Impact of a Research Experience Program on North Dakota Tribal College STEM Student Retention

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Abstract

Recent educational research shows that students who engage in research projects are more likely to complete STEM degree programs when compared to other students. This paper discusses the impact of a university-tribal college collaborative research experience program, Tribal College Undergraduate Research Mentoring Program (TCURMP), on the participating tribal colleges STEM student retention. TCURMP is a collaborative effort between two research universities and each of the five tribal colleges in North Dakota. This program is set up such that selected tribal college students will conduct research in their campuses through the academic year with one faculty mentor from their campus and another from the university. Research skills, rather than discovery research, is emphasized in the program. Students get to select projects of relevance to their community, formulate hypotheses, search and review background information, conduct experiments, analyze results, prepare presentations, and present in conferences. Factors of this program that could impact retention are discussed. Students who completed research projects under this program finished their 2-year degrees and moved on to 4-year degree programs or to take responsible jobs. The impact on retention could be discussed only in a descriptive manner rather than in statistical terms because of small number of students involved.

Introduction

Community colleges in the United States are currently experiencing radically increased enrollment and, although traditionally concerned with two-year undergraduate education, have become the focus of programs which encourage research as a means of retaining and developing students who have chosen science, technology, engineering, and mathematics (STEM) as their field of education. Historically, undergraduate research has not always been considered to be important or even practical, but in the wake of educational research showing that authentic, inquiry-based projects help students improve in math /science skills and also help students to maintain interest in science fields, many broad-based funding agencies such as the National Science Foundation (NSF) and National Atmospheric and Space Agency (NASA) have found it germane to fund programs aimed at starting intervention at earlier stages in students' education.

Most of the high school students on the North Dakota Reservations aspiring to pursue careers in STEM areas are likely to enroll in the Tribally Controlled Colleges (TCCs) first and then move on to four-year universities. However, there was a concern with the low enrollment in STEM courses and programs. In order for this situation to improve, programs which would not

only motivate students to pursue college education in STEM but also guide them through graduation had to be developed. A core group of faculty from the two major universities (North Dakota State University and University of North Dakota) and tribal colleges (Cankdeska Cikana Community College, Fort Berthold Community College, Sitting Bull College, Turtle Mountain Community College, and United Tribes Technical College) in the State worked together to conceive, design, and implement different STEM-enhancement activities for the tribal college and reservation high and middle school students[1]. This effort culminated in continued funding from the North Dakota Experimental Program to Stimulate Competitive Research (NDEPSCoR) of the NSF, since 2004 under the title "Nurturing American Tribal Undergraduates in Research and Education (NATURE)." A research component, Tribal College Undergraduate Research Mentoring Program (TCURMP), was added to NATURE in 2007 as a pilot program. It was later included as a regular component of NATURE [2, 3]. Current information on the program can be obtained from the website: http://www.ndsu.edu/epscor/NATURE/index.html .

Recent educational research has shown that students who engage in research projects are more likely to enroll in and complete STEM degree programs when compared to other students[4]. Increased understanding of the research process[5,6,7], a shift from passive to active learning[8,9,10], enhanced research and laboratory skills[6,7,11,12], and increased understanding and interest in the discipline are some of the benefits undergraduate students gain by engaging in research. Also in the last several years, the tribal colleges have been validating traditional tribal knowledge and exploring scientific concepts from Native perspectives. Embedded in this effort is a deep respect for traditional tribal knowledge and a desire to combine the Western notions of scientific methods and that of Native science concepts in the right proportions in order to create something that is academically rigorous and relevant to the needs of the contemporary tribal societies[13]. This approach was integrated into the tribal college student research mentoring model of the program. The research experience program is set up so that the students have the opportunity to work with two co-mentors, one from a tribal college and the other from a university, working collaboratively through the academic year. Students do research on their respective campuses during the academic year. The expectations are that the university and tribal college faculty mentors would help students to select research topics, develop the appropriate research questions (hypotheses) and advise on techniques/methods of investigation, design of experiments, data analysis, drawing appropriate conclusions, and preparing presentations and reports of their research findings. Imparting research skills is the emphasis; discovery research is not necessarily the main goal. Details and implementation procedures of the research mentoring model can be found in Padmanabhan and Davis, 2008 and 2011[2, 3]. The overall goal of the program is to facilitate retention of students in STEM areas by offering them research experience opportunities. The collaboration between the tribal college and a mentor from a research institution linked to improving the community with the objective of retaining and nurturing students is the hallmark of this program. Another salient feature of the TCURMP is the flexibility the TCC students and faculty have in the selection of any research topic of relevance to their community. Under this program, instructors at TCC were asked to recruit interested students and organize research projects of relevance to the community which would be for the duration of one or two semesters. Both individual and team projects were allowed but no more than two students could work on each team project. Titles of student research projects developed in this program from 2007 to 2012 and their completion status can be viewed by clicking the Research Initiative tab on the NATURE web site. The community-relevance aspect of the

research projects was the emphasis of a recent paper by LaVallie et al., 2013[14]. LaVallie et al. provide a detailed description of an example project under the TCURMP program.

Details of the collaborative nature, overall benefits to the tribal college research capacity, potential to generate university-tribal college collaborative research proposals to funding agencies, feedback from university and tribal college mentors and students etc., of TCURMP can be found elsewhere [2, 3, 14]. The focus of this paper is on the impact of TCURMP on retention. The following sections include discussions on the TCURMP features that impact retention, lessons learned in regard to program implementation and expandability, and the actual impact.

TCURMP Features that Impact Student Retention

- Real-World Science: In college-level research usually students contribute a part to a complex whole, supervised by faculty that are knowledgeable, rather than testing simplified hypotheses on their own; this model allows students to participate in the research project from its very conception to completion and dissemination of their findings at professional conferences. The emphasis is placed on presenting at university-level conferences to ensure proper mentoring, encouragement and academic accountability as opposed to local or intertribal conferences which tend to regard poster and power-point sessions as competitions, usually juried by non-science personnel, where popular interest is a priority over sound conservative research.

- Cultural Relevance: Students in the program select a subject of research of interest to them, which usually has some relevance to the community. The reservation community itself is particularly concerned with local environmental or infrastructure issues since the reservation is seen as not just a place to live, but as an ancestral homeland designated to them for stewardship, from which they will probably only leave temporarily or not leave at all. Education is seen as a way of improving the job and economic situation on the reservation, not just in benefitting the person who pursues the education.

- Exposure to Research Protocol: Students are asked to do literature searches; most students state they have rarely done this previously, and they accomplish this with some supervision. As a group, students and mentors look at various sources and select articles by the relevance to the study. Student researchers quickly learn that eliminating sources is more of a problem than finding information and that website credentials are important.

  The mentor at the college usually outlines the proposal and assigns students to various tasks- often the students and the mentor meet as a group and plan the most efficient way to accomplish tasks and rough out a time-line of the study. Most students later state that these studies were much longer than any previous study they had undertaken in the past and that they had not worked before in a collaborative effort. The students also are able to note that planning and execution follow distinct stages- literature search, experimental design, data collection and evaluation, and drawing of conclusions.

  Exposure to technical writing was invaluable for most of the students; although writing skills are poor across the board in the U.S., scores are particularly low at TCCs. Science

and math scores on assessment tests such as the Praxis (for secondary education students) are moderately lower than national medians, but English skills are very much lower. For final deliverables, the mentors and students discuss what should be included in a poster or report. The students submit written data reports and the mentor shows the students how their narratives are expanded to a poster and a full report. The students are required to proofread the poster and final report and suggest changes or additions. Several students later stated that technical writing experience in these projects helped them with composing college papers in their coursework.

- Exposure to Technology: Student interns are able to use a variety of scientific instrumentation, most of which they have not previously encountered. In the research projects completed, students have used the atomic absorption spectrophotometer, gas chromatograph/mass spectrometer, and bomb calorimeter for various purposes, giving them research opportunities at least partially on a par with larger university experiences. Most of the students have had only limited experience with transferring of data to Excel sheets for evaluation for statistical purposes or in generating graphs for interpretation of trends in data. Gaining experience in these areas is important in placing the students near the same level as students with broader high school or collegiate experiences.

- Research as Coursework Reinforcement: Students who work with faculty as mentors are probably surprised to note that these faculty members are working scientists, not just tiresome taskmasters lecturing endlessly at the podium and handing out mounds of tedious homework. They see a different side of science- professionals seeking answers to real problems, and using their knowledge to that end. Homework that had seemed meaningless now was used to calculate actual results; concepts that were memorized to pass a test now had real application. "Inquiry" approach in teaching has been shown to be quite effective not only in retaining student interest, but also in reinforcing educational concepts through application; however, most college instructors are restricted by the laundry list of competencies that must be covered in a course during a semester, with little time for inquiry investigations other than what is offered in once-a-week laboratories. Programs that promote smaller scale research which can engage more than one student at a time are very important in that they can increase the "inquiry" aspect of education when time (and funding) constraints make it hard to incorporate this into the traditional coursework scheme. The only drawback of programs like this is the programs cannot be expanded to include more students and more full- and part-time faculty to mentor.

Lessons Learned

Most of the challenges associated with the program are related to recruiting and keeping the students in the program which are affected by the following three factors.

Competition by other research training programs: Recruiting student researchers is more and more competitive because of increasing availability of other research opportunities such as Research Experience for Undergraduates (REU) and funded research projects that TCC faculty serve as principal investigators. For some years, it is not uncommon that the number of research

training opportunities was substantially higher than the number of interested students (not enough students to meet the enrollment targets for one or more research training programs). This occasionally led to accepting students with less interest in the program and some of these students did not complete the project. This challenge will continue since the program does not have flexibility particularly in terms of increasing incentives such as stipend to be more competitive.

Demanding nature and timeframe of the program: Since student researchers are involved in the projects from conception to final delivery, the program is more demanding than other research opportunities in which research ideas, hypotheses, or even literature review sometimes are already available to the students. Student researchers also have to write a proposal and report(s) and prepare poster and/or PowerPoint presentations. The academic year timeframe of the program makes it difficult for students to manage between classes and research. The most two common reasons for students for not completing their projects are personal and a need to put in more time and effort to do well in classes.

Scope of STEM fields: There have been several potential student applicants that were interested in the program but were not qualified to participate because their field of study does not fit a traditional definition of STEM fields. Some of them were extremely motivated and academically excellent. For example, the program received inquiries from students interested in psychology and management information system research and could not accommodate them due to a need to remain within the rigid scope of STEM fields to be in compliance with what was proposed to the funding agency.

Impact on Retention

In general, only a limited number of Turtle Mountain Community College (TMCC) students graduate with an associate degree. In 2009, 19.5% of the students who started out in 2007 graduated, and in 2011, 10.6% graduated. An even smaller percentage of these students go on to four-year degrees. However, amongst former student researchers of the TCURMP, the graduation rate was 100% and advancement (or planned advancement) into a STEM four-year program was nearly 100%.

Interestingly, it might be argued that well-motivated students who are destined for success anyway are the ones who are choosing to join into the research programs, but this is not entirely the case. Although the research opportunities were advertised by flyer around campus, volunteers were not always forthcoming, mainly because of worry on the part of students about losing study time to research activities. Most of the student researchers were recruited by the mentor at TMCC to join into the program because they had listed themselves as being STEM undergraduates, and were attending either chemistry or physics classes. The recruitment of the students was somewhat random and was not based on grades since the students were usually new to the class. Unfortunately, it is not known what the exact retention rate was for STEM students who did not participate in research, but it is probably logical to assume that it would be higher if research opportunities had been more widespread, since the retention rate for those who did participate was very high.

In Sitting Bull College (SBC), out of 104 registered in 2007, only one graduated with an Associate degree in 2009 and 9 graduated in 2010-11. Out of a total of six students who participated in TCURMP, all graduated and went on to enroll in their BS in environmental Sciences program. Most of the students who were not retained were much weaker students and usually did not make it to the point where they were ready for the research program.

United Tribes Technical College (UTTC) participated only minimally in TCURMP. In the last four years, UTTC did not have students in this program. Therefore, they were not able to assess the impact of TCURMP on their retention. Besides, UTTC also runs a STEM research project mentoring program of their own via two courses. So, it was difficult to separate the impacts. No information on retention could be obtained from Cankdeska Cikana Community College (CCCC) and Fort Berthold Community College (FBCC).

Conclusions

Co-mentoring of TCC students by a university and a TCC faculty, though laudable, has been difficult to implement in an effective manner, particularly because the research project has to take place throughout the academic year. Nevertheless, for some projects, the co-mentoring model worked extremely well. Students' interest and progress could be sustained in those cases with relative ease. In general, for all the participating colleges it was difficult to separate the impact on their retention due to TCURMP because some students participate in multiple programs. The lack of a student tracking system applicable to such programs in the tribal colleges may be another reason. Students who completed research projects under this program finished their 2-year degrees and moved on to 4-year degree programs or to take responsible jobs. The impact on retention could be discussed only in a descriptive manner rather than in statistical terms because of small number of students involved.

Statistics on the TCURMP students and the program evaluation are maintained by EPSCoR for NSF. An external evaluator collects data and prepares evaluation and effectiveness summary for EPSCoR. The TCURMP can potentially be implemented in other states with tribally controlled college(s). The NSF has been considering using the TCURMP and its parent program NATURE as a national model.

Although there have been individual project successes, as a program still it needs some fine-tuning to overcome difficulties in implementation. Ideas to improve the program, and to recruit and support more students and faculty are constantly explored by seeking feedback from the constituents.

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