Background to the Gateway Science and Math Course Reform Program

For more than two decades, research has shown that student success in STEM disciplines is most negatively affected by students' lack of success in the gateway courses that develop essential skills and introduce students to disciplinary studies (Tobias 1990, Seymour and Hewitt 1997). Teacher-centered pedagogies that focus on passive learning from lecture combined with instructors who are teaching at levels that supersede students' actual abilities are key components of student failure in these gateway courses (Tobias 1990). Across the United States, gateway science and math course reform focuses on accessible and demonstrated effective changes connected to replacing passive lecturing, algorithmic problem solving, competitive curve-based grading, and "cookbook" laboratory assignments known to dissuade students from continuing in STEM courses (Seymour and Hewitt, 1997; Handelsman et al., 2007; Tobias, 1990) with more actively engaging, relevant, inquiry-based, and collaborative instructional designs (Fairweather, 2008; Handelsman et al., 2004, 2007; Hake, 1998; Fraser and Tobin, 1998; Sellers et al., 2007; Mintzes and Leonard, 2006; Wieman, 2007; Wieman et al., 2010). In addition, research (Sellers et al., 2007) shows that active, collaborative learning approaches are more inclusive of students who come from backgrounds traditionally not well represented among those who are in STEM fields, such as Hispanic and Native American, low-income, and/or first-generation students. Active, social, collaborative learning opportunities in class are closely aligned with culturally-rooted approaches to learning that are prominent among New Mexico Hispanic and Native American students (Sanchez, 2000).

Each year of the grant period, UNM's Project for Inclusive Undergraduate STEM Success will support three, gateway-STEM course-reform projects facilitated and overseen by the Office of Support for Effective Teaching (OSET). Each course-reform effort will be defined by internally-solicited proposals from departments targeted by the project (those teaching one or more of 25 gateway life/physical science or mathematics courses: Biology, Chemistry, Earth & Planetary Sciences, Mathematics & Statistics, Physics & Astronomy). The proposals (due in March of each year) will specify commitment of the core regular and part-time faculty who teach the course and will require the collaborative participation of key faculty members from Central New Mexico Community College (CNM) identified by the CNM Dean of Math, Science and Engineering. Submitted proposals must show foundational, but not necessarily expert, understanding of the discipline's pedagogical content and instructors' knowledge of research-based models for course reform. OSET workshops preceding submission of department proposals will assist faculty to develop proposals by providing opportunities to experiment with

and utilize proven approaches particularly important for success of low-income and minority students (e.g., Handelsman et al., 2007; Sellers et al., 2007, Saul and Beichner, 2005).

Each course-reform team composed of approximately four UNM and one CNM faculty members will work during two summers that enclose an academic year of initial implemented changes. The first summer will include high expectations for course reform, such as outcomes plans; course-curriculum revision; outcomes-aligned in-class assignments developed or borrowed from textbook-publisher or open-source resources; inquiry-based lab exercises; reliable and valid summative assessment instruments; and assembly of a resource archive of teaching and learning aids for all future instructors to use. The resource archive is critical for sustainability of the reforms because the faculty teaching gateway courses change over time and, in some cases, many sections are taught by part-time instructors or graduate teaching assistants. The first-summer work will begin with a STEM-focused version of OSET's 2-day course-design institute with a follow-up half day to integrate concepts from the institute into the original course-reform proposal. During implementation the following academic year, OSET will host brown-bag lunches open to all – inviting participants from all UNM and CNM STEM and education departments – to share challenges and successes that will promote constructive discussion, feedback and modification to the reforms. The brown-bag series will also recruit other faculty to submit course-reform proposals. During the second summer of each funding cycle, faculty teams will make adjustments based on project evaluation and outcomes assessment during the previous year. Faculty teams receive summer-salary compensation for work in course-reform (first summer: approx. 1 month; second summer: approx. 2 weeks). Various OSET-sponsored events during the year will include faculty from peer institutions who are leaders in STEM course reform to provide guidance, assistance, and advice.

A 15-month Graduate Assistant position will also be provided to the department responsible for the reformed course. The graduate student selected for this position (preferably desiring a career in academia) will be a resource person to assist the faculty work during the first summer and succeeding academic year, can assist with assessment during the year, and help faculty with finalizing the reform package during the second summer.

Course-reform proposals can include requests for support from the by Peer Learning Facilitator (PLF) and STEM Student Interest Groups (SSIG) components of the Project for Inclusive STEM Student Success.

The course-reform projects are investments during the grant period that will continue to return value as redesigned curriculum elements, pedagogical guides, and teaching materials are archived and provided for future instructors under the mentorship of the faculty who led the department-based projects and OSET. Curricular and instructional reforms will take advantage of existing and ongoing institutional investment in new learning environments and teaching and learning technologies.

List of Strategies to Address Key Factors for Successful STEM Course Reform
1. Faculty are part of the solution, because *they* make the changes to curriculum and instruction. Expert Office of Support for Effective Teaching (OSET) guidance and resources from workshops help to disseminate ideas, but faculty are empowered as informed change agents. No cookie-cutter templates for course reform are expected. Each faculty team contributes its own disciplinary expertise and a consensus view of supporting pedagogical content knowledge.
2. Many or all instructors teaching the targeted courses, not just an interested individual, will be involved, increasing likelihood of high-impact success. Instructional and assessment resources will be archived for use by all instructors including part-time and graduate-student instructors, so as to sustain the reform despite instructor turnover.
3. The process is rewarded through compensation for curriculum and instructional reform work. GA support, PLF assistance during implementation, and OSET resources are also available. Faculty work will be publicly recognized on both campuses, and teams will be encouraged to undertake publishable classroom action research.
4. Each course-reform-project Graduate Assistant (GA) will be part of a team with other GAs working on other courses. This team will join Office of Support for Effective Teaching (OSET) activities that build science-education expertise and provide a "preparing-future-faculty" component to the project.

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