June 5, 2012

Dear Ms. Adamez,

Thank you for hosting my recent visit to Coastal Bend College (CBC). It was a pleasure to see the four campuses, meet with the students, faculty and administration, and to gain some perspective on the goals and aspirations of the redesign efforts. During my visit I was impressed with the potential of CBC and the commitment to the students by the faculty and staff.

I have attached a report based on observations made and conversations had during my visit. Following from your stated goals, I focused of my recommendations on creating science courses that would increase enrollment, persistence, and completion of students from underrepresented groups in STEM disciplines. I used your proposal as a guide, but used my perspective of work being done across the country to shape my recommendations. I focused my suggestions on four main categories: active learning, information technology, civic engagement, and assessment.

As you consider my recommendations, please feel free to contact me with any questions or for clarification. This review should be an iterative process, one that is responsive to the wishes of the faculty in charge of implementing the changes and to the constantly evolving educational landscape. I look forward to continuing the conversation.

Sincerely,

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REPORT TO COASTAL BEND COLLEGE: REVIEW OF PLANS TO IMPROVE STEM COURSES TO ACHIEVE GAINS IN STUDENT RETENTION.

I visited the Beeville, Pleasanton, Kingsville, and Alice campuses of Coastal Bend College (CBC) in mid-April, 2012. During these visits, I met with students to learn of their experiences in the classes they take, and with faculty to learn of the pedagogical strategies/philosophies they employ. These were informative sessions and they permitted a detailed view of the strengths of the program as well as areas that might benefit from shifts in pedagogical approach. I also met with administrators to discuss the level of commitment on campus for the redesign process that CBC will undertake.

General Observations
Several things stood out during my visit. First, the commitment to high quality education among the faculty was notable. Having a dedicated and committed group of instructors is one of the best predictors of success in redesign efforts. Second, the infrastructural improvements that are underway will also help achieve important goals of improving science instruction at CBC. Third, the administration appears supportive of the redesign efforts, but strong leadership will be required to maintain investments in the STEM disciplines beyond the grant period. Fourth, and most importantly, CBC has a diverse student body composed of some highly motivated individuals that seem eager to learn. The latent talent and enthusiasm exhibited by many of the students points to a higher probability that redesign efforts will be received fairly and well. From an instructional standpoint, the diversity in educational background found among the students represents a challenge that instructors will face as they consider different redesign options. Instructional techniques that are highly effective with inexperienced learners can lose their effectiveness and even have negative consequences when used with more experienced learners. There are several strategies that instructors can implement that will challenge the most prepared students while at the same time allowing those who require more remediation to continue moving forward. I place my recommendations in four broad categories (with several corollaries that are identified below). These appear to me to be the most promising areas for growth while providing relatively rapid results for assessment purposes. In bullet form, these categories, expanded below, are:

- In-Class Active Learning & Inquiry-Driven Laboratories
- Technological Opportunities
- Civic Engagement
- Assessment & Professional Development Opportunities for Faculty
Active Learning (sensu lato)

Didactic pedagogy is an efficient means of disseminating information, but it is often not the best strategy for engaging students or achieving true learning. This is especially so for the learning goals outlined in CBC’s OASIS grant proposal. One area that will likely lead to significant gains in student learning will involve implementation of active learning instructional approaches in both the classroom and lab. By active learning, I mean modes of instruction that shift the emphasis so that students become agents and advocates of their own learning. This does not mean that all the lecturing that is currently done should be abandoned or is without value. In fact, I was impressed with the quality of the explanations and examples that were used in the classes I sat in on. CBC has a deep pool of talented teachers on its staff. The goal for the science courses at CBC, however, should be to incorporate curricular practices that build progressive challenges into the syllabus such that students move from passive learners to skilled problem solvers. The challenge is to find a way to combine “example study” as is currently done in many lectures at CBC with “problem solving” that is at the heart of active learning. Empirical evidence indicates that achieving that combination leads to optimal learning, and this should resonate with CBC students.

“Example study” appears to be the major teaching strategy employed at CBC whereby the instructor presents content and works out examples for the students. This type of pedagogy is not as effective as having the instructor integrate elements of the problem solving process in the examples that are chosen. It is important to note that this approach is already used by CBC faculty, but it should be more widely implemented. Two strategies may help with restructuring the “example” mode of presentation in many of the CBC STEM courses. The first involves providing incomplete examples that students have to complete themselves. The professor can incorporate in-class discussions around blanks or question marks that s/he places in the example being discussed. The second involves introducing problem-example pairs. With this strategy, the instructor walks students through the solution to a particular example and then provides an isomorphic example (i.e., nearly identical example in terms of the solutions expected) without an answer and asks students to provide the solution. The use of models can be very useful in both of these cases. For example, I observed the excellent use of a model to introduce CBC students to how the diaphragm creates negative pressure within the lungs in a physiology class during my visit. This was an exceptional way to introduce an incomplete example with missing information. The institution may thus need to invest in models that instructors believe will help aid their instruction, but any request for equipment should include a clear statement for how the material will be used in service of active learning.

Case studies offer another and immediate opportunity to turn CBC classrooms from example study to problem-solving/inquiry-rich environments. One resource that may be of particular assistance in moving
away from example study is the National Center for Case Study Teaching in Science at the University of Buffalo (http://sciencecases.lib.buffalo.edu/cs/). Case studies can be used to teach scientific concepts and content, but are superior to example studies because they also reinforce the critical thinking skills we want our students acquire. The use of cases in the classroom makes science relevant because many of the best cases are based on science problems that students encounter in the news. Additional details about case study are provided in the Civic Engagement section below.

In-class activities involving cooperative learning would also help break up long lectures, and would lead to increased student learning, retention of content, and overall satisfaction with the learning experience. My observations indicate that most of the students in lectures at CMC were avidly taking notes, and were thus attending to that activity rather than learning what was being presented. STEM instruction at CBC would benefit if professors could transition some percentage of their lectures to include cooperative learning teams. This strategy complements, and can be used in conjunction with, the active learning approaches described above. My interviews with CBC students indicated a strong desire on their part for these types of learning experiences. The active, team-based learning approach also allows CBC to build student-tutoring aspects to the courses, and students indicated that peer-based instruction was a positive and helpful experience. The new lab designs will facilitate this type of instruction.

One of the most important changes that I would recommend would be to include a greater degree of research-based hypothesis testing in inquiry-driven labs. This will undoubtedly improve STEM instruction at CBC. Laboratories offer the opportunity to employ open learning, which has no prescribed result that students must achieve other than honing their scientific critical thinking skills. While CBC’s labs appear to be structured such that a specified outcome or expected result is the goal, inquiry-driven labs require students to discover the “answer” based on results from the experiments performed (i.e., based on data interpretation). While students take an active role in this mode of instruction, teachers must still guide them to the desired learning goal without explicitly stating what that learning goal is. This is a fundamentally different approach to STEM instruction, but one that promises major advances in student learning and engagement.

Given the talents of many at CBC, there are real opportunities to create hands-on, field-based labs that take students into their local environments. A rich source of ideas can be found at the Association for Biology Laboratory Education (ABLE; http://www.ableweb.org/), which hosts an annual meeting to discuss novel teaching tools and strategies. The faculty at CBC have already created unique labs and teaching activities, and ABLE might be a good place for them to publish these results (I raise this point
again in the Assessment section). In addition to field labs, the rise of biotechnology and the presence of major centers of biomedical research in Houston, San Antonio, and Austin indicate that molecular-based experiences might be an area of growth for CBC labs. Many of the basic molecular genetics tools that students should be introduced to (e.g., DNA isolation, PCR, gel electrophoresis, DNA sequencing, gene expression) have been streamlined for introductory courses. They have also become much more affordable, but CBC would have to invest in some of the equipment necessary for incorporating these types of labs to make it an integral part of the introductory courses. Many companies (e.g., Carolina Biological) offer packages. Faculty may also need some training in the techniques. It would seem that biotechnology and molecular biology would appear to an area of programmatic growth as well as an opportunity to emphasize active learning in the labs.

Results consistently indicate that inquiry-based instruction and problem-based learning strategies will help retain students in STEM disciplines. The benefits of inquiry-driven pedagogy has been articulated in a number of publications but the most concise, direct, and applicable to CBC was produced by the Council for Undergraduate Research in 2009. The report focuses on incorporating research at community colleges and can be found at: http://www.cur.org/urcc/. I would encourage CBC faculty to contact some of the authors responsible for this report, and I would single out Dr. James Hewlett (Finger Lakes Community College; hewletja@flcc.edu) who has spent more than a decade thinking about ways to enrich teaching objectives with inquiry-driven laboratories. Dr. Hewlett currently heads the Community College Undergraduate Research Initiative (http://www.ccuri.org/).

Technological Opportunities

As we move towards an “infodense” world where data is accumulated at increasing rates, it is imperative that students become aware of what technology offers. There are at least two ways that information technology (IT) can be used to enhance the in-class experience. The first is to use tools to supplement/complement lecture-based activities. Resources listed at a website like http://www.getbodysmart.com/ap/site/resourcelinks/links.html can be used in lectures, and help create a more dynamic classroom. There are many available resources. One example that may be of interest is the University of Pennsylvania Medical Animation Library (http://www.pennmedicine.org/health_info/animationplayer/) that provides a host of resources that would seem applicable to several courses at CBC. Adopting these tools would align with the wishes of many CBC students given that several individuals in the focus groups articulated a desire for more IT. During my visit, it appeared that the dominant use of IT involved power point and Blackboard, and while these
are valuable didactic tools (and students appreciate having electronic access to power point slides and study guides), they lack flexibility and can erect barriers to active learning.

The second way that IT can enrich instruction is through the use of virtual labs that broaden the scope and enhance to reach of STEM activities. Wet laboratories can be expensive. Virtual experiments offer the possibility of reducing costs while increasing the quality of the lab experience. One example would be the modules available at a company like SimBio (http://simbio.com/), and the OsmoBeaker Collection may be of particular interest though the Evo- and EcoBeaker modules are excellent. To realize the promise of this IT strategy, CBC must have a computer laboratory or mobile laptops that are available for student use (which may necessitate an investment in computers/space). For students that have computers, they may be able to do these activities on their personal machines.

Emphasizing IT-based approaches to instruction may open new opportunities that go beyond classroom work. First, by adding a stronger digital component, more material is moved online and thus may apply to distance learning courses. Second, faculty can accumulate the best information on the web, and create a resource base can be a common tool used by all classes. A course web page can serve as a reservoir of material that goes beyond traditional STEM topics (e.g., studying tips (http://www.howtostudy.org/), resume writing (http://owl.english.purdue.edu/owl/resource/719/1/) and cover letter preparation (http://www.youtube.com/watch?v=uSLGa2bRU-g)). These types of resources would likely be of significant help to CBC students, and the focus group conversations I had indicated that the students would be appreciative of this type of effort. Finally, adopting IT-rich teaching strategies necessitates being sensitive to different levels of comfort and experience with technology that the CBC student body may have. This point was brought up frequently during the focus group meetings I had. Several students recommended having training sessions early in the semester so that all students can be brought up to the same level of competency with computer-based instruction.

Incorporating additional technology will help achieve some of CBC’s stated goals. Technology-rich simulations will encourage more student interaction and hands on learning, group activities, and increased student engagement. Adult learners will likely appreciate the flexibility that technology often offers, which can often include flexible course scheduling and introduce variations in course length.

**Civic Engagement**
A recent report by the Association of American Colleges and Universities (“A Crucible Moment: College Learning and Democracy’s Future”) discusses and highlights the centrality of education in a democratic
society for democratic citizenship. Science education is critically important in this regard given how many issues that we face today deal with scientific concepts. Despite the importance of a civically engaged and educated population, we find ourselves in a period where the quality and quantity of civic education is in decline. STEM courses offer the opportunity to civically engage students while at the same time offering topics that can enhance the quality of the classroom experience. That is, civically minded topics can be used to build curricular offerings.

During my conversations with students, it became clear that they are looking for ways to meaningfully connect with the material being presented in their classes. This is a ubiquitous problem in education – how do we make material relevant to students who lack the experience to understand why material that seems like minutiae has ramifying importance to broader issues in society? The major career interest among the students with whom I spoke centered on human health. Faculty at CBC may be able to take advantage of this interest by incorporating community-specific concerns in their classes. There are many examples in the area that could be drawn upon. Diabetes, heart disease, obesity, and cancer are four health topics that can be directly related to concerns of students in CBC classes (and classes across the nation). Agricultural activities and petroleum exploration in south Texas may lead some students to question the environmental and health impacts of these economic activities (e.g., pesticide use, groundwater contamination). Faculty can use these civically minded topics to their benefit as pedagogical tools.

Indeed, the case study approach described above offers powerful pedagogical techniques for teaching in STEM disciplines because they relate scientific information to meaningful and relatable situations. That is, they employ topics that require civic engagement and necessitate citizens to be educated to meaningfully participate in debates about the issues. For example, the case study “Do You Really Know What You're Eating? A Case Study on Genetically Modified Foods” from the National Center for Case Study Teaching in Science gives students the chance to understand 1) the techniques used in production of GMOs, 2) basic aspects of microbiology, 3) ethics of genetic manipulation, and 4) the role that policy plays in agriculture and economics. Some other case study choices that may be of interest to CBC students include: “Pesticides: Can We Do Without Them?,” “A Case of Diabetes Insipidus,” or “A Light Lunch?: A Case in Calorie Counting.” The list of topics continues to grow and has been vetted by trained college instructors for ease of implementation. The faculty could organize a series of meetings to present and discuss case studies that they think would be particularly useful for STEM instruction at CBC. By building relevance with case studies, CBC faculty would achieve gains in the class (i.e., active learning) as well as perceived relevance by the students, which would likely help issues of retention. These gains would be relatively easy to assess (see next section).
Assessment & Professional Development for Faculty

Movement in terms of student educational gains should be one of the primary goals of the redesign effort that CBC is undertaking. There are two complementary paths to follow to achieve this goal. The first involves creation of a curriculum aligned with clearly articulated pedagogical goals that can be critically assessed. Some of the tools to use in this type of assessment are provided below. The second path involves developing a practice of continuing professional development for the faculty. Maintaining perspectives on the educational landscapes will allow for implementation of best pedagogical practices.

Assessment: The first step in the assessment component of CBC’s redesign is to have faculty agree on the modes of assessment that they will take part in when modifications are made to particular courses. The assessment piece has to be embedded in the redesign and learning process, and will require a series of meetings to decide on common goals. There are several publications that faculty may be interested in using to guide their assessment plans (e.g., “Assessing Science Learning: Perspectives from Research and Practice” published in 2008 by National Science Teachers Association press; the whitepaper “An Assessment Framework For the Community College: Measuring Student Learning and Achievement as a Means of Demonstrating Institutional Effectiveness”). However, any assessment plan is going to involve 5 essential steps as part of a learning design process. The steps include:

1. Defining measurable learning outcomes.
2. Developing assessments geared towards the learning objectives identified above.
3. Designing and delivering learning activities (e.g., case studies, labs).
4. Assessing the learning outcomes.
5. Interpreting assessment data and using findings to make decisions about curricular changes.

This should be an iterative process with step 5 leading back to step 1. In many ways, the first step is the most difficult, because this is the place where faculty must decide what their goals are for a particular course (e.g., “75% of the class correctly identifies stages of meiotic recombination”). Faculty should list all competencies and identify measurable outcomes for each competency; these outcomes will serve as the basis for assessment questions (#2 above). Frequently, a positive outcome of this assessment activity is the improvement of course syllabi, with clearly stated learning objectives. This would address some student comments about having more uniformity among, and detail about, their courses in terms of faculty expectations.

Once the assessment questions are identified, a variety of assessment tools are available to faculty implementing the assessments. Data that faculty collect can include scores on quizzes, performance on classroom assignments, surveys of student satisfaction, performance on certification exams, among many
other options. Data can be quantitative or qualitative with questions that are objective or subjective (depending on the goals of the assessment). If possible, pre- and post-implementation comparisons are strongest. That is, students involved in redesigned coursework should be compared to students who were taught with the traditional model of instruction. This can be done in tandem (if a “treatment” class can be identified) or based on data from previous classes. If, for example, the redesigned courses won’t be taught until spring 2013, then faculty could collect meaningful data during the summer and fall sessions of 2012. Alternatively, redesigned sections of a particular class can be taught and compared to “traditional” courses in terms of clearly articulated learning outcomes.

*Professional Development*: The other side of the assessment coin is the professional development of faculty. Investing in on-going training is one of the most cost effective ways to improve STEM education. Faculty at CBC should be encouraged and supported to attend and participate in national/regional meetings and educational learning communities on a regular basis (e.g., Association of Biology Laboratory Education, National Science Teachers Association, Association of American Colleges and Universities). Faculty can alternate their attendance at meetings so that they are not obliged to go each year. But all faculty can benefit, even if they don’t attend the meetings, provide that CBC builds in a developmental workshop each year so faculty who do attend can present their findings to the whole group. Indeed, disseminating results to the faculty who don’t attend can be included as a stipulation of receiving support for attendance at these meetings.

Given some of the pedagogical approaches I witnessed during my visit, it is clear that the CBC faculty have much to add to current conversations about best practices in science education. Offering the intellectual products generated at CBC up to public scrutiny will also help hone the pedagogy employed. In this regard, scholarly contributions to publications like the *Journal of College Science Teaching* should be encourage through some form of institutional compensation. Even if publications are not generated, CBC faculty should be encouraged to become part of some of the national consortia that focus on STEM education at community colleges. One that may be of particular interest, given the skills that CBC faculty possess, is the previously mentioned Community College Undergraduate Research Initiative (http://www.ccuri.org/).

Respectfully submitted,
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