 169-176, 2006.

This article discusses several merits and caveats of interdisciplinary courses taught by a cohort of faculty from disparate disciplines such as biology and geology. Since I recently began team teaching a watershed course with a psychology colleague I was already aware of some of the pitfalls of team-taught courses such as varied teaching styles among faculty within and across disciplines. One of the merits of interdisciplinary team-taught courses mentioned in the paper is that it allows students to see their own faculty disagreeing on many hot button issues and topics. Students see firsthand that faculty can even disagree vehemently at times over issues. The article also pointed out the benefits of interdisciplinary work at a liberal arts college such as my own such as honing a student's critical thinking skills and communicating effectively across traditional disciplinary boundaries. The barriers of interdisciplinary taught courses was most useful to me as it suggested ways to overcome department needs that many times trumps several faculty from being able to team teach interdisciplinary courses.

2. Jordon. R, Nudging Academic Science into the Public Sphere Academe 93(3): 52-54, 2007.

I found this article via one of my ERIC searches a great read. The author discusses the merits of faculty working with a community partner(s) in addressing a research problem. The paper puts forth the claim that working with a community partner on a research matter does not represent a diminution of one's scholarship and described several examples. I found this article inspiring in that as part of my interdisciplinary

studies, I have recently begun a student-based stream assessment study with a community partner, the Valley Creek Restoration Partnership. Equally inspiring was the author's conviction that one need not be an expert in a field to have a meaningful relationship with a community partner.

3. Woltermade CJ & Blewett, W, Design, Implementation, and Assessment of an Undergraduate Interdisciplinary Watershed Research Laboratory *Journal of Geoscience Education* 50(4) 372-379, 2002.

The article described a cohort of laboratory field courses students take that are centered on watershed studies. The laboratory courses used a local watershed to provide intensive undergraduate field training in the collection and analysis of environmental data. The courses are taught by faculty in several disciplines including Geology, Biology and Education. The intent of these interdisciplinary courses is to further student investigations in a wide variety of courses across the curriculum. One thing that I found informative is that interdisciplinary studies of this magnitude almost always require some type of external funding. The authors did receive funds from an NSF Course, Curriculum and Laboratory Improvement (CCLI) grant they were awarded to pilot their project. We recently applied for an NSF CCLI grant to sustain our interdisciplinary watershed studies at Cabrini College. The article has given me insight into improving our chances of success if our grant gets rejected such as having an external advisory board to critically review and assess the various interdisciplinary courses on an annual or semi-annual basis.

4. Gill S, Riebling BJ, & Theophano J, Multidisciplinary Lenses on Nature *Interdisciplinary Environmental Review* 9(1) 1-9, 2007.

The article stresses the need for a multidisciplinary discussion that reflects rigorous environmental science and current views from the humanities and social sciences. The authors point out that presently the sciences have very little dialog with their counterparts in non-science related disciplines. It is argued that without a meaningful conversation between the sciences and the social sciences, it will be exceedingly difficult if not impossible to solve many of the environmental problems currently inflicting humanity. The authors then proceed to give several good examples to support this claim. The authors do point out a difficulty with environmental multidisciplinary studies in that each discipline; whether it be in the humanities or the biological sciences, tend to view their discipline as the "keystone" or most important discipline in solving environmental problems. Hence, multidisciplinary work between colleagues in different disciplines can become divisive as faculty views their own work as the most important part of the multidisciplinary team. The authors then go on using several examples of multidisciplinary teams genuinely collaborating with one another and show how the collaborative effort led to a far deeper understanding of a particular area of research. As I move forward with other colleagues on my campus in different disciplines working on both local and global watershed-related issues, I found this article extremely informative. As a team, it will be important to stress the need for genuine collaboration and that each member of the team's work is on equal footing with all other team members in order to maximize our chances that the work will lead to something both meaningful and powerful.

5. Farrel TA & Quiros N, An Academic Model for Interdisciplinary Environmental Education and Problem Solving in Costa Rica: A Case Study of the School for Field Studies *Interdisciplinary Environmental Review*

7(1) 37-45, 2005.

This paper describes interdisciplinary models of environmental studies using Costa Rica as a case study. Students enroll in one of several environmental courses based in Costa Rica and involve themselves in solving one of several ecological problems in Costa Rica such as water privatization, sustaining biodiversity, preserving forest ecosystems and the pros & cons of ecotourism. The paper points out some of the barriers of these types of study abroad interdisciplinary courses such as insuring and convincing a college's administration that the study abroad course will be academically rigorous. As I have very recently begun to plan interdisciplinary studies on watershed issues in El Salvador with students, I found this paper informative. Future endeavors on El Salvador water issues stems directly from a trip I took to El Salvador with several of my colleagues from various disciplines this past May and seeing first hand some of the water issues that affect a large population of the Salvadoran people. After talking to several of my colleagues, they agree that it would be great if we could like a local watershed course to a watershed course that has a global dimension such as studies in El Salvador. A watershed course based around El Salvador water issues also fits the new Core Curriculum at Cabrini College where there is an expectation that students gain a greater understanding of global issues.

Carol Hurney

James Madison University, Harrisonburg, VA

Assignment #1: Introductions

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

I teach the non-majors biology course at James Madison University. I also teach a few sections of the introductory lab portion of our major's course. I really LOVE teaching the non-majors and have been using a lot of different teaching strategies in this course (most recently, clickers). Typically, I have about 75 students in each section where I help them explore all sorts of topics including human cloning, evolution, cancer, and drug addiction and this past semester I let them pick some of the topics, so I ended up running a unit on the colony collapse disorder in the honey bee population. Life is good in the world of non-majors.

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

My take home from this group is the motivation to publish some of my SoTL work. Collecting the data is one thing, but finding time to get it out there is something quite different. In addition to my role as a teacher and a biologist (I study salamander tail development); I recently transitioned into a new role as the Assistant Director of the JMU Center for Faculty Innovation. This is the campus teaching and learning center and I help coordinate and run a number of faculty development programs designed to enhance the learning environment at JMU. So, I also want to bring back ideas from our work to other faculty on my campus.

Interestingly, our programming theme for the 08-09 academic year is SoTL. I guess I am hoping to "walk the walk" so that I can help/inspire other faculty to join me.

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

Outside of the classroom you will find me teaching aerobics at the local gym, riding my bike or cooking something fabulous in my newly renovated kitchen. I share my world with 3 amazing cats and they seem to like the new kitchen as well. The last book I read was "Animal, Vegetable, Miracle: A Year of Food Life" by Barbara Kingsolver, which inspired me to purchase a share of a local community supported agriculture program. This means that sometime soon a whole BUNCH of organic vegetables will start being delivered to my house and so I may be bringing samples for all of you in July.

Assignment #2: Reflections

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

My research problem focuses on the meta-reflective process that Bass discusses in his article. Do students know when they have learned something? Or that their learning has improved? The two classes I teach have very different student populations. The non-majors introductory biology course is filled with students of various backgrounds and ages. Initially these students do not understand that skills they can obtain from this class can have a significant impact on their lives. They think they should just come to class, memorize a bunch of terms and then be on their way. I want to create an environment where they see the value in achieving

the course learning objectives and that they can track their own journey towards becoming a scientifically literate citizen. My other course, introductory lab for biology majors is targeted for freshman biology majors. These students often think that they already know how science works and feel confident about their ability to deal with biological content. Unfortunately, this mindset proves to be a barrier for some of these students to see that they still have much to learn. In many ways, getting the introductory biology student to explore their own learning process is more difficult than it is with the non-majors. But in both cases, I want the students to be aware of their own learning process. To that end, I want to know that the teaching strategies I use in each learning environment impact student perception of their mastery of the course learning objectives. I hope to approach this problem by collecting meaningful data regarding teaching strategies I use in these classes to promote the meta-reflective process.

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

I was particularly struck by the “Inverted Pyramid” discussion by Bass. Early in my teaching career, I was giving the final exam to the non-majors class. As I sat there and watched them take my exam, I was looking over the questions and thinking about the semester we had just finished. Although I didn’t have the language to describe the problem back then, I did realize that I wanted those students to gain skills about how to use science in their lives. I had even incorporated skill building teaching strategies and other projects that would impact the development of such skills. So why did my test only contain 50 content-based, multiple-choice questions?

I wanted to stand up and tell the students to STOP taking this stupid test! That is when I flipped the pyramid and started to teach & TEST to the skills that my students were developing in my class.

3) Which of the 12 properties of SoTL in microbiology education proposed by S. Benson’s article are particularly relevant to your project at this stage?

I am somewhat of a novice in the SoTL process, so I am examining the literature to determine how other educators have explored this problem (Property 4). I have attempted to collect data regarding some of my teaching strategies, so I am hopeful that the Biology Scholars will help critique my experimental design (Property 3).

Finally, I think this problem is central to many disciplines and will foster connections to different biological sub-disciplines as well as many other educational areas (Property 11).

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

5) What do you see as tangible products to be developed as a result of your Scholars experience within the next 12 months?

In the next 12 months I will develop research strategy that I can use to collect data from my two classes so that I can describe the impact a learner-centered teaching environment has on the meta-reflective process of students.

6) What do you see yourself presenting at the follow-up session at ASMCUE 2009?

In the next 12 months I will develop research strategy that I can use to collect data from my two classes so that I can describe the impact a learner-centered teaching environment has on the meta-reflective process of students.

7) What will you need to develop these products?

Encouragement, feedback and time!

Assignment #3: Annotations

My annotated bibliography contains articles that address multiple facets of my research questions. One of my research questions focuses on the use of personal response systems in large classes and so I have included two articles that address the efficacy of these devices. I am also interested in exploring the impact of the Socratic teaching method and although I did not find many resources that addressed this teaching strategy, I did find articles on facilitating effective discussions. In addition, I include an article that deals more broadly with the impact of active learning. Finally, I have an article that discusses the transfer of cognitive skills in higher education. This article provides a context for both of my research interests (non-majors intro bio and majors biology laboratory).

1. Caldwell, J.E. (2007). Clickers in the large classroom: Current research and best-practice tips. *CBE-Life Sciences Education*, 6, 9-20.

This paper gives an excellent overview of the uses of clickers in the classroom and then goes on to focus on pertinent research questions. In addition to summarized the current literature on clicker research, the author provides insights on issues such as content coverage, student attitudes toward clickers and impact of clicker use on attendance and grades. The paper concludes with an overview of best-practices. This article provides an excellent launching point for the clicker component of my research question.

2. Trees, A.R. and M.H. Jackson. (2007). The learning environment in clicker classrooms: student processes of learning and involvement in large university-level courses using student response systems. *Learning Media and Technology*, 32(1), 21-40.

An important aspect of clicker use in my non-majors biology class relates to how well the use of clickers in my course integrates into the overall design of the course. This paper explores the social and educational infrastructure needed to support effective clicker use. More importantly it examines the ways in which student characteristics and course design relates to the impact clickers have on student learning. The authors analyze student survey responses from 20 courses that measure student assumptions about large classes, desirable learning processes, classroom involvement, and student motivation. This analysis suggests that students who value feedback, do not value a traditional lecture style, and prefer to be engaged tend to be more positive about clickers. Now all I have to do is make sure those students enroll in my class!

3. Grover, N. (2007). How to create successful discussions in science classrooms. *Biochemistry and Molecular Biology Education*, 35(6), 397-403.

This paper is a descriptive study of the components of successful discussions. Given that the Socratic method is similar in some respects to discussion-based teaching, I feel this article will help me dissect the components of the Socratic strategies I utilize in the majors laboratory course to help the students better prepare for this learning

experience. In particular the author explores what it really means to discuss science concepts and how effective preparation on the part of the student will influence the discussion. This paper provides a better context for me to build the Socratic dialogue with my students in a way that helps them to understand the benefits of this type of learning environment.

4. Freeman, S., E. O'Connor, J.W. Parks, M. Cunningham, D. Hurley, D. Haak, C. Dirks, and M.P. Wenderoth. (2007). Prescribed active learning increases performance in introductory biology. *CBE-Life Sciences Education*, 6, 132-139.

This article examines numerous course designs that differ in the type and amount of active learning exercises. Since learner-centered teaching strategies can be viewed as extension of active learning, I feel this paper provides the balance for my thought processes. I had the pleasure to meet the primary author of this paper, Scott Freeman, and have used his introductory biology book to support the laboratory course I teach. This type of paper sends the same message I hope to send in my work. "If you do it, they will learn!" I also appreciate the methodologies the authors employ to address their research questions and will most certainly attempt to design similar experiments for my projects, if possible. Although, I think I will need a refresher in statistics.

5. Billing, D. (2007). Teaching for transfer of core/key skills in higher education: Cognitive skills. *Higher Education*, 53, 483-516.

Creating a learning environment that promotes the development of scientific reasoning skills provides the foundation for the non-majors and majors courses I teach. So I feel like I am supposed to be reading papers like this one. This paper reviews over 700 papers that contain analytical and empirical evidence addressing the teaching and learning of tasks with high cognitive content. Although this paper doesn't specifically address scientific reasoning skills, many of the variables analyzed align with the cognitive processes of science. Most importantly, this paper provides insight into some of the work addressing the meta-cognitive process. So I will continue to work my way through this paper as I continue to prepare for the upcoming institute.

Bethany Stone

University of Missouri, Columbia, MO

Assignment #1: Introductions

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

I teach at the University of Missouri in Columbia, MO. I am an "Assistant Teaching Professor" which means my job requirements are exclusively teaching with no research obligations. I teach General Biology and elective courses such as Infectious Diseases and Genetic Diseases to non-science majors. I also teach Botany which includes plant science, biology and non-science majors.

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

Even though my job does not have research obligations, I want to conduct education research to keep myself fresh and in touch with my students. I am especially interested in documenting student misconceptions as they enter my classroom, but, like Trish, would like to assess their learning at the end of the course as a measure of teaching effectiveness. I hope the program will help me form quality research questions, create informative assessment tools and interpret results.

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

I am married with a two-year-old boy and four-year-old girl. We live on 65 acres, have horses and are starting to build a new house. The last book I read was "The Ghost Map" by Steven Johnson about the Cholera outbreak of 1854 and the beginning of epidemiology. Don't be fooled, however, the book before that was pure mind junk.

Assignment #2: Reflections

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

Many of the concepts we cover in biology are sub-microscopic, without detail when viewed under the most powerful machines. The scale makes learning biological concepts difficult for most students. DNA, genes, alleles, chromosomes -- all of these fundamental concepts in molecular genetics are unfortunately (for the learner) physically small. Students struggle to relate to or understand these terms as easily as they can terms like "gymnosperm", "uvula" and "Drosophila". Bass's paper, The Scholarship of Teaching: What's the Problem included the following quote from Diana Laurillard: "Teachers need to know more than just their subject. They need to know the ways it can come to be understood, the ways it can be misunderstood, what counts as understanding: they need to know how individuals experience the subject." In my research project I hope to discern students' understanding and misunderstandings about molecular genetics when they enter introductory biology. From this research, I hope to develop methods that can help students understand, and experience, these biological concepts. I also hope to advance understanding about the problems that make these concepts so difficult to teach, one of the properties outlined by Benson in his Twelve Properties of Scholarship of Teaching and Learning in Microbiology Education.

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

I was struck by Randy Bass's statement that he, "resolved to make every course component intentional." Intentional reading assignments, exam questions, lecture material and other course components require a clear starting point and a clear learning outcome. That means defining clear learning goals, assessing students' prior status with these goals, formulating learning tools that help them reach the learning goals, and creating assessment that measures their achievements. All of these steps are deliberate in a way that makes it clear to learner and outside observer that your goals were well defined and, hopefully, met by the learners.

I was also struck by the Boyer Report's summary of scholarship as four activities, of which only one was teaching. To be "scholarly", the other three types of scholarship (discovery, integration, and application) need to be explored as well. The Biology Scholars program opens avenues for educators to expand their use of discovery, integration and application and, by doing so, increase scholarship in the classroom.

3) Which of the 12 properties of SoTL in microbiology education proposed by S. Benson's article are particularly relevant to your project at this stage?

One of the powers of the Biology Scholars program is that the research will be shared throughout the process, another of Benson's Twelve Properties of Scholarship. The critical analysis, suggestions and input provided by peers throughout all steps of our research projects will increase the chances that our projects will result in meaningful, and scholarly, results.

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

5) What do you see as tangible products to be developed as a result of your Scholars experience within the next 12 months?

Twelve months from now I would like to clearly state priority learning goals in the topic of molecular genetics and share data about prevalent student misconceptions and holes in understanding in molecular genetics, pre- and post-instruction. I hope to define this situation so biology educators can create and share effective teaching strategies to overcome student difficulties with this material. To start on this process, I will create a pre-instruction assessment tool that will be administered to my general biology classes and will measure students' understanding, or misunderstanding, of basic concepts in molecular genetics before it is explored in the classroom. I will then reassess their understanding after instruction as a measure of learning.

6) What do you see yourself presenting at the follow-up session at ASMCUE 2009?

7) What will you need to develop these products?

Assignment #3: Annotations

I am researching student misconceptions on genetics, but focusing on molecular genetics in non-science majors. That is, I am interested in students' understand of terms like "chromosome", "genes", "DNA", "protein" and the relationships between these terms. I would like to identify misconceptions and the sources of these misconceptions so I can design targeted instructional tools on this material. Unlike Jenny, I have not created an assessment tool so my primary focus at this time is on literature that will help me create viable assessment.

1. Duncan RG and Reiser BJ. (2007) "Reasoning Across Ontologically Distinct Levels: Students' Understandings of Molecular Genetics", *Journal of Research in Science Teaching*, 44(7); 938-959.

In this study, the researchers explored 10th grade-students' understanding of molecular genetics, focusing on genes as physical entities, but also as packets of information. The authors argue that students struggle with this information for three reasons: the concepts are inaccessible to the students because they are sub-cellular, the concepts are spread across many biological levels, and that multiple molecules are key players that also span many hierarchical levels. They assessed the students using written assessment and interviews before and after instruction. What I liked about their assessment tools is they used open-ended questions that avoided "false positives" for misconceptions -- a problem outlined in Jenny's reference, Clerk and Rutherford (2000). They focused their interviewing on the relationship between genes and proteins, but their methods and many of their questions could be expanded to include the relationships between genes, chromosomes and DNA. While they identify some interesting misconceptions they did not explore the source of those misconceptions. Are they a lack of background (and so not really a misconception -- just a lack of any understanding)? Or are they caused by something in previous coursework or popular media? I would like to expand on their work and include the source of these alternative conceptions.

2. Marbach-Ad G. (2001) "Attempting to Break the Code in Student Comprehension of Genetic Concepts", *Journal of Biological Education*, 35(4); 183-189.

While most studies I have read have been conducted on a specific grade level, this research spans early high school, late high school, college and post-degree, pre-service teachers. Students were assessed on their understanding of molecular genetics using open-ended questions on written questionnaires and verbal interviews as well as concept maps (see more below in 3b). They received fascinating results. Students at all levels compartmentalized their definitions of "genes", "DNA" and "Chromosomes" as either structural (chromosomes) OR functional (genes and DNA), but not both. If the definition was functional, terms were made distinct even though, in reality, they have similar functions. For example, genes "determine traits" and DNA "transfers hereditary information from one generation to the next". The conclusion of the study was that students at all levels fail to make many connections, both structural and functional, required for a full-picture understanding of molecular genetics.

3. a. Rotbain Y, Marbach-Ad G, and Stavy R. (2005) "Understanding Molecular Genetics Through a Drawing-based Activity", *Journal of Biological Education*, 39(4); 174-178.

b. Yarden H, Marbach-Ad G, and Gershoni JM. (2004) "Using the Concept Map Technique in Teaching Introductory Cell Biology to College Freshmen", *Bioscene*, 30(1); 3-13.

Many students claim, correctly or not, that they are visual learners. Both these papers use visual tools to facilitate and assess student learning. I like the first paper because the authors present a drawing-based learning activity that encourages students to analyze, complete and replicate figures commonly found in biology textbooks. The upper-level high-school students were assessed on their understanding of molecular genetics after the activity and their scores and learning attitudes were compared with a control group who received traditional instruction. The researchers found that the visual tools increased student performance on the post-instructional assessment. In the second paper, biology majors were given an introduction to concept maps and asked to create a concept map of various terms in molecular genetics. The researchers then used the concept map as a tool to assess student understanding of the concepts. By using this assessment technique the researchers were able to uncover several misconceptions that were previously unidentified by the instructor.

I included these papers for two reasons. First, some of their assessment methods using drawing or concept maps could be used in my assessment. Second, someday I hope to develop instructional methods that target these misconceptions and the techniques presented in these papers may be a good place to start.

4. Klymkowsky MW, Taylor LB, Spindler SR, and Garvin-Doxas RK. (2006) "Two-Dimensional, Implicit Confidence Tests as a Tool for Recognizing Student Misconceptions", *Journal of College Science Teaching*, Nov/Dec; 44-48.

I have previously conducted research in my classroom on student understand of molecular genetics, but the assessment tool we used (mostly multiple choice) failed to assess how sure students were in their answers. In order for a wrong answer to be deemed a misconception, the student must have some confidence in their incorrect answer and not be guessing. In this paper, the authors present a study on the usefulness and gender-neutrality of implicit confidence tests -- tests used with multiple-choice assessment to measure students' confidence in their understanding. They provide substantial background about misconceptions and include their logic for using the two-dimensional tests (TDTs). The focus of this research was to test this method for gender bias. Previous research has indicated that female students are naturally less confident in their opinion, so they compared the number of times students of each gender indicated they were "confident", "semi-confident" or guessing on the TDT. Their results indicate there is no difference in the selection rate of those options between the genders.

5. Clerk D and Rutherford M. (2000) "Language as a Confounding Variable in the Diagnosis of Misconceptions", *International Journal of Science Education*, 22(7); 703-717.

I did not know about this paper until I read Jenny Knight's bibliography, so I want to give her full credit for finding this resource! As I create assessment tools this paper

seemed important to include as it directly addresses the over-diagnosis of "misconceptions" (AKA "alternative conceptions") in education. I agree with the authors when they describe multiple-choice tests as creating the illusion of misconceptions that do not actually exist. To test this hypothesis, they administered a multiple-choice physics exam to 48 students and selected 9 students for a follow-up interview to more deeply explore their understanding of the material. In their results, 23.5% of all "misconceptions" are false positives, meaning students answered the question incorrectly on the written exam, but demonstrated sufficient understanding during the interview. An average of 16% of the incorrect answers to the physics questions they raised revealed true misconceptions; that is questions that were answered incorrectly on the written exam and again in the interview. This study emphasizes the importance of creating discerning assessment tools and using multiple methods to measure student understanding.

Didem Vardar-Ulu

Wellesley College, Wellesley, MA

Assignment #1: Introductions

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

I am Didem Vardar-Ulu a second year tenure track assistant Professor in the Chemistry Department at Wellesley College, in good old Massachusetts.

As you'll soon see, I had a rather indirect way of getting to the position that I have right now, which includes teaching as a part of the job description. Hence, one of my biggest expectations from this experience is to build a long lasting social and scholarly network with colleagues, who share a similar interest and passion towards science education.

I had my undergraduate degree in physics in Turkey and came to Boston for my Ph.D. in Biophysics and then did a total of 5 years postdoc mainly in the field of Structural Biology/ Biochemistry. For all of these 15 years I was based in exclusively "research" oriented settings and there was very little, if any room or sympathy for spending (wasting) time with teaching. I loved (and still love) bench-side research, yet I also felt that I truly enjoyed any opportunity to get involved in teaching and training other students. As years went by, I also realized that I wanted to contribute to the understanding of how science education can be made more effective and have a say as to how to go about it. Hence, two years ago when I became aware of an opening at Wellesley College, which is an all undergraduate women's liberal arts college that gives equal emphasis to undergraduate research and teaching, I was extremely happy to venture a setting change. With that said, though I love my job, I have to confess that with almost no teaching experience, picking up different biochemistry courses offered by the department both to science majors and non-science majors who are almost all premed students as well as specifically to Biological Chemistry majors carrying out lectures and labs and trying to implement a few (that I now realize perhaps too many at the same time) unconventional teaching strategies was challenging to say the least.

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

Since based on my training and experiences I consider myself to be an experimental Biophysical chemist, I like to think about my classroom as another work bench. So what got me so excited about this SoTL program and this fellowship in particular was to perhaps have the opportunity to learn how to conduct education based experiments in the classroom with the same rigor and quality that I am used to doing in the laboratory and how to objectively evaluate the outcome. In short, how to turn my intuition and passion into scholarly work. So hopefully, I'll have a much better idea about it in a year.

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

I am married and have a VERY ENERGETIC son who is 4 years and 4 months.

And between first two years on this job with demanding premed students at Wellesley and my son at home, I have forgotten the meaning of free time, but I do love traveling, spending time outside and swimming –especially miss the long spring

time back in Istanbul and the blue warm Mediterranean sea (still not a big fan of pools). A recent book I read and really liked is Snow Flower and the Secret Fan.

Assignment #2: Reflections

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

The specific question I want to investigate is a result of some preliminary observations I had as I was teaching the two different Biochemistry courses in the College this year. The Chemistry Department (which I belong to) offers one, one semester Introduction to Biochemistry Course for a multitude of science majors (dominated by biological sciences, chemistry, and neuroscience) as well as a few non-science majors who are pre-meds. The second course is a two-semester Biochemistry Course designed primarily for Biological Chemistry majors, who take it in their junior or senior years. Over 90% of the students taking these courses are pre-med students. The two courses have pretty similar content learning expectations with a bigger variation in the “other expectations” based on the professor who is teaching the course. Finally, they have very similar pre-requisites except that the one semester course requires two semesters of organic chemistry and the two semester course requires a Cellular Physiology Course.

I came up with my research question towards the second half of the spring semester as I was desperately trying a wide variety of techniques to motivate the students to take more responsibility in their own learning and feel productive about it. Not surprisingly, there seemed to be a very clear correlation between the enthusiasm students showed toward learning and how comfortable (and hence positive) they felt throughout the process.

So I decided to work on figuring out the key elements that are the real prerequisites for productive learning (both short and long term) in an interdisciplinary field. My hypothesis is that there are two totally independent factors that are in action: 1) The content knowledge from different disciplines that students bring in to the first day of class and expand on throughout the course 2) An analytical thinking/ logical reasoning skill set which ensures that they can put these (unfortunately extremely compartmentalized) information together to tackle and explain interdisciplinary problems. Initially, I had assumed that by the time students reach their junior/ senior years in college they would have had at least some basic opportunities to develop on both of these areas so that an upper level interdisciplinary course in Biological Sciences (such as Biochemistry) would be an enjoyable and fruitful application ground for them. However, I have observed that despite the relatively uniform and broad educational background we offer at Wellesley, the students display an amazingly varied competence in these two categories which I believe greatly impacts how they perform. So throughout this year I would like to design and develop a methodology that would both test the relative importance of these two factors in student learning and performance (during the course and beyond) and also could potentially aid the professor teaching the course customize their teaching efforts for a particular cohort of students each semester.

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

I have two big challenges/ concerns in this undertaking. The first one is probably more applicable for everyone in this group and that is: How do you perform “experiments” with student subjects and ensure that you get the right, objective,

and interpretable controls/data while ensuring that everyone gets the same learning opportunity? (A similar dilemma to the one faced in clinical research where some people end up with placebo materials). Also, as a branching concern from this point is the fact that students are human beings, so they think, they feel, and they learn, which means that it is not possible to rerun your experiments over and over again and assume that they will produce independent data.

3) Which of the 12 properties of SoTL in microbiology education proposed by S. Benson's article are particularly relevant to your project at this stage?

This is why I think the problem centric design (Benson- P8) and reflective analysis (Benson-P1) as well as becoming fully aware of what others have already done (Benson-P4) are most relevant to the current stage of my project, though I see the importance of many of the other points as the project develops.

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

The second challenge I have is due to my status as a junior tenure track faculty who is coming up for reappointment in a liberal arts college that prides itself in setting high standards of excellence in both teaching and traditional research. Although I do agree that a lot of the ideas outlined in the articles we were assigned to read are and should be trivial for a true scholarly educator, in these past two years I have come to appreciate how varied actual philosophies and expectations about teaching could be even within the same institution. Probably this is why of all the reading assignments we had, the one that resonated most with me was Benson's clear distinction between "excellence in teaching" and "scholarship of teaching". Of course, I feel that the ultimate goal for scholarship of teaching should be to arrive at a point that combines it with excellence of teaching. However, I completely agree (and even now have my own personal experiences) with Benson's statement that many scholarly attempts in teaching or educational research may fail, just like in any other areas of research and since as Bass nicely puts it we should be focusing on "defining and investigating educational problems rather than trying to fix them", a negative result should be as valuable as a positive one. However, now I realize that such an approach is extremely risky for a junior faculty in an institution where the success or excellence in teaching is mainly (if not solely) determined by student evaluations administered just before the finals.

5) What do you see as tangible products to be developed as a result of your Scholars experience within the next 12 months?

So what I hope to gain through this one year immersion is some wisdom as to how to construct worthwhile scholarly educational research projects in a way that would be true to the real nature of doing scholarly research (without the fear or threat of failure), but also get advice on how to best execute them so that as Bass nicely puts it : "the ongoing investigation of the problem rather than its terminal remediation" would be a beneficial exercise in student learning and curriculum development even when the outcomes negate the hypothesis. I would certainly welcome any suggestions and help from the group to achieve this goal and get started in developing specific research projects that would bring about concrete and testable outcomes.

6) What do you see yourself presenting at the follow-up session at ASMCUE 2009?

For ASMCUE 2009, I plan to have at minimum a specific set of materials to assess the relative importance of the two factors (content knowledge and reasoning skill-

set) in determining a productive learning experience for students taking interdisciplinary courses, as well as hopefully some preliminary data on a few initial trials conducted on the cohort of students I will be teaching over the 2008-2009 academic year.

7) What will you need to develop these products?

Assignment #3: Annotations

This assignment of searching for previous research in the SoTL field was an extremely interesting and an eye opening experience for someone like me, who is use to going to Pubmed on a daily basis and immediately finding almost an exact match to what I am looking for. Certainly this was not the case when I tried to search all the different sites suggested in our assignment starting with some of the keywords I had in mind for my research. After working my way around many very interesting but at best tangentially relevant material, I came to believe that there are three main reasons for this: 1. I am still in the process of defining exactly and clearly what my project is going to be about and learning the precise or appropriate jargon that go with it. 2. It seems like in the SoTL field a lot of referencing to other work and their findings is very anecdotal, so it is extremely difficult to trace some ideas or data to primary sources or citations. 3. There really seems to be a lack of previous work in the specific area I am interested (which I am surprised at, but happy about at the same time) So most of the following annotated references, as well as many others I started collecting are articles that helped me redefine my project as: The relative importance of discipline specific prior knowledge (specifically chemistry and biology) versus informal and/or formal logic skills for success (defined as demonstrating "critical thinking") in an interdisciplinary field (specifically in the field of biochemistry).

1. Thompson Ross, A., Zamboanga Byron L., (2004) Academic Aptitude and Prior Knowledge as Predictors of Student Achievement in Introduction to Psychology. *Journal of Educational Psychology*. Vol. 96 No.4 778-784

This is the only article that comes relatively close to the type research I would like to carry out for my project. It describes the results of a study that aims to determine whether preexisting differences in the general ability or the aptitude of the students contribute (and if so to what degree) to the previously studied positive association of prior knowledge with course achievement. It starts out by discussing the impact of prior knowledge in new learning, both potentially assisting and hindering it and how it specifically affects psychology courses. The authors then pose the question if the facilitating effects of prior knowledge could perhaps be due to differences in general student ability or aptitude. To answer this question they used pretest scores to predict exam performance in regressions that included measures of student aptitude as well as course-related influences on student achievement (American College Test –ACT- scores were used as a part of aptitude evaluation). They also set out to investigate if prior knowledge could also be a source of misconception and erroneous ideas that can undermine accurate understanding. To assess this point they created a second pretest that assessed students' endorsement or rejection of ideas from the popular culture related to topics in psychology. Their findings showed that measures of prior knowledge as indexed by the pretest of psychological knowledge is the most significant predictor of course achievement even

with measures of academic aptitude (i.e. ACT scores) and course involvement controlled. However, they also found out that ACT scores were strongly related to exam performance underscoring the importance of preexisting differences in student aptitude or ability.

2. Newell William H. (1992) Academic Disciplines and Undergraduate Interdisciplinary Education: lessons from the School of Interdisciplinary Studies at Miami University, Ohio. *European Journal of Education*, Vol. 27, No.3

This article discusses in a much broader sense (since it reflects on the complete Interdisciplinary Studies program at Miami University) the relevance and/or importance of disciplinary background in student learning in interdisciplinary courses as well as if interdisciplinary courses could adequately prepare students for advanced work in specific disciplines. It is an exploration of different issues posed by advocates and critics of interdisciplinary programs about the relationship between disciplines and interdisciplinary education and a summary of how they are resolved in practice within the context of an exemplary interdisciplinary program. It details out many specifics within the program such as the description of the program, student preparation, staff preparation, visibility and roles of disciplines within the courses, and disciplinary outcomes of the courses. It also discusses different approaches employed for the assessment of disciplinary skills gained through interdisciplinary courses. It concludes that interdisciplinary courses promote the same intellectual rigor as traditional disciplinary courses since it utilizes concepts, theories and methods from various disciplines with exactly the same rigor. However since it is more than the pieces of disciplines from which they are constructed, they extract the perspective embedded in each of those pieces to produce a broader, more holistic perspective. It argues that the interdisciplinary process is ideally suited for the promotion of "strong sense critical thinking" while disciplinary courses often promote "weak sense of critical thinking". I found this article very valuable in clearly laying out and comparing skills expected and gained in disciplinary versus interdisciplinary courses in what seemed to be a relatively objective and pretty inclusive point of view.

3. Lauer Thomas (2005) Teaching Critical-Thinking Skills Using Course Content Material: A Reversal of Roles. *Journal of College Science Teaching*, May/Jun 2005; 34, 6 p.34

This article describes the challenges of successfully implementing the teaching of content material using Bloom's six hierarchical levels of intellectual growth in the classroom and demonstrates a successful strategy to achieve this goal when critically thinking pedagogy is used to teach content as well as teach students how to think critically. The author evaluated if higher-order critical-thinking skills could be taught in a classroom using course content material, by using the concept of critical thinking without specifically identifying or labeling it in class. He presented the concept in three phases: introduction, mastery, and evaluation and used everyday examples to demonstrate each phase. He also detailed very specifically in practical terms how he structured his classes to guide students along the way and assess their progress. Finally, he summarized and analyzed his findings to conclude that thinking at a higher level can be taught in the classroom using course content material and placing less emphasis on teaching factual knowledge and more on conceptual-thinking skills should be a high priority for science instructors since it would provide students lifelong skills, rather than short term gains in learned information. Although

this study was not directly related to an investigation of the effect of prior state of students for success in developing conceptual-thinking skills, it provided extremely valuable insight of how one can go about achieving it in class specifically during a course and helped to clarify for me how to separate pre-course parameters I wanted to test for my project from the in-course parameters that will certainly impact the outcome, by identifying specific elements I would work on (and keep constant) during the course I would like to use to perform my studies on and helping me decide on how I define my "successful outcome".

4. Paul Richard, Elder Linda (2007) White Paper: Consequential Validity: Using Assessment to Drive Instruction. September 2007. PDF accessed 07/03/08
http://www.criticalthinking.org/assessment//assessment_WP.cfm

This article outlines "The Critical Thinking Community"'s definition of critical thinking and describes what the students are expected to learn about critical thinking during the teaching of discipline based thinking to better devise instruction that match that particular end view. The authors describe the main goal of conceptualization of critical thinking as getting every student in every class at every moment "intellectually engaged". Then they go on defining intellectual engagement and describe what is required to teach for intellectual engagement. Then they talk about the importance of using assessment as the guiding force in instruction and discuss what typical standardized "critical thinking" tests actually test. Finally they compare holistic vs. componential assessment and conclude that substantial work needs to be done to work towards finding assessment strategies that test student's ability to make the connections between the logic of the discipline they are studying and what is important in life. This, they claim, will ensure that the students to become self-directed, self-disciplined, self-monitored, and self-corrective thinkers. I also found this article very useful in terms of helping me define very clearly what I would like to use as my success target for my interdisciplinary biochemistry course(s) I want to include in my project and think about different criteria to evaluate student performance.

5. Hirsh E. Donald. Jr. (2003) Not So Grand a Strategy. Education Next, Spring 2003, Vol.3, no. 2

I valued this article a lot because it outlined some valid concerns about introducing the "higher-order (thinking) skills" too early on in the education system without giving students enough opportunities to learn basic content first. The author argued using some very specific examples that to successful demonstration of higher order thinking skills is strongly dependent on competence in the curricular content through which the skill is taught and hence cannot be taught and exercised as an independent abstract and general concept. He talked about the importance of "activating the knowledge bank" and expanding the "working memory" through the availability of relevant, previously acquired knowledge. He claims that for practical purposes there are no such things as transferable higher skills of problem solving. Student's ability to perform well in problem solving depends on having the relevant information in his working memory and describes the results of emphasizing teaching "higher-order skills" in the expense of curricular content has been damaging to those students who have not gained broad academic knowledge outside of school. I found this article useful and relevant to my research project because it provides specific examples and evidence that argues for the importance of discipline based prior

knowledge (one of the parameters I would like to test) for success in higher order skills that I would like to use as a criteria for success in an interdisciplinary course.

6. Harper-Marinick Maria (2001) Thinking Critically about Critical Thinking. Mcli Forum Teaching, Learning, and Technology in the Maricopa Community Colleges, Fall 2001, Volume 2

This article is one of the articles included in the mcli Forum as a part of their learning and instruction initiatives and describes the need to go beyond mastering the content knowledge and be proficient in critical thinking to be successful in today's world. While acknowledging the importance of relevant knowledge and previous experience in developing critical thinking and problem solving skills however, it emphasizes the need to incorporate facts and concepts into evaluative thinking. What I liked about this short article was the fact that it nicely bulleted assumptions about critical thinking from previous research, providing additional references to look into if needed and providing its own definition about critical thinking, again giving me an opportunity to think about how to define student achievement for my project.