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"*Focus on Physics*" – UNIV100, PHYS100 and PHYS299B

I have not yet taught a course at UMD and I will not teach in the Fall 2014. I have not been assigned a course yet, but the Physics Department has given me the flexibility to be a part of a course restructuring to address attrition of Physics majors. So rather than a piece-meal alteration of an existing course, I plan on incorporating the information I learned at the Chesapeake Project in a course series called *"Focus on Physics"*. I believe this will have a two-fold benefit to the sustainability effort at UMD. Specifically it will i.) enhance the retention rate of STEM majors at the university, who can then go on to have an impact on the environment at the scientific level, and ii.) provide base education and research experience for scientific investigations into sustainable research. Below I will describe the proposed *"Focus on Physics"* course structure and highlight where the integration of the science of sustainability will take place.

Despite a concerted effort by the University of Maryland, College Park, the flagship science education institution in the state, the retention and attrition rate in physics in particular and STEM majors in general portrays a grim picture. The last five graduating classes (between 2009 and 2014) of physics majors at Maryland have seen annual attrition between 49% and 69%. The attrition rates in STEM majors across the university have been equally alarming (between 49% and 57%). The figures for attrition are even higher for transfer students, many of whom transfer from local community colleges, and particularly for underprivileged, women, and under-represented minority students. The day–to–day of most physics research suffers from a disconnect from society, where an understanding of the direct impact of the research we do is not understood, either by the public or the researcher. The lack of clear, immediate social goals in science has been identified as a source of attrition in STEM, especially among women. Research into sustainable science can provide the link between science and society that some early researchers crave.

I will be part of an integrative course restructuring at UMD which concentrates on the college-transition-stage of a young scientist's career, including women, minorities and transfer students. The three-part course includes a i.) transition to the university culture and environment, ii.) instruction on methods to investigate physical problems and iii.) a research experience component.

UNIV100 – *The Student in the University*

The purpose of this course is three-fold: 1) to provide the resources (skills, tools and information) incoming freshmen need to transition successfully into the university environment, 2) to introduce students to the field of physics: what it is, what physicists do, the nature of research and how can students be involved in research, and 3) to expose students to techniques proven to help with success in physics (thought problems, rigorous math practice, understanding physics grading schemes, etc.). In addition, students explore their own learning styles through personality testing and value assessment. Peer-based instruction is used to develop problem-solving skills, physics faculty present research and research opportunities, and basic skills such as time management, healthy eating habits,

and sustainable efforts and practices at the university are covered, relying on trained experts in the university community.

PHYS 100 – *Building Your Physics Tool Box*

The jump from the ``welcome to college'' concept of UNIV 100 to "here's research" of PHYS 299B (see below) was too dramatic a leap, requiring the creation of additional intermediate course to help facilitate this transition. This course will create a new type of exposure to scientific and engineering elements that both contextualize the STEM experience and where the creative aspects of the students experience will help frame the learning environment, in particular to redefine the scientific method in terms of an individual's learning identity. The goal of the course will be to answer this question: How does one frame their relationship to science using a personalized scientific method and how does one use their creative strengths to investigate those interests? Ownership of the creative process through the students past experiences and strengths will help define a unique role within the scientific community. The first part of the course will be based in the classroom with the goal of getting students to understand the nature of science and engineering from their own perspective. Specific topics will include: evaluation of current pedagogical scientific review papers to find the thesis and restate that thesis in their own words, give opinions about the nature of science under study in the paper, methods of deconstructing complicated phenomena, identifications of where their own scientific reasoning comes into their academic pursuits and the strengths and uniqueness of their approach. Emphasis will be placed on creating a connection to society and examples of how scientific research in the sustainable community can facilitate this will be given. The initial focus of these pedagogical papers will be on condensed-matter-based technologies like the transistor, which use to show how current electronics technologies will be used to solve a portion of our energy problems. This will lead into the second part of the course: inquiry-based learning into a student's interest using a personalized scientific method where the process rather than the result will be emphasized. Aspects of this interest -- define in collaboration with the a professor to be worked with in Phys 299B (see below) -- will be deconstructed and investigated using computer-based simulations. For example, for students mentored by me, element of study will be the most common sustainable device: the solar cell. During this exploratory learning process, emphasis will be placed on the short comings of current solar cell technologies, giving rise to the experiments proposed for Phys299B. This ``research'' portion of the course will take place under the guidance of both professor and a student-based (upper division undergraduates and graduate students) teaching assistant team. The development of a personal scientific method that is effective in solving problems will help the student to form an identity within the broader scientific community, as will the strong overlap working on research with members (professors, undergraduate and graduate students) of the community.

PHYS 299B – *Use the Physics Toolbox to Engage in the Research Process*

This course is a discovery-based research course in which students develop and implement research skills by completing a research project. Early engagement in research with faculty and a connection to society has a strong effect on retention. This research course expands on the basic skills developed in earlier in the sequence, while teaching

other research skills in a collaborative environment. The course engages students with the research skills they will need to become successful physics majors through a mentor-guided research project, which gives students the opportunity to do authentic science -- as opposed to the typical ``canned'' lower division laboratory experiments with known results. PHYS 299B was piloted this year with 12 students who worked in pairs on 6 distinct research projects, ranging from galactic rotation curve models to studying impacts in granular matter. A sustainability component of this research was lacking and will be instituted in future version of this course. The students completed research posters that were presented to their peers, mentors, and other physics and astronomy faculty, students and staff. In addition, the students presented their work to the whole university community at the Maryland Undergraduate Research Day. Many of the students continue to work with their mentors, and others have moved to different research areas.