STATUS OF STEM EDUCATION AT THE UNIVERSITY OF NEW MEXICO:

A SURVEY OF THE LANDSCAPE

October 2016

UNM

Center for Education Policy Research

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Prepared for the STEM Collaborative Center

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Introduction

In the spring of 2016, the Science, Technology, Engineering and Math (STEM) Collaborative on UNM"s campus approached the University's Center for Education Policy Research (CEPR) to conduct a study of the status of STEM education on campus. The study would be comprised of a series of semi-structured interviews of various faculty and administrators and student focus groups from which a set of themes could be derived to inform report findings. Staff from CEPR in collaboration with the STEM Collaborative director prepared a set of interview and focus group protocols. The study conducted over the late spring, summer and early fall resulted in the conduct of eighteen interviews with individuals who hold various administrative and teaching positions across the campus as well as five focus groups made up of students from both the STEM disciplines and social sciences.

Each of the interviews typically lasted between an hour and ninety minutes, while a focus group lasted between forty-five to sixty minutes. In each case, the interview or focus group was audio recorded then submitted to a professional transcription service for processing into a manuscript. Each of the manuscripts has been analyzed to ascertain themes and to compare and/or contrast perspectives among the various informants. The results from this analysis are used to inform this report.

Since this study was an internal assessment within the university, it was not submitted for review and approval by UNM's Office of Institutional Review Board (OIRB). As such, and in order to gather findings that could provide an accurate assessment of STEM education at UNM, informants were encouraged to be as candid as possible. To support this openness, they were provided the guarantee that no ascription of quotations would be given in the report. With this guarantee in place, the interviews were conducted either in the individual's office or a closed conference room. Each focus group was conducted on campus in a conference room located in Manzanita Hall, the previous location for CEPR. An incentive of a $25 gift certificate to the Lobo Bookstore based on a name drawing was included to help recruit students.

The CEPR wants to extend a sincere thank you to all of the individuals who agreed to take time out of extremely busy schedules to participate in an interview or focus group. Without their cooperation, this report would not have been possible. A main purpose of this report is to help stimulate discussion about STEM education on UNM's campus among members of the administration, faculty, professional staff and student body, as all either serve to provide this education or who receive it in preparation for movement into either advanced studies or the workforce.

Limitations

Because of the limited number of individuals that have been interviewed or participated in focus groups, this study makes no claim to be a definitive assessment of the status of STEM education at UNM. Nonetheless, the qualitative findings collected over the course of the project offer insights into various strengths and challenges related to the conveyance of STEM education at UNM from both the faculty/administrator and student perspectives.

In particular, the number of students, fourteen, who participated in a group, is small. Various means of recruitment, including distribution of flyers via student groups or college list serves, student events, and direct face-to-face engagement were used. While over 90 students who expressed interest in participation were signed up, the number who actually participated dwindled due to conflicts in work/class schedules, limited time availability, or simply not showing up at the scheduled day/time. Despite this small number, the insights the students brought to the discussions are informative and provide an important aspect of the overall findings.

Finally, for both sets of informants (i.e. interviewees and focus groups attendees), a point that must be stressed is that each of these individuals provides a personal perspective and as such must be considered as somewhat limited, regardless of their position and how informed the perspective they offer.

Structure of the Report

The following discussion is broken into a summary of main thematic findings from the interviews and focus groups and detailed across eight different topic sections. Because of the nature of conducting interviews versus that of focus groups, each of the interviews provided an opportunity for more in-depth inquiry than could be accomplished with the focus groups. In addition, as a function of their position administrators and faculty members possess more knowledge about various aspects of undergraduate education at UNM than students and vice versus. Consequently, the various perspectives offers some interesting comparisons and contrasts. Selected quotations are included to convey particular points and statistics from either UNM or state or national sources serve to provide context as appropriate.

For purposes of tracking who participated, interview informants were requested to provide their names, title, length of service, and nature of their employment at UNM. Students were asked to provide their name, degree discipline, where they came from, and their current year of matriculation. Because of the guarantee given to the informants of no ascription, this information is not provided in this report. The composition of the two groups is as follows. The administrators and faculty members were comprised of a total of eighteen individuals whose roles included:

- One associate provost
- One dean
- One associate dean
- Two who held joint associate dean and faculty positions
- One vice-chancellor
- Three department chairpersons
- Two faculty members
- Five who held joint faculty and program director positions
- Two program directors

The focus groups were comprised of fourteen students whose majors included the following disciplines:

- Two in computer engineering
- Three in computer science
- Two in civil engineering
- One in nuclear engineering
- One in chemistry
- One dual major in biology/biochemistry
- One in biology
- One in biochemistry
- One in medical laboratory sciences
- One in psychology

In the discussion that follows, in order to provide the reader a means to differentiate between groups, the quoted text will be denoted as follows:

Administrators/Faculty/Program Directors will appear as bold text;

and

Students will appear as italicized text.

The main topic sections addressed in the interviews and are as follows:

- Strengths of Your Role in STEM Undergraduate Education
- Biggest Challenges for Undergraduate STEM Majors at UNM
- Obstacles for STEM Undergraduates at UNM
- Emerging Opportunities for STEM Majors
- Well-Served STEM Undergraduate Populations at UNM
- Least-Served STEM Undergraduate Populations at UNM
- Gaps in Support Services/Organizations for STEM Undergraduates at UNM
- Overlaps in Support Services/Organizations for STEM Undergraduates at UNM

Each of these main areas had different probes added, some of which were asked and some were not based on the dynamic of the conversation. An additional two questions were offered. First, interviewees were asked for three recommendations to improve STEM education at UNM. Second, they were asked whether they could think of a question that should have been asked but was not.

Focus groups participants had a parallel, but different set of questions. This protocol was structured to be relevant to the student and provide insight to their thinking concerning their STEM-related experience at UNM. They were provided with a series of fourteen questions, which in all cases, included additional probes. The twelve central questions are paraphrased as follows:

1. Where did you come from, what is your major, and why did you chose to attend UNM?
2. Are any of you first generation students?
3. Did some adult help you form your decision to become a STEM major?
4. What do you like about being an undergraduate major at UNM?
5. Can you discuss any challenges you might be facing as an undergraduate major?
6. Can you tell me about any of the opportunities that you have taken advantage of while at UNM?
7. At any time have you participated in any interdisciplinary activities while at UNM.
8. Are any of you taking courses in a "flipped" classroom here at UNM?
9. How many of you are thinking about pursuing advanced study?
10. How many of you are intending to join the world of work once you graduate?
11. Do you think you will be adequately prepared for graduate school or the world of work?
12. Are any of you interested in starting your own business?

Focus group participants were also asked two closing questions. The first, "If you had a minute to talk to UNM President Frank about undergraduate STEM education, what would you tell him?" Then, finally, as a check on the line of questions used, focus group participants were asked whether there was anything that should have been addressed but was not.

What follows is a synthesis of these findings.

Strengths of Your Role in STEM Undergraduate Education

This topic area was addressed primarily to provide some context of how the different informants fit within the larger structure of the university. Of course, any perspective is tied to the maxim of "Where you stand, depends on where you sit," posited by Rufus Miles in the 1970s. The various administrators/faculty who agreed to participate in this study provide informed perspectives from their particular position within the organization of STEM education across UNM. Most, but not all, of the informants hold positions where they engage in both administration and teaching. The strengths these individuals bring to this collective effort are multifaceted and attest to the quality of the education that students receive while at the university. They reflect various disciplines and responsibilities that make up the component elements of Science, Technology, Engineering and Mathematics education and their perspectives offer an assessment of this landscape at UNM.

Some of the informants have been in their discipline upwards of twenty-five years or more and others have a lesser term of service. A total of sixteen have a doctorate and while most have been academics over the course of their career, at least two came to the university after time in industry. Their academic titles range from senior lecturer to full professor and department chair and others have appointments as director or other responsibilities as high ranking members of the administrative structure of the university. Depending upon their discipline, many have previous or current experience in laboratories and several have served or are serving on university, state or national coordinating committees, advisory boards, or professional groups such as the National Science Foundation or National Institutes of Health. Several are recognized experts in their fields who have received prestigious honors. They write books and articles, create courses, engage students, serve on committees or advisory boards, deal with budgets, and handle numerous administrative tasks during the course of their work. They reach out to school districts and teachers in efforts to improve the "pipeline" of students coming to UNM. They develop various interventions and supports for students once they arrive at UNM to help these young people transcend challenges connected to the lack of preparedness many students bring in order to bolster the probability of their undergraduate success. They strive to provide usable data and analytics that can inform and improve undergraduate (and graduate) education at UNM. In every case, whatever their title and role, the perspective each offered through the interviews show a commitment to provide an opportunity for an outstanding education to all students who have embarked on the path of an undergraduate degree in a STEM field.

Student Orientation & Advisement

Any student who comes to UNM is provided an orientation and advisement. Orientation is typically handled over the summer prior to fall semester and can be either a one- or two-day experience. Orientation also occurs prior to spring term. Students receive general information about the university and it resources, learn about opportunities they can experience, take placement tests, sign up for schedules, and get an initial taste for life as a Lobo.

In general, students found the experience worthwhile, yet it would typically require them getting onto campus and actually being here to get a full sense of their physical engagement of the environment:

I think it helped me a little because there were some things I didn't know were on campus that I could use. It really helped me figure out where everything is, and how to get around campus a lot faster. I did learn a lot of things just exploring, when I finally got here.

I don't think it was necessarily orientation that helped me figure all that stuff out. I think maybe it was mostly experience.

Another important component of a STEM student's experience is advisement. There has been a shift in the recent past around how undergraduate advisement occurs. Previously students received advisement from staff at the general university level. At times, some students found the earlier approach to advisement lacking as shown in this quote from a fourth year chemistry major attests:

No. When I was a freshman, I went to go talk to my advisor about the classes that I needed to take. This was when I was a biochem major. I already knew the classes that I needed to take. I just needed somebody to tell me when I should take them. I went in as a freshman and I asked, "Should I start my science classes right now, within my freshman year?" They told me, the advisor, I don't remember who it was, "No, just don't take any of the sciences until you're a sophomore," which threw me off for a whole year. I should've started taking science classes [laughter] from the very beginning, but I didn't, so that threw me off a year. As far as advising, no. The first year, they didn't help me until I actually transferred to the correct one.

Now students receive routine advisement each semester from staff, who, while still under the University college umbrella are assigned to particular departments and are more grounded in the specific requirements of the discipline. The following from an interview describes the revamped orientation process for new students:

There's a couple of different pathways, but there is new student orientation that involves about 3,500 students per year, who are in their first time, full-time class. They go through summer orientation sessions, and if they've selected a STEM discipline, they meet with the particular college that houses the degree that they've chosen, work directly with advisors. About a year ago we changed the advising structure so that whatever degree you're pursuing, you're meeting directly with the program, rather than University College. We used to have general-purpose advisors in University College. That structure's now changed. Those students are now housed within their college. They're actually assigned, for advising purposes, to the college of the degree that they wish to pursue, according to their intended major.

Students are required to attend advisement in order to have registration holds lifted. The advantage of this approach is that it assists students in maintaining a clear conception of where they are in their degree trajectory and by being apprised of various courses and sequences they need to maintain for completion. While the advisement structure has been improved, some students have suggested alterations to either accommodate them as non-traditional students or help them navigate their movement to life beyond their undergraduate studies, as seen with these statements, the first from a student of psychology student and the other from biochemistry:

I have found that academic advising does really well with traditional students, but I'm a nontraditional student. I'm a single mom and I commute to school. I'm older, I'm almost 27. I would've liked that [fixed sequence and tight scheduling of courses that the College of Engineering requires] to have been done for me, even though it's a much longer timeframe that I'm gonna be in school cuz I only take two or three classes at a time. That would've been really helpful. I usually just use Lobo Tracks. I don't think that's as good as meeting with an advisor and getting that service of laying out what you need to take and when you should take it.

Every semester we have to meet our advisor before we can have our holds taken off. Which is good, you need to check to see if you're on the right path. Advisors should be a little more helpful and have more resources that they can point you to. I feel like, there's none for premed students where they help you with your application process and basically set up your timeline for you. I feel like they should cuz sometimes you don't know when your application's due or when you should take the MCAT—you just don't know. I feel like that should be more of what your department advisor should do.

In terms of the first student, she has found an alternative to formal advisement that serves her schedule and needs although she clearly sees it as less than ideal. For the biochemistry student, one of the services currently existing on main campus to assist those pursuing careers in the health professions is the Office of Pre-Health Professions Student Development, physically located in University College. The other potential source of advisement for this type of student is in the Admissions Office of the School of Medicine. In order for students to access those advisors for questions, they must first attend a required Pre-Med Orientation session, which is offered 4-5 times a semester.

Programs and Initiatives to Assist Undergraduates

The university provides various initiatives and supports that help students develop in their chosen disciplines. Interviewees mentioned different STEM-related programs directed towards various student populations, whether based on gender or underrepresented group status, such as the American Indian Summer Bridge Program, STEM Pathways, Maximizing Access to Research Centers (MARC), Initiative for Maximizing Student Development (IMSD), Ronald E. McNair Scholars Program & Research Opportunity Program (ROP). Each of these will be discussed in more detail later in this report.

While the above list is not exhaustive, it illustrates in part efforts underway at UNM to assist students, especially first generation and those from underrepresented groups navigate the path through an undergraduate STEM degree and into advanced studies. In general though, there appear to be no formal structures in place within departments designed to help students move from undergraduate status to either advanced studies or entrance into the workforce. Most exchanges appear to occur as an integral part of the courses they take and informal discussions they have with faculty or their peers.

I would like to see us do more of that and maybe we'll get better over the next few years. We've done I think a rather poor job of certain aspects of premed and pre-professional advising. We're actually not too bad about telling people what's going to be required in terms of the things that'll have to be on your transcript. We're not very good about breaking the bad news to eager and ambitious students that they are, based on their track record, highly unlikely to get into medical school. Maybe they ought to be considering something else. I talked with a student yesterday in the hall who was coming to the realization that she didn't really want to be a doctor. Maybe she should go into biomedical engineering or biochemistry. I'm glad to have that conversation with students.

In addition, various departments, such as Chemistry and Chemical Biology, Biology, Earth and Planetary Studies, and the different Engineering groups, are increasingly offering undergraduate research opportunities that can help students develop skills and competencies they will use in graduate school or the workplace. The advantage to the student with this arrangement is obvious—they get paid employment in their discipline while being located on campus which minimizes scheduling conflicts encountered by having off-campus employment. These opportunities can take the form of student employment or work study. A couple of the informants noted that one of the structural shortcomings sometimes associated with work-study assignments is that, while the student has paid employment

the job is often outside their discipline with the associated lack of exposure to how their field of interest works (i.e. enculturation) or developing practical applied skills that can help them succeed. One interviewee observed:

> **There are some structural barriers to helping students immediately start using their work-study awards, in ways that would advance their major. Yet, that's what work-study should be. It shouldn't be cheap labor for food vendors in the sub. It should be cheap labor that gets students—cheap cuz the government pays part of the salary—into programs in their discipline, where they learn job-related skills, where they form connections within their discipline…. If we can find some way to help remove those structural barriers, so that students coming in can actually get jobs in areas of their discipline, it would be fabulous.**

Another pointed out that work-study students have the benefit of being subsidized labor, and thus pose less of a budget impact:

> **They're student employees. Well, they're both, so we hire them as student employees; sometimes they come with work-study, and then we use the work-study, and then pay them what they need in addition. That's very helpful. As you probably know, we've got a good program, but we're constantly dealing with the budget constraints. If we can have some of that student employment subsidized by work-study, that's preferable, but, yeah, they're student employees.**

Further, students in the College of Engineering can often receive placement in an internship, which are sometimes facilitated through other initiatives on campus as noted by one of the students:

> *I'm in this program now, the STEM UP program, where they give you internships and they pay for you to work in the summer. You only get that if you're full-time, but it's really hard, cuz you don't wanna take four or five technical, really heavy classes…. so I just pad it with workout classes, essentially.*

If things work out between the organization and the student, these types of placement can often lead to a full-time position once the student graduates.

> **What I hear from the people that provide these internships is that they love to have students who come in, and if they like them, they'll hire them as sort of permanent interns, and then convert it to a real job when they graduate. In terms of those sorts of job opportunities, students learn about that through internships, and we get the word out to them all the time. That goes out through email, etc.**

However, apparently student interns are sometimes left to their own devices:

> *I've actually gotten a lot of experience in the engineering department, but it's all kind [of] contrived. They're like, "Oh, do this," and then you do it, but it's not like real world. I've had internships where they're just like, "Oh, do this." I'm like, "How do I do that?" They're like, "I don't know. Figure it out. I'm busy."*

Interdisciplinary Collaboration

In terms of interdisciplinary collaboration among departments, efforts occur at the department level, for example, between math and computer science, chemistry and biology, engineering and the planetary sciences, chemical biology and the school of medicine. The collaboration appears to be tied to the need for different departments to be able to access the expertise and resources associated with each other.

Yes. There's a lot of ways that happens. It always can happen with individual PIs. Again, the PIs—their science might intersect, but the glue of where the real translation happens is with the research staff and the laboratories, the field work, the graduate students, the undergraduate students. They become people who walk in and see both those different worlds if it's a two-discipline collaboration. The earth sciences are inherently collaborative, we accept grad students from other disciplines—physics, chemistry, math, computer science—and then get them going into our discipline. It welcomes people from others, so maybe more than many departments we're quite interdisciplinary just in the way we normally operate.

As noted in the quote, interdisciplinary collaboration occurs among faculty from different disciplines who work together on research projects or other university endeavors. Generally, the collaboration happens on an informal basis and is seen as beneficial.

Surprisingly little on a formal basis. The collaborations that happen tend to be more based on individual instructors. I have a joint appointment in chemistry and in the BA/MD program. The BA/MD program has a group of instructors who teach in all of the premed sciences—but also their humanity sequence. We meet as a group four times a semester, twice in a big group and twice in the sciences group. At that level, myself and [another instructor], who teaches organic chemistry, meet with the person who teaches physics. The person who teaches the life sciences, calc[ulus], genetics, biology, the cellular molecular biology and the biochemistry, and that group is an interesting and a useful one, and I think we learn a lot from those kinds of collaborations.

Generally students did not see much interdisciplinary collaboration occurring among different departments. One made mention of occasional efforts that occurred between mathematics and computer science. Another made mention of the interdisciplinary nature of biochemistry and the overall structure of the Honors College.

I think Mathematics and Computer Science, they do some workshops together. Computer Science Department organizes some seminars time and again. There was an event two weeks ago that was an annual event that CS Department organizes every year.

I feel like biochem[istry] is pretty interdisciplinary—everything is mixed, basically. You have research. It's basically like statistics, biology, physics. Everything's just mixed. Also, the honors classes are very interdisciplinary. I've taken a few of those classes. Yeah, those are nice. I think I would like to see more interdisciplinary courses.

Mentoring for Undergraduates

While there appears to be little formal mentoring relationships in operation across the various STEM departments, it does occur on a more informal basis, most likely within the contexts of undergraduate research, internship or relationships that develop by students seeking out assistance or guidance from faculty. These relationships require the students to be proactive in seeking out these opportunities.

In terms of anything formal that's called mentoring, no, we don't. We don't do that, but it does happen very informally. I have several students that I've gotten to know very well, and they come and drop in all the time asking questions about not just classes, but grad school, careers, how do they do this, that, or the other thing. It happens, but it doesn't tend to happen in any formal kind of setting or formal sense.

Certainly through engaging them in research activities, or honors research, things like that we're certainly open to. There are programs that come and go at different times. There was one

called Uno that was an NSF funded initiative that emphasized minority populations. In terms of [mentoring] for all of our students, I think faculty is very open to serving as mentors in different capacities for whoever comes to them.

I think the students who go see their professors in office hours and who work in research labs and get to know professors, get more integrated into the fold. [They] have more access to mentoring and support and connection than students who just come and take the courses and remain anonymous.

As one young woman who is seeking admission to medical school states, these informal mentor relationships can result from being connected to an outside group, in this case a sorority, which she used to build a connection to a resident at UNM School of Medicine:

Not through UNM. Well, I mean, in my sorority there's alum that are really involved with us. Recently, one of our members [who] graduated from [med school] in California [is] doing her residency here at UNMH. Through that networking, she's mentoring me now. That's only been [over] the past year, and I've been trying to do this on my own for years.

Other students concurred that developing a relationship with a professor was a positive experience that could be very beneficial.

Then professors, they're super cool if you get to know them. They're one of the best aspects, I think, of going to university is you just get to interact and talk with them. Then they can give you more opportunities. One of the professors gave me a job in the building. She was like, "You wanna work for this other professor?" I was like, "Yeah, sure." Then I was just talking to her yesterday. She's like, "You should do research with me next semester cuz I think I can get you a $2,000.00 scholarship kinda thing." There's a lot of opportunities.

I definitely agree with the professor stuff. Cuz once you make a connection with them, it just kinda goes all over the place and you can get into whatever major you're in or field they're in.

The next section addresses the challenges that undergraduate STEM majors face while at UNM.

Biggest Challenges for Undergraduate STEM Majors at UNM

Students who pursue a degree in any of the STEM fields face a tightly structured sequence of courses to complete a degree. This is the reality students face whether they are in one of the physical, life, computational or engineering disciplines. In the past, they faced a gauntlet of courses in chemistry, biology, physics and mathematics that had historically been referred to as "killer" or "weed out" classes.

These courses are required as foundational which all students who seek degrees in the various STEM disciplines have to complete prior to advancing to upper division coursework and ultimately to advanced studies or employment. As a consequence of the way various courses intersect and build upon each other, STEM degree pathways, particularly in first and second years of study, do not lend themselves to much flexibility in the how and when they are completed. These courses are designed to instill in students the proper knowledge and skills to succeed in different settings whether they need to understand particular equations or to avoid contaminating or blowing up themselves or others in a laboratory.

For whatever reason, failure rates of upwards of 50 percent in the "killer" courses were not uncommon thus precipitating the need for students to repeat courses and thus delay degree completion beyond the four-year goal to five or oftentimes six. An example from chemistry provides some context as to the preparedness of students:

> **We used to have between 30 and 50 percent drop/fail rates. On a good year, it was one in three, which is pretty terrible, and there are a number reasons for that, but one is the lack of preparation of the students coming in in terms of both chemistry background and math background, but also study skills and college readiness.**

These delays cost both the university and the students time and money and likely contribute to student self-doubts they could "do" science and decisions to move to disciplines outside the realm of STEM or withdraw from the university outright. This reality is caught in the following statement from one of the interviewees:

> **The very biggest challenge is getting through their course sequences sufficiently quickly that they have time to engage in research. The very biggest reason that students have trouble getting through their courses in a timely fashion is their incoming math preparation. Incoming math preparation not only slows your progress to core math, but it also slows your progress to science courses, slows your progress to chemistry and so on. That incoming preparation that gets students a semester or a year behind is a very big deal.**

In light of this situation, UNM undertook an initiative for course redesign that sought to address the failure rates. Recognizing that the situation was often not so much an issue of a lack of student ability as one of being *underprepared*, various STEM departments working with the STEM Gateway initiative formed committees to explore ways to redesign these courses by addressing the pedagogical approaches used and to create various types of supports students could engage with to improve their understanding, skills and competence related to the subject matter. The goal was to provide them a means to succeed in courses where so many had struggled and often failed.

For example, in the Department of Chemistry and Chemical Biology, these efforts resulted in the development of redesigned courses for both semesters of general chemistry (Chemistry 121 and 122). What emerged is a classroom framework that is based on principles of active learning whereby students are engaged in small group discussion, peer-to-peer learning, and the use of peer learning facilitators (PLFs) to support the development of student competence and skills in the science of chemistry. In addition, the department also developed what has become known as a "parachute" course, Chemistry 120, where students who fail the initial exams in Chemistry 121 are allowed the option of stepping out and transferring into 120 that gives them the opportunity to study more foundational concepts before reentering the 121-122 sequence. For students who agree to take this option, the choice does not negatively impact grade transcripts, which for those who plan to move on to graduate or professional schools of study play such a critical role in acceptance decisions.

Another example is provided by the Department of Mathematics that has been instrumental in the development and operation of a facility located in the UNM Centennial Library, known as the Math Learning Laboratory or MaLL. The MaLL provides a self-paced learning environment for students who have a low score on their ACT (<17) or math placement exam and appear ill-prepared for the rigors of college level mathematics. By engaging in this setting, students can establish enough skills and competence to support their movement forward through college level mathematics. They do this by self-study supported by various tutors and by taking or retaking, as necessary, an exam known as the Compass that allows them to move out of the MaLL and onto college-level math courses. As noted by one of the interviewees, the goal is to get the students out the MaLL as quickly as possible.

> **Remedial math is not gone, it's just been shortened…What we did do is get remediation down to five minutes, for some students, and eight weeks, for a whole lot of them. It made it so they could take another shot at the placement exam. Then, when they wouldn't go and take their second shot at the placement exam, we set it up so that the first-week quiz was a placement**

exam in disguise. If you passed it, we didn't ask you. We dropped you, and plunked you in the MaLL. We just integrated placement in remediation, and made eight weeks the norm, and had a lot of students coming out after four weeks. We just did everything we could to get them out as fast as they could.

These approaches used by Chemistry and Mathematics help mitigate the effects of being underprepared for the rigors of college level work and the negative time and financial consequences that accompany failing a course.

Are UNM Undergraduates Adequately Prepared to Enter the Workforce?

There was uniform agreement across both groups that most STEM undergraduates were adequately prepared to enter the workforce. If they graduated from most departments, they possessed the requisite skills to move into this next phase. In some instances, there was the recognition that having an advanced degree, primarily the master's, was a better choice than just the bachelor's. Nonetheless, many stated that graduates could move into government or industry and succeed. Thoughts along these lines are seen in this selection of comments:

I think the majority of our students do leave prepared for the job market. Now, there's a lot more to the job market than just understanding subject matter. We also have a lot of societal issues. I have been hearing, from the employment side, that our students aren't as well-versed, for example, in issues of diversity, or in really understanding some of those.

I think it really depends upon what programs they're coming in with. Well, I think there are some. I think most of the engineering students probably come out pretty well-prepared. I have heard from a local high-tech employer who graduated from UNM as did his cofounder that they really wanted to hire UNM computer science graduates, and they wound up not finding anyone here. Because they were theoretically trained and not practically trained, and so they were not ready to go out and start programming.

Yeah. I do. I think there are many fields where—I think they are in terms of being hired for basic level jobs in natural resources and state agencies and things like that. Many of them have many more career options if they come back for a Masters. That opens a lot of doors with those agencies. Many of them are interested in professional or graduate school. They're definitely qualified for that.

In response to a question related to whether they felt they would be adequately prepared to enter the workforce, the uniform response from all the students was a conditional yes. Many of them spoke about how schooling really does not prepare you adequately for the world of work as seen by the following.

I don't think there's really any educational program that can really prepare people to be in the workforce. I think you can be prepared to ask the right questions and know how to find the answers, but I don't know that you can ever really be inserted into a job and be able to perform at a very high level right from the get-go.

I'm not so sure about that. They prepare you well for the exams and class loads and everything. I don't think they prepare you that well for your career or working in an office environment or stuff.

A parallel question was asked of interviewees concerning whether the NM economy was robust enough to absorb the university's STEM graduates. The responses were mixed.

Is the State's Employment Market Robust Enough to Absorb UNM's STEM Undergraduates?

In response to this probe, the answers were focused on the structure of the state's economy. For some graduates, such as chemical engineering, the opportunities simply did not exist in the state, which would necessitate moving elsewhere, such as Texas, where that industry exists. In contrast, graduates in civil engineering were likely to be able to find jobs in the state if they wished to stay. The larger background issue was related to salary levels, New Mexico is often not as competitive as other states to keep talent and thus contributes to the brain drain.

No, there's not enough. There's definitely a brain drain happening in this space. I'm sure after you talk with other people—we can't hold 'em. We can't hold 'em in this space. I'm not a born and bred New Mexican. My husband came here for the labs. Because of that, I know a lot of professionals here. Their spaces where they can go are very small. What happens when one doesn't work out at the labs? They have to go. Until being here was a big deal, them cutting back on their industry, that's a rough one. How do you create that industry? Well, that's a much bigger thing, right? We've got the students who'll do the work, who will do a good job with the work. It's too hard to keep up.

I think there's an adequate number of technical jobs for the students who are seeking those. I think that's certainly possible. Anecdotally, a lot of students tell me that they couldn't find exactly what they were looking for, and they didn't want to go out of state, but they had to anyway. By and large—well, a lot of our students are looking to get out state, and so, there is opportunities all across the country, and they're very excited about that.

That's maybe a Bureau of Business and Economic Research (BBER) question [laughter]. In certain areas that data that you saw here, if you look at that workforce data—I'll look for the last year, and I don't know what it is for other states, but let's look for the most recent year we have, '12-'13. For UNM, they're 54 percent employed in the State of New Mexico. I don't know what a typical number is there, but 54 percent are finding jobs. This is a year later. This is only one year later in the state. Are they underemployed or all of these other things that happen? I don't know.

No. I don't know. Some, of course, are going to the lab. Some are going to the schools. That's working fine. A lot, of course, are going on to graduate school.

Any Sense of how Many of UNM's STEM Graduates Stay in or Leave New Mexico?

When asked whether the interviewees had any sense of how many graduates stay or leave the state the general response was no. The departments do not currently maintain those records, however, some interviewees indicated there was discussion of doing so. Most commented on contacting the UNM Foundation or UNM Institutional Research as a source of that information.

We really drop the ball on really tracking our graduates. We went through a bit of a crunch, about seven years ago. A lot stopped.

I have no data on that.

I wish I could say that. I would love in the context of a grant like this to have somebody who can help organize it because a lot of us have a lot in our heads almost in terms of going down through because—let's say we have 15 majors on each track a year, just roughly. I actually have

bar charts of that sort of thing, and I don't mind doing a data—it would be very good to do a data thing. Actually, the academic program reviews are requiring that, but the time step is pretty big, ten years. It's not like in one year you can have a snapshot of all the programs, but with institutional research, we should take a look at some of that.

Ten of the fourteen focus group students indicated they plan to leave the state once they graduate. The most cited reason was to seek job opportunities elsewhere. This perception is summed up in the following.

Go where the money and the jobs are. There's not really [any] here.

Obstacles that STEM Undergraduates Face

High School Preparation

Uniformly, one of the major themes that emerged from the interviews is that inadequate preparation in their previous schooling is the single biggest obstacle that students entering a path for a STEM discipline face. While the primary focus of this shortcoming was directed toward math, many also identified a basic deficiency in general science knowledge and ability as another serious obstacle. As noted by various informants the percentage of Calculus I ready freshman hovers around 25 percent.

However, according to statistics compiled by the UNM STEM Gateway, the percentage of Calculus I ready students is closer to 6.5 percent based on a survey of entering students in the fall of 2012.[1]

Math preparation in high school. That is the biggest barrier for student success in the engineering curriculum. [For] all of our engineering curricula, and computer science, which is housed in engineering, the first math course in the curriculum is Calculus I. Only about 25-percent of the students, who are first-year students at UNM, who say, "I want to be in one of those majors," only about 25-percent are ready to take Calc. I when they arrive at the door.

The bigger challenge is the majority of entering students who are not even ready for college level math (i.e. college Algebra) and must take foundational math (Math 101). In other words, a majority of freshmen come to UNM and are two to three years behind, as the following quote spells out:

There's 60 percent of our incoming students who will start either in foundational math, math 101, which is kinda the intro before you can get to college algebra. College algebra is the intro before you can get to pre-calc, which is the intro before you can get to calc. Two to three years behind in math is where they come in. It's not as if we have inappropriately leveled them in many cases. This was our big innovation with math curriculum…we've created a mechanism for them to test out in the first two weeks—to test out again in the eight week part with a quest that more of them will more quickly get to what is known as core math, or their first math course in their STEM sequence. For a long time, if you went to degrees.unm.edu, it would list for every…engineering degree, what happens when you start in calculus semester one. Well, if 70 to 80 percent of your students are not calc ready, how can you even set it up as an option? Then it's not real at all. That's math.

There are some students that are very well-prepared. We get some fabulous students here. By and large, we get so many students who aren't prepared for college-level math that it's horrifying.

[1]STEM GATEWAY BRIEFING TITLE: Math Enrollments for First Semester Students (Project Completion Date: 3/7/14).

The last thing I heard from APS, the other thing, students were having so much trouble doing algebra as freshmen. Maybe they were gonna push algebra back to the sophomore year. We said no, wrong direction.

What this means in practical terms is that students who come in unprepared for Calculus I and wish to pursue a STEM discipline degree are facing at minimum an additional year or two to complete their degree. This delay requires students, if they are on the NM Lottery Scholarship, which is effectively good for three and a half years and typically paired with a Bridge Scholarship, to find additional funding in order to finish their degree. Some have sufficient family resources to fall back on, however, others must find other funding, which may require them to work or get a student loan and face larger debt once they graduate. If they cannot tap into other resources and decide to leave college they have the double burden of the debt and no degree to help them achieve a job with sufficient compensation to live and pay off the loans.

Nine of the fourteen students said they believed that their high school adequately prepared them for the rigors of college level work. The comments related to this probe were mixed with the responses contingent upon the school they attended and the workload they faced while there.

I think my high school did a good job preparing me. We had a lot of AP classes that I took. I don't know if that's true for the rest of my peers in high school. I don't know if they were challenged as much as I did, myself.

Not exactly in my field. My high school was just general teaching the main subjects and some arts, some sports, and whatnot. I did feel that they helped me with workload, especially my last year, with a lot of AP classes. There was essays every week, or 12-page papers. I think that was pretty helpful in helping me learn how to organize myself better.

Not even a little bit. Not at all. I did all my classes online. It was a very small workload. It was so easy to get through the classes. When I came to UNM I was totally astounded by the level of work that was required. I could do it, but it was just so much time. It was so time consuming. I wasn't used to that. I definitely wasn't prepared for that.

Looking Upstream at High School Preparation for Students and Teacher Licensure

To assess the root of this problem of underprepared freshmen, it is necessary to look upstream. The figures provided above are not surprising when they are considered in context of mathematics course taking patterns for high school seniors over the past two academic years of 2014-15 and 2015-16. As shown in table 1 below, the PED reports that for the last two years roughly one-half of seniors were taking an algebra II class or higher. Based on the figures given above, many of these students are not receiving the level of instruction and preparation in mathematics necessary for them to start in Calculus I, the gateway to all STEM disciplines.

Table 1. NM High School Seniors Enrolled in Algebra II or Higher for SY 2014-15 & 2015-16

Academic Year	Number of Seniors	Number of Seniors taking Algebra II or Higher	%
2014-2015	23,233	12,082	52%
2015-2016	23,348	11,134	48%

Source: New Mexico Public Education Department Math & Science Bureau (September 2016)

Why is the quality of mathematics instruction so low in the state of New Mexico? The reason may be tied to the structural components of the teacher licensure system. In school year 2014-15, 1,859 teachers in New Mexico had a grade 7-12 math endorsement and the figure for SY 2015-16 was 1,839. In addition, across all mid-and high schools in the state there were a total of 120 long-term substitutes for math courses during school year 2014-15 and 110 for school year 2015-16, according to the NM PED Math & Science Bureau. In New Mexico, a long-term substitute is

categorized as being in the same classroom for a period of four or more weeks (NMAC 6.63.10.13). According to New Mexico Administrative Code (NMAC) Rule 6.64.4, mathematics teachers for grades 7 through 12 are required to add an endorsement to an initial license (i.e. Level 1 or L1) that requires 24-36 semester hours in mathematics and pass the Content Knowledge Assessment (CK) in mathematics. Upper level (L2 or L3) licensure endorsement requires similar requirements but also includes the option for the teacher to be certified by the National Board for Professional Teaching Standards in mathematics.

Science teachers also comply with a licensure structure that does not emphasize subject area expertise but rather exposure to general fields within science. Science teachers for grades 7 through 12 in New Mexico are required to meet college course completion requirements for endorsement that generally means they will take an array of courses across disciplines without developing expertise in any one. This requirement does not preclude a person holding a bachelor's degree in a particular area, just that they are not required. As detailed in NMAC Rule 6.64.6, for licensure the PED requires 24-36 semester hours in science and to pass the Content Knowledge Assessment (CK) in science. Upper level (L2 or L3) licensure endorsement requires similar requirements but also includes the option for the teacher to be certified by the National Board for Professional Teaching Standards in science.

The point to be made here is not to pillory teachers, they are faced with extraordinary demands that make their jobs nearly intolerable at times. Rather, the purpose is to highlight the structural shortcomings for licensure that the state of New Mexico has in place that does not require teachers of mathematics or any science to be degreed in the field they teach. Techers are required to have a minimal grounding, perhaps equivalent to a minor, in their endorsement area. Districts and schools across the state often face a shortage of getting competent teachers in the first place so expecting them to employ teachers with a bachelor's in a STEM discipline is perhaps unrealistic. The issues are not unique to New Mexico. In the United States teachers neither receive the respect often conveyed in other countries or compensation that would allow them a decent standard of living. That said, if the state of New Mexico wants to support better preparation of students for college entrance they likely will need to reconsider the current requirements for individuals going into the field. For a detailed treatment of how some other countries, such as Japan, China (i.e. Shanghai), Singapore, Finland, and Canada, handle teacher preparation, compensation and ongoing professional development see *Surpassing Shanghai: An Agenda for American Education Built on the World's Leading Systems.*[2]

Recent research published through the National Center for Education Statistics that looked at teacher retention indicated that providing a mentor to new teachers during the crucial first five years and providing them compensation levels of above $40K a year contributed to retention.[3] In New Mexico, the requirement for teacher mentors has been in place at least since the mid-2000s passed as part of the Public School Reforms Act of 2003 that aligned the state with the federal No Child Left Behind (NCLB) Act. How widely this requirement is currently being implemented is unknown. In terms of compensation, the state legislature increased the base pay for beginning teachers to $34,000 a year in FY 17 having been at $30,000 for several years through fiscal year 2014 and increased to $32,000 for FYs 15 and 16.[4]

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[2]Marc S. Tucker, ed. Surpassing Shanghai: An Agenda for American Education Built on the World's Leading Systems (Cambridge, MA: Harvard University Press, 2011).

[3]Gray, L., and Taie, S. (2015). Public School Teacher Attrition and Mobility in the First Five Years: Results From the First Through Fifth Waves of the 2007–08 Beginning Teacher Longitudinal Study (NCES 2015-337). U.S. Department of Education. Washington, DC: National Center for Education Statistics. Retrieved 9/26/2016 from http://nces.ed.gov/pubsearch.

[4]Source: New Mexico Legislative Education Study Committee, personal communication with staff, 9/28/2016.

If a student has received the proper type of preparation in both mathematics and the sciences before entering UNM, based on individual motivation and drive, they are ready to move through the challenging rigor of their STEM degree discipline and often will perform well. These initial STEM-related skill sets are identified as being ready for the introductory general chemistry course sequence and for Calculus I as well as being able to write. Such success presupposes the student has been exposed to a rigorous course of high school chemistry, typically conducted over a two-year sequence, and has successfully traversed the path of geometry, Algebra 1 and II, trigonometry, pre-calculus and possibly Calculus I that reaches back to middle school and continues into their senior year, and has been given effective instruction in English Composition. Without preparation, engagement, and continuance in these two primary disciplines of math and chemistry and development of the associated skills, students are not ready to succeed in a STEM discipline. As one interviewee succinctly phrased it:

> **Those who come in prepared with the parents who are STEM majors, they rock it out.**

Across many districts in New Mexico, the unfortunate reality is that teachers in many high schools have often received only the basics of a science or mathematics education and have completed the minimal amount of course work and passed a competency exam that allows them to receive licensure. This situation can be compounded by the lack of adequate equipment in laboratories that facilitate the development of proper skills in biology, physics, chemistry or the earth sciences. The issue appears to be particularly acute in small rural districts that have not, for a multitude of reasons, been able to make the necessary investments in staff and/or equipment that would support the college preparation of their students. In context of a discussion on high school preparation, one interviewee reflected on how young people from high schools in small NM districts lack of fundamental supports in their classrooms:

> **I think that some of that is due to their experience in high school and the resources that their high schools have. I've had the experiences of talking to kids who come from high schools where the Bunsen burners in the chemistry labs didn't work and where they essentially had substitute teachers the entire year they were supposed to be studying biology. Those kids obviously arrive with very, very inadequate foundations of understanding for those sciences.**

Even within large districts such as Albuquerque Public Schools or Las Cruces the necessary elements for an adequate preparation for college are sometimes found lacking. In some instances, when students have followed the correct "preparatory" path, taken Honors or Advanced Placement courses, and presumably have done well in terms of grades, they come to UNM as freshman and find they are unable to handle the rigors of the STEM gatekeeper courses. Two of the interviewees made comments on this state of affairs:

> **Sometimes a student will contact me—often, one of my own—and they say, for example, "I have AP credit for this, but I'm worried that I might not be prepared. Should I still take gen chem one," or whatever.**

> **We have students who come in who took calculus in high school. More than six percent of kids take AP Calc in high school. They're not calc ready when they get here. I saw this with my own daughters, is you get on that path. You're taking Algebra this year, then geometry, then algebra two, then calc, without stopping and saying. It's like we're gonna whip over the surface so you all know how to take a derivative. Why would you take a derivative?**

Whether students simply lack the opportunities of an adequate preparation for college their public schooling is expected to provide via adequately trained teaching staffs and physical resources, or they have come to believe they have the skills to succeed in college but do not and struggle once they get there. The first group of students is often found in districts serving Native American reservations or smaller towns across the state, as reflected in a quote by one of the focus group participants, who migrated from Mexico to NM:

No, for sure for me [being adequately prepared in highs school] is a big no. I mean, I went to Socorro High School. I don't know if it's here in Albuquerque also, but you just do the minimum work and you get an A. Unless you're taking advanced classes, then that's where the teachers really actually put in more work and care about teaching you the things that you need to know. The only class that I could say that actually taught me anything in high school was my English class, and I found it beneficial because I didn't know how to write English. I was still learning how to speak it. My English honors teacher, she's the one that really pushed me to learn how to write correctly. That's how I knew that I didn't need to be in a lower level English course because of her. I mean, I took the placement test, and I passed it. My science classes, no. I mean, they were okay, but when I was here at UNM, I didn't know how to study. I didn't know what I was doing, and I cried my first year, my first semester, every night, 'cause I had no idea what I was doing in my classes. For me, it was a big no, as far as science.

Whereas the second group are those students who were perhaps not challenged sufficiently, were not required to do a lot of homework and still got good grades. As pointed out earlier, the situation is often not one of a lack of ability, but rather one of being underprepared and to what extent, as reflected upon by one interviewee:

It's shocking to me. The kid says, "Oh, yeah, I took calculus in high school, but never had to do any homework." Wow, how could that be? Anyway, that, to me, is—it's not just about the specific math skills, or whether they've taken chemistry, because just about all of them have taken chemistry. Not everyone has taken physics. It's not just that. It is the skills required to be successful in college is that many of them just have not been exposed to in their high school education, which is sad, but I guess that's the way it is.

As a consequence, whether students have failed to make the "long march" through their mathematics and science curriculum or they attended districts and schools with minimal resources and had teachers with only basic level skills and understanding of the subject areas, they enroll at UNM where they often struggle from the start. The realization that they will be facing serious challenges with college level work may come in the form of a placement exam score or a failed grade on a first exam. This situation is captured in a comment from one of the students who transferred from Biology to Psychology after "hitting the wall" of Calculus I:

Kind of. I started out doing Biology. When I went into Calculus, I would say that influenced my decision to leave Biology. [Laughter] Then it was mostly online research that I decided to choose Psychology.

With adequate and early identification and intervention towards correcting these deficiencies and sufficient motivation on the part of the student, they can transcend the shortcomings they possess, move forward through a rigorous course of study and eventually get their degree, even if that means a somewhat longer path to completion. As borne out by the perspectives of various interviewees, these students are not just simply written off and allowed to fail. They can succeed. If they have the good fortune to become engaged with programs such as the IMSD, they can realize outstanding opportunities, as one of the interviewees attests:

We have a very strong record. We have students going from UNM to Cornell and Carnegie Melon and Stanford and Washington, UCSD, Utah, all over the country, Wisconsin. We've had a significant impact on—in fact, I think, based on some numbers I recently saw, I suspect that our program is responsible for about half of the STEM students that go on to get PhDs from UNM. I was really shocked by that, by the UNM numbers, because our numbers are not like that.

Given the proper opportunity and the right supports UNM students from whatever backgrounds can achieve. The next challenge considered is the cost of getting a STEM education at UNM.

Costs of an Undergraduate Education at UNM

In figures provided through the UNM Office of Admissions website for the 2016-17 academic year, the estimated total cost of attendance is $21,360 for in-state full-time students of which $6,950 is the actual cost of tuition and fees. If they are able to complete their degree in four years, this has the price tag of approximately $85,000. Out-of-state students face approximately $15,000 more in expenses per year. When asked about the cost of an undergraduate education at UNM both interviewees and students saw it as a value for a Level 1 Research University, as the following quotes attest:

> **I think that the students know that this is an incredibly good value. I mean it's one of the reasons I like being at the University of New Mexico, because I think we are really providing a pathway for poorer students, and that's not true at even state universities. It's not true at Madison, it's not true at Ann Arbor—particularly at Ann Arbor. I think this is still a very affordable—with the lottery scholarship, which I think is a wonderful thing. The lottery scholarship, is being used in a way as it's intended. I know there are problems. I don't know if you know, in the State of Georgia, they have the Hope Scholarships. It's a similar thing.**

This assessment is especially true for in-state students who are beneficiaries of the NM Lottery Scholarship, which when combined with a one-semester Bridge Scholarship, provides coverage of their tuition costs over the four years they are expected to be at UNM to complete their undergraduate degree. Trouble can arise though if there is a family or health emergency that arises and causes the student to have to withdraw or step out to deal with the crisis. Such an occasion will mean an end to the scholarship.

> **The only time I think I really hear anything about the cost is—because I think UNM is pretty good value for students who qualify for the Bridge Scholarship transition to the Lottery Scholarship and don't have life happen to them in a way that challenges their ability to do that. My only problem is I think that there are a number of very well intentioned, serious students who have a major illness or a family member who needs their support or who passes away, that causes them to drop out of school for one semester and then their Lottery Scholarship is gone.**

As noted above, if a student in a STEM discipline does not come in prepared for Calculus I and the rigors of gatekeeper courses such as the sequence of general and organic chemistry and has to start at a lower math course or repeat a course or courses, completion within four years is not feasible. This circumstance is faced whether the student is able to take courses over the summer which are not covered by the scholarship and are often limited in availability.

The majority of the fourteen students who participated in the focus groups noted that they work in addition to taking classes. The other was seeking employment. The fortunate ones have been able to find work on campus either in the form of student employment or under their financial aid package through a work/study arrangement. There has been an increased effort to provide internships or research opportunities to undergraduates in various engineering disciplines, biology or chemistry that, beyond the clear benefit of providing paid employment, offers the student practical and applied opportunities to get experience in their discipline. Sometimes these opportunities can be realized through undergraduate research opportunities, which programs such as Chemistry, Biology and Engineering offer, or employment through CAPS, which is located under the Center for Teaching and Learning (CTL). As seen with the following quotes, the goal is to improve the skill sets of these students and make them more attractive to employers.

We are trying to hire them to be teaching assistants, and we are trying to hire them to be graders. Some of them frankly are being recruited to do undergraduate research. I do believe that most undergraduate tutors and TAs learn a great deal of chemistry. I encourage them to do this—nothing like teaching it to somebody else to make you understand it.

There are other entities on campus that provide different types of tutoring and support. It's my opinion that we provide the best support for STEM tutoring, and part of that is because this organization, which had been known as CAPS, has been around for quite a while, and had several different directors. I think each director and each iteration has fine-tuned it. So, there's a very rigorous and developed program for our student employees. We don't just pick someone who's, let's say, good at calculus, and then throw them on the floor to talk about what they know. We train them according to research-based best practices, and we also think of our student employees as students foremost. We think about ways that we can professionalize them, and we even give workshops on how to make this particular work experience useful in their resumes, and going and getting jobs.

On the other hand, the obligation of having a job is sometimes compounded by family responsibilities that may include care for their own child or the desire to start a family, as reflected in this returning student's comment about deciding to opt out of a dual major in order to allow for this life change and that of an interviewee who sees the overemphasis of maintaining 15 hours as a discouragement to degree completion for those with other adult obligations:

That's why I'm not thinking about double majoring in statistics. That was originally my plan. I was going to do statistics and computer science. Statistics is absolutely so scheduled. They have four-semester sequence that you have to do at a certain time. My husband and I wanna have a family pretty soon and I'm gonna have to take time off to have a baby. I was like, "I'm not gonna add an extra two years to my schedule in order to study statistics."

Some other things that we would like to do to improve the success rate of these students from underperforming high schools or students who just, for any reason, came in underprepared, it turns out that sometimes the solution is to take an extra course, to do something like the stretch English classes, which take longer. It also turns out that some of these students have a difficult time sticking with 15 hours per semester, because they have family obligations. They have work obligations. What we're doing, in effect, is financially discouraging them from finishing their degrees by placing these incentives on the 15 hours on the 4-year graduation.

A broader issue about costs that emerged surrounds the issue of increased fees and how these exert additional financial burdens on students. The first comment is from a student and the second is from a faculty member.

I just got an email that they're not only increasing tuition, but they're increasing course fees. That's not even included in the lottery so you have to pay the course fees which are already 60 bucks each course. Now it's gonna be $200.00 or something.

Just last week, in our general chemistry lab, we asked a student to buy a notebook. The student wrote to me, "I'm really sorry. I just can't afford it so I'm going to miss this experiment. I'm going to do better once I can pay for the notebook and I will put all my effort into catch up." I told the student, just stop by. I'll give you the notebook. I can imagine there are many more students like this. In the past, they just paid the tuition and not many fees. Now, we don't raise the tuition but we add so many different fees to it. Usually even with a scholarship they don't pay those fees. That increased the burden on the students. A lot of them not [only have] to support themselves [but] to support an entire family.

Undergraduate students who attend UNM, especially from in-state, enjoy a relative bargain in the education they are pursing. This assessment extends to students from out of state who commented that they are drawn here for both the programs the university offers primarily in nuclear and civil engineering and the costs of obtaining it. The Lottery Scholarship offers three and one-half years of tuition coverage. Combined with the one-semester Bridge Scholarship, it provides tuition coverage for completion of a bachelor's degree in four years, an achievable goal for those who are prepared and maintain a fifteen hour course load. Although the expansion of various fees exerts additional financial pressures, the current cost of receiving a bachelor's at UNM remains a comparative bargain in higher education.

Need for another Sputnik Moment or Call for a Moonshot?

The question asked of interviewees was whether the United States needed another Sputnik moment or a call for a moonshot. These probes, of course, are allusions to the events in the late 1950s and 1960s that precipitated large-scale interest and mobilization of the country's technological prowess, part of which was directed towards improving the math and science skills of its young people. The period these calls were made was during the Cold War when the US and USSR were at loggerheads with each other. The responses given were mixed and phrased, on one hand, as either, yes, it would be helpful if there was more of a national zeitgeist that could ignite a concerted effort in this area. On the other, the perspective put forth was one of not really, because everyone is totally immersed in technology and the attendant change that accompanies this immersion, especially in the realms of computer technologies and communication. It is more of an issue of becoming educated and attuned to the skills necessary to work within the developing reality. Others commented on the need for the state and the federal government, specifically the national labs to reassess priorities. These perspectives are captured in the comments below:

> **I heard all about that all growing up. I don't know that—it certainly wouldn't hurt. I mean I think there have been these sort of mini-Sputniks over the years, but it probably wouldn't hurt. I think one of the things we find in STEM education is that back during that era, the Sputnik era, the time right after World War II, the 20 years after World War II ended, engineering was perceived as a real ticket into the middle-class. I think maybe a Sputnik moment would be great to help reinvigorate the desire for science, but it's not necessarily perceived right now by kids as the only way to get where they want to go.**
>
> **I think that we, as the United States, are much further behind in a lot of different areas than a lot of other countries. I think that they're definitely—again, I think that's where we're missing the boat, by not putting an emphasis and a value on education. I don't mean that it's any person's fault. I think that we, as a community, are missing the boat there, generally from government to private, across the board.**
>
> **I think as a nation, we do. We need something. Because clearly, just knowing that we're no longer in the top ten even isn't enough. Hasn't been enough of an impetus, at any level.**
>
> **Maybe, do we have it though with the internet revolution and what's happening with information? Maybe that's already happened. It doesn't need to be state-supported, but it's just happening anyway. You look at the pace of innovation, and it's crazy. It's tough when you're living in it to see it but just think about the changes that have taken place over the last ten years. Maybe it's happening, and we're just not seeing it. When I first came here, I remember the labs were saying—this is after the Nuclear Test Ban Treaty—how we're gonna become a national resource for doing all this. This is 1990, the birth of the internet, and whatever this is, 25 years later, [New Mexico] to have nothing to do with any of that technology. I think the**

commercial side is where everything is happening. We've been out of that game here, because we tend to be more government types of jobs. These are the high-tech areas [and] I think we kind of missed some opportunities in the way we prioritized.

Role Played by the New Mexico Economy

Responses from the interviews on the role played by the New Mexico economy in STEM education varied. Some respondents focused on the key elements of oil and gas production and its role in supplying the state coffers. Others focused on the job opportunities various businesses and industry offer. Many commented on the need to diversify the economy to attract new industries and higher paying jobs. This solution, of course, is connected to a comprehensive state and federal policy approach beyond the scope of this study. A sample of these perspectives is offered:

Oh, yeah. The price of oil is everything. We don't have a diversified economy. Our economy comes and goes with oil and [gas], yeah, essentially those two extractive industries. We're also sensitive to it because we're incredibly dependent on—most of our economy— recycling tax dollars. The federal government and the state government are a huge fraction of the trafficking of money in our state. If we were able to develop the economy of the state in a way that generated more corporate employment, more higher paying jobs, that would totally (a) create demand for technical fields like STEM, and (b) it would put more money into the state coffers to improve the quality of our institutions and our educational system.

Well, I think the large healthcare economy creates a focus on health professions. The state has been willing to fund things like more nurses and so on, which is good. At some levels, the interest in the health professions can be supported because we have a big healthcare economy, if you think about all the hospitals and things. The national labs are good. For students who can get into those programs with internships and so on, those are well-paid and good opportunities for students.

I think pretty much what we do is very tied into the New Mexico economy.…I'll mention one thing that we are slowly developing, and that I think will be more suitable for us later, and that is aero…. What we do is have concentrations. Students can do a concentration in aero in the mechanical department….Electrical engineering has a concentration in astro, which means satellites and things like that. It's not a highly visible program, so if a student wants to do it, we can make it happen.

New Mexico has not cultivated the high tech economy that you might expect from the state having two major DOE laboratories. [Laughter] We are still in the position of having to import graduates from outside the state to take those positions, because our own graduates are not always the caliber they're looking for. Boy, once you get outside of that, we don't have a high tech economy. Our people aren't going to professional school. Well, maybe they're gonna teach in high school, or maybe they're gonna help run the fertilizer business their family's been doing for years.

Emerging Opportunities for STEM Majors

Trends on the Horizon

One of the questions concerning emerging opportunities for STEM majors asked of interviewees, was what trends they saw on the horizon. While there was no consensus the various interviewees gave some intriguing ideas of what may be emerging based on their particular point of view, which, to no surprise was associated with their discipline. What follows is a selection of areas that interviewees saw as emergent. One is the selection of biochemistry as a major, thought to be grounded in the perception they will be more able to get to medical school. Another posited the growing field of bioinformatics where the large stores of data now being collected can be analyzed for such applications as gene sequencing in conjunction with organizations such as the Santa Fe Institute. Various movements into environmental science and alternative energy with attendant work on materials and electrical related to photovoltaic, as well as materials involving nanoparticles. A lot of things involving biology include cross-pollination work in biochemistry, biomedical engineering, and materials that can offer career opportunities. Various interviewees focused on the increased emphasis of getting undergraduates involved in research that was supported by the formation of department committees devoted to this end.

Concerted Efforts to Attract Women and Underrepresented Students

When asked about efforts to attract women and students from underrepresented groups several interviewees mentioned various programs with a particular focus on STEM education. While not exhaustive, these include:

The American Indian Summer Bridge Program – while not STEM specific, provides a five-week intensive residential program that includes an academic component to grant credits and where participants learn study skills, time management, leadership development, and other related to supporting academic success.

STEM Pathways – developed to help beginning students, especially Hispanic and low income, attain a STEM degree. The program includes various initiatives—Gateway Science and Math Course Redesign; Peer Learning Facilitators; STEM Gateway Workshops & Activities; and Data & Impact.

Maximizing Access to Research Careers (MARC) – funded through a grant from the National Institutes of Health. The program is focused on increasing the number and competitiveness of underrepresented students engaged in biomedical research by increasing research opportunities. The MARC is a competitive and selective program that admits five students each year according to the program's website.

Initiative for Maximizing Student Development (IMSD) – offers research training and professional development to prepare students for graduate school in biomedical research through a combination or financial support, scientific education and mentoring.

Ronald E. McNair Scholars Program & Research Opportunity Program (ROP) – a federal TRIO program designed to prepare first generation college students with financial needs or students from traditionally underrepresented groups for doctoral studies. The ROP is a state-funded program that is geared towards supporting students from underrepresented groups move into doctoral programs.

In terms of undergraduates, women are in a majority status on campus comprising some 55 percent of its makeup based on UNM student population demographics.[5] Women have a strong presence in biology and biochemistry and several interviewees expressed some wonder at their numbers in chemical engineering. However, in most other engineering disciplines there are not that many. As one interviewee pointed out, in the early 1990s there was a large influx of women into engineering eventually topping out at 25 percent of students. With some exceptions, such as chemical engineering, this number has remained consistent since. The perspective given below provides some estimates for UNM and also ends with the question asked here and across the nation of "Why?"

> **When I was in undergrad, there were approximately zero-percent women in engineering, and, of course, that's the way it had been forever. Then, probably in the late 1980s, early 1990s, suddenly, the doors opened for women, and in a very short amount of time, we went from 0 to about 25-percent. And that's not UNM that I'm talking about, I'm talking nationally. UNM's enrollments very much follow the national trend, so all of a sudden, it just opened up and women walked through the door. The doors were open. Unfortunately, it's still kind of perceived as a male kind of profession, and that's unfortunate, and I don't know why that is. It varies from discipline to discipline. Chemical engineering tends to be about 50-percent women. If you have a discipline that's got the word "bio" in it, it tends to be even more, 60 or 70-percent women. Mechanical is on the other end, and it's more like 15-percent. Electrical is right in the middle. It's an interesting problem, and a lot of thought has been given to this nationally. Boy, it has been a sticky problem. For 30 years now, after this jump to 25-percent, people have just been doing all these things to try to make this more appealing to women, and the numbers have just been stuck. We can't figure out why.**

While this informant used a figure of 25 percent of students in the UNM College of Engineering the American Association of University Women in a recent report pegged the national figure as 20 percent.[6]

Although an in-depth discussion of the issues concerning the paucity of women in STEM fields is outside the scope of this report, it is worth noting that the reason that women don't flock to STEM related careers is not related to their overall ability to "do" math or science. Throughout the primary grades of schooling, girls take math and science classes in roughly the same proportion as boys. The reduction appears in secondary education where the 20 to 25 percent participation figure stated above has remained in place for the past thirty years. As one interviewee stated,

> *There's still a lot of that [gender stereotyping] out there. There's still a lot of perception in the world that girls aren't good at math, which is total nonsense. There's this perception that boys are better at engineering than girls. Based on my class, the 25-percent in my class that are women kick the guys' butts. The average woman in my class is probably about ten points ahead of the average guy, so that's all nonsense, but it's still out there, this perception that this is for boys and not for girls, and I don't know what to do about that.*

According to this same informant, women play significant roles in professional technical organizations across the state, stating that every professional organization that he has ties with is run by a woman.

In the College of Engineering, minorities, especially Hispanics are extremely well represented. The college typically is able to produce a 50 percent rate of graduates annually who are Hispanic. This figure is compared to the 46% of

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[5] The University of New Mexico Spring 2016 Official Enrollment Report Albuquerque Campus, As of Census Date, February 5, 2016. http://oia.unm.edu/facts-and-figures/documents/Enrollment%20Reports/spring-2016-oer.pdf

[6] AAUW, (2010) Why So Few? Women in Science, Technology, Engineering and Mathematics, by C. Corbett, C. hill & A. St. Rose. Washington, DC: Author. Pg. xvi.

Hispanics who help make up the composition of the undergraduate population at UNM.[7] Other underrepresented groups such as Native Americans and African Americans also have a noticeable presence in the school. The key to these individuals achieving success (i.e. getting a bachelor's) appears to be getting past the first year of studies, a major demand and accomplishment for anyone entering the engineering profession. An active recruiting effort by the college specifically targets students from underrepresented groups as noted in the following:

> **We try very hard. That organization I mentioned before, Engineering Student Services, one of their jobs is recruiting, and they focus very heavily on recruiting underrepresented minorities to engineering. They sponsor all the student organizations focused on minority groups. There's the National Hispanic Engineering—actually a couple different Hispanic engineering organizations. There's a couple different Native American engineering organizations that we have the local chapter of. There's actually a women's one as well that we sponsor and work with those students. There's an African-American one, all these organizations. We have student chapters of it. We encourage those, and we really work hard to make those students successful. What's interesting to me is, you would think that nationally, the way people talk is that minority students don't do as well, and blah, blah, blah. Well, that's not true here. If they make it past that first year, and they get into our programs, they are indistinguishable from the population as a whole.**

In general, what becomes apparent is that UNM has undertaken several efforts to reach out and engage students who are female or from underrepresented groups. Opportunities are present for those students who seek a STEM degree and supports are available for those are in need. The widespread outreach made to underrepresented students and the ability of the College of Engineering to have one-half of its graduation class comprised of Hispanic students is testament to UNM's identity as a Hispanic serving institution and its commitment to providing an equitable opportunity to all its students.

Use of "Flipped Classrooms"/ Active Learning Pedagogies

The use of a pedagogical approach known as active learning is becoming more well-known and practiced. Sometimes referred to as a "flipped classroom" for its shift away from a strict lecture format to engaging students in peer-to-peer discussion, facilitated learning and more hands-on approaches, the approach is directed towards making students an active agent in their education experience. A particularly productive approach has been the use of Peer Learning Facilitators (PLFs) in the beginning chemistry sequence and through CAPS, an approach whose future is uncertain due to the end of the federally-funded grant program, the STEM Gateway, which provided operational funds for the PLFs over the past several years.

While there was an in-depth discussion provided in another section of this report that will not be repeated here, it is worth noting that this approach is becoming adapted by various faculty. While some of them addressed the time-intensity of preparation the approach demands, many also pointed to the advantages the pedagogy avails to students. A selection of comments provides examples of these perspectives:

> **Yes. The STEM Gateway thing for biology 202, 203 and 204 provided an opportunity to go after that active learning environment. We haven't attempted to force people into doing it, 'cause it requires a lot of work and it requires an engagement on the part of the faculty member. Trying**

[7] The University of New Mexico Spring 2016 Official Enrollment Report Albuquerque Campus. As of Census Date, February 5, 2016. http://oia.unm.edu/facts-and-figures/documents/Enrollment%20Reports/spring-2016-oer.pdf

to get someone to do something they don't wanna do is probably not gonna be successful. A number of our faculty have taken those issues to heart. I'll be interested to see how those trends go over time.

Yeah, that's why I was wondering if you were gonna talk to [a member of the Chemistry faculty]. We've got that beautiful classroom, the CTLB. I know that she did her chem redesign all around the idea of group work, problem-based learning, reading at home, coming together, and flipping it.

Right now both semesters of that sequences are completely flipped classroom. Although I tend not to use that work. I prefer the word like active learning or student-centered learning. Anyway, I would say we try to make it 100 percent in our general chemistry classroom, they're active learning, using active learning strategies. Different instructors have slightly different styles but they all buy into the idea that students can learn better if we focus on what they're interested in or what they need and facilitate the type of activities that they can use to get into more effective learning. If you visit our general chemistry classroom you don't really see a lot of lecturing. Instead you see a lot of small group discussions, peer learning. We have at least 50 percent of our general chemistry sections using the active learning studio classroom. Both the students and faculty like that environment.

In response to whether any of the students had participated in a "flipped" or active leaning classroom, several of the students indicated they had not yet, while others who had stressed the efficacy of the experience was contingent upon the faculty member. Other students expressed interest in being in such a learning environment.

Not necessarily for class. I'm in a writing class, and our professor, he posts little small snippets of text that he finds fascinating or funny or something like that.

It depends on the professor. I had a class that was like that, but the professor was terrible. I actually, coincidentally, was in the online portion of the class, so yeah, I never had to go to that class, which I heard terrible things about. I think it's professor-dependent.

That would be helpful.

The conversation shifted to whether there was any effort being made to instill an entrepreneurial mindset in undergraduates, the topic to which the discussion now turns.

Encouragement of an Entrepreneurial Mindset in STEM Undergraduates

Overall, the general comments from both interviewees and students were that development of an entrepreneurial mindset is not being emphasized. The exception to this statement is the Innovate ABQ being operated by UNM in conjunction with the City of Albuquerque as a means to help launch fledging enterprises. Innovate ABQ is located near downtown Albuquerque and provides an environment to make this development happen. Another component of Innovate ABQ, known as the Innovation Academy, provides direct support for students who will be housed in the same location. The facility will provide a space for students to live in a dormitory like setting, hatch an idea for a business, establish the operational basics and take it to market. During the focus groups, some students expressed awareness of the effort but none had yet become directly involved.

Of some note is that roughly one-half of the students from the focus groups indicated that they would like to start their own business at some point in the future. Many of them that voted in the affirmative came from either

computer science or civil engineering. However, most of them indicated that they were not receiving much support or interest from faculty. One indicated that he would like to start his own medical clinic but was beginning to shy away from the idea. Some comments on the topic include:

> **Yes. For many years, we've had a course, both at the undergrad and the graduate level, called Entrepreneurial Engineering. I'm not sure if we've taught it in the last couple of years, 'cuz the person doing it moved on. We have a course on the books related to that. We encourage our students to participate in the Innovation Academy that UNM is starting, and I think there's a fairly significant number of them doing that. Yeah, we have some participation, and again, not every student is interested in that. Plenty of students just want to go get a job and do their job, but there are plenty of students who are interested in that kind of an activity.**
>
> **Probably by practice. It's always useful to talk with people that are in these different areas, the whole STEM workforce, let's just say, and everything that goes with that. I teach the capstone course for the environmental science students, just as an example. I've just realized a lot of times you're teaching things, like what you're talking about, entrepreneurialism. There are things that you're doing that relate to that, but the students don't know it, and you might not even know you're doing it. I think that's one of the great hidden values of our mandates for assessment is to be creative and look at these kind of workforce elements to see where they are in our in our curriculum**
>
> **There's a lot—in fact, it was in today's paper, they have a talk about that. Rob DelCampo, who runs Innovation Academy, is talking to all the incoming freshman about tacking on innovation-related courses to their majors. I think there's a tremendous amount of activity.**
>
> **How would you go about encouraging students to do such a thing? I don't know how you would do that with undergraduates, to be honest. We've brought in entrepreneurs to talk to our undergraduates about it. What they decide is, gee, I really wanna be an entrepreneur. Then the second thing they decide is, "What part of California do I wanna be in?"**

Responses from students give the assessment that entrepreneurs are not in the academy or they are having their own dreams of owning a business:

> *I've had a lot of professors with a lot of proprietary experience in that way, cuz a lot of 'em have PhDs so they went the academic route, which is not even business. They actually are repulsed by the idea of owning their own business, almost. It's just like there's different kinds of people. I have one professor—he's actually my boss right now—who worked in industry, but he never owned his own business. Those people are out there doin' it. They're not in academia teaching.*
>
> *Yes, I want to start a company for the first quantum computer, for like big data analysis, security algorithms.*

In a broader sense concerning opportunities for STEM undergraduates, several of the focus group attendees noted that they took advantage of various opportunities UNM provided. The comments covered topics as diverse as the use of the libraries, to access to computers, clubs, office hours with their instructors or course TAs, to the ability to be around faculty and staff who possess PhDs and to see them as inspirations and role models for their own educational aspirations. Part of the interview process focused on thoughts of which undergraduate STEM populations were well served by UNM, the focus of the next section.

Well-Served Undergraduate STEM Populations

There was a general consensus across the interviews that students in the College of Engineering were being well served. The consensus was built on perspectives related to the school's programs, its supports for students, the enrollment numbers, the internships and other opportunities, and the high employment rates of its graduates. Some comments also related to the college's relationship to Arts & Science and the funding structure of the university towards the Engineering. Focus group participants were not asked about either well- or best-served undergraduate populations.

> **Everybody's got their skills. Engineering has a great tutoring capacity. They've always had their engineering minority programs and that kinda stuff. They have people that are very interested. They don't have the student numbers. They have fewer students in the entire College of Engineering than in biology.**
>
> **In general I think that the engineering students are very well served by UNM....I think that engineering does an exceptional job not only of educating their students, but also kind of going beyond that and sort of exposing them to career opportunities and really facilitating that. I think that engineering does a great job with that.**
>
> **I think engineering probably does a pretty good job. They have a lot of student engagement things. Their formula race car. They have kids working on robotics and drones and stuff. I think that that unit reaches out a lot, just because they're very hands on. I think students like that.**
>
> **The engineering students are better served than the arts and sciences students, partly because the college has better funding per student than the others, and partly because now they've been allowed differential tuition, including differential tuition on Arts and Sciences courses. Partly, they're gonna use that to raise salaries, or they say that partly, they're gonna use that to improve tutoring. Of course, they also have good relationships with employers and with the labs and so on, so they're better served than other student populations.**
>
> **Engineering has things a little easier than Arts and Sciences. No, let me take that. Incredibly easier.**
>
> **Well, I would have to say that all of ours are doing great. We do have—not well known to most people—a bioengineering industry here. I think we are preparing a lot of students for that. I guess if I was going to say any one of our fields that would be one. As mundane and boring as civil engineering is, we provide a huge number of the professional civil engineers that are out there building Paseo del Norte, that interchange. Anywhere you look around where something's being built, our students are out there. We do a very good job tying into that part of the New Mexico economy as well.**

Others had the perspective that Physics and Biology were both doing well by their students.

> **I think [the IMSD] community that's [been] built is impactful for those students in bio. I think physics and astronomy, the students that they work with—I wanna say this. I'm not sure it's true. Our last Goldwater was a physics student, and I believe physics has been the home for more of our Goldwater students. Those are the students who get a really big scholarship, kind of in their sophomore/junior year.**

> **Physics is doing pretty well. They've got ways that the undergraduates can participate in things, feel like they're part of something. Yeah. There's pockets of good labs like that around.… Physics students seem to be pretty happy.**

Others commented on Chemistry's positive impact for its students, primarily tied to the quality and commitment of its teaching staff and administration.

> **I know that chemistry has some wonderful people and is really committed to education, to teaching. [The faculty and] the Chair have really been supportive of that.**

There was some concern expressed about long-term trends related to the modification of entrance requirements into the College of Engineering. Specifically, the focus was directed to students who come to UNM extremely unprepared in mathematics and were placed in the Math Learning Laboratory (MaLL). The question raised was how with the reduction in admittance standards these students will affect attrition rates within the college if they are starting effectively two years behind where they need to be with competency and if this would contribute to increased frustration and withdrawal from the school.

> **Well, once upon a time, yes, but that's because the engineering school wasn't letting them in until they'd reached a certain level of math. Now, under the new system, the engineering school is admitting people who are going to the MaLL, taking the pre-MaLL class. How that's gonna work out for those students who would have a very long road to success in engineering? And, it's not clear that they can succeed before they give up. I don't know what that's gonna do to attrition from engineering. Once upon a time, yes, because students, because of the entry characteristics. Now, I'm not sure what's happening.**

As seen in the various comments, there is agreement that both the College of Engineering and its students are well-served within UNM's STEM landscape. While other departments and initiatives, such as IMSD, received some notice for its relationship with and opportunities provided to its students, primarily Physics and Chemistry, Engineering by far received the most recognition.

The next section flips the approach and asked, who are the least served STEM undergraduate populations?

Least Served STEM Undergraduate Populations

A large swath of interview respondents thought that Native American and first generation students were not being well served in the STEM programs.

> **Native Americans are especially underserved in STEM. In some of the places where Native Americans congregate, you can hear negative things said about STEM. Because of the fact that Albert Einstein could be in Kayenta or Tohajiilee or someplace like that, I think it's really important that we figure out ways to do a better job with the Native Americans who have an interest in STEM, cuz there's so much opportunity.**

> **I know that we are struggling to have success with our Native students; I know that that's been an issue. There's folks in biology…who have done really amazing work with mentoring Native students, but she's one person and that's a problem nationwide. It's certainly a problem here, and we have like six percent Native students. I mean it's small, but it's a pretty big percentage compared to other research universities. It's significant enough that I think we could do more to really solve that problem.**

> **Oh, the population that I would say is first-generations. If they don't know how to hook into the system, they can flounder.**

In particular, one respondent commented on students who were not prepared as being the least served.

> **Again, I think it's just the student that's less prepared, academically, is probably the least served. I think in the past few years to really have tried to do a better job. Especially I see the changes in math and English that provide that opportunity for students. We need to do more. We need to do more.**

Another group that received attention was Hispanics. Pointing to the number of withdrawals at the end of the first semester of the 2015-16 academic year of approximately 2,000 of which 997 were Hispanic, this individual made a call that more needs to be done for this group.

> **Can I say a specific population? I'm still seeing a lot more Hispanic students leave the university than any other population. We are the largest, so it's also easier to see those numbers. For example, from fall to spring, in the fall we had a little over 27,000 students enrolled. In the spring, we had 25,000 students enrolled—so, about 2,000. Of those 2,000, 997 were Hispanic. Now, that's not to say that it's the same 25,000 to 25,000, but that, in and of itself, is very telling that, of the 2,000 that didn't come back, 997 [or] 47 percent were Hispanic. We're definitely missing the boat, and we need to do more in that area.**
>
> **I don't think that we've had particularly good success with African American students. Even though we are a majority minority, I know that there are men of color who struggle. I even know minority African-American faculty find themselves not as comfortable as they could be at UNM, and that's interesting, and in Albuquerque.**

One perspective that shifted the focus to departments was directed toward biochemistry majors as not being well-served by the university. The perception appears to be rooted in the control of the major which occurs through north campus and the School Medicine and not under Arts & Sciences located on main campus. Another take on this was that undergraduates interested in molecular and cell biology were less-well served than others because the expertise in the graduate program is elsewhere.

> **I think that the larger the major, the less well-served the students are. The biochemistry students are not well-served because it's a large major that we can't manipulate resources. In the biology department, which is a large major, students interested in cell and molecular biology are less well-served than some other students because the faculty expertise in the graduate program is in ecology and evolution. Those students can get lots of really small classes. Students in cell and molecular biology, a lot of the pre-health profession students, get upper-level classes that have more than 100 students. That does not serve them well.**

Whereas another thought students in the geosciences were not well-served in both supports and funding.

> **We're woefully underfunding and under-supporting students in the physical sciences. I'll go ahead and agree—say the same about the physics and the chemistry as well, but we get lost in the—it's like, "Oh, it looks like it's okay," because biology is, in fact, more diverse with respect to gender and with respect to ethnicity than any of the physical sciences programs. We have a lot of work to do. The point is that the disciplines that are out there are not as populous. Just because the number's smaller doesn't mean it's not absolutely critical to have people who are deeply trained in the geosciences.**

As far as thoughts about how to deal with these problems, there was recognition that if provided the supports and structures for succeeding within a STEM discipline, it is at least necessary to give these various students an even odds chance of doing so. There is also the matter of changing the mind set of faculty who had to endure the old way of "swim or sink." The response to that is, does it have to remain that way?

> **We're educating. We're educating, and they are changing those things. But give them a fighting chance. Give 'em a structure that allows them to succeed. I think the message you send, if you give 'em the other one I showed you, is "What are you doing? You should change majors." That's indirectly what you're telling them. "This is not the major for you, cuz you're gonna be two years here before you start to do anything in your major." That is changing. That is changing.**
>
> **There is a component of UNM students that [think] you can grow up in New Mexico and be ready to handle that school-of-hard-knocks kind of training. In fact, probably most of the existing faculty came through that school themselves, but the reality is: does it have to be that way, and who are we closing out by doing that?...Whether you work on the straight curriculum—to me that's the most powerful way. Students only have so much time. If you're building a big cushion for other ways to help them do that but you're not gettin' in the door of how that curriculum succeeds, we're not gonna have a difference in our students' time to degree because they still have those [core courses to complete].**

A body of research has emerged over the recent past that has focused on the concept of a "growth mindset." This term refers to a perspective that instead of perceiving intelligence as well as any number of associated skills as fixed assets, research in this area of cognitive studies indicates and has provided strong evidence that they attributes are actually quite malleable. Most importantly, the work is directed towards instilling resilience in the individual to overcome frustration and failure and eventually succeed. The use of this approach with underprepared students may offer them a valuable tool to assist them face the challenge of completing a STEM degree. Researchers in this field include Carol Dweck, David Scott Yeager and Marilla Svinichi.[8]

The final set of topics addressed gaps and overlaps in services or organizations related to STEM education. A review of selected responses in combined form is considered next.

Gaps & Overlaps in Support Services and Organizations

The last central blocks of questions in the interviews focused on gaps and overlaps related to undergraduate STEM education at UNM. The first part will address gaps followed by a discussion of the overlaps. A central theme that emerged from several of the discussions centered on lack of coherence and coordination among the various programs that serve STEM undergraduates. In conjunction with this is the need for enhanced communication provided to the university community (faculty and students) to alert them to what is available.

> **First of all, it would be very good for the people running programs that are sending emails and connecting with STEM students…if there were a group getting together to talk about what**

[8] Svinicki, M. (2016), Resilience: The Re-Interpretation of Failure?. The National Teaching & Learning Forum, 25: 12. doi:10.1002/ntlf.30076; Yeager, D.S., Johnson, R., Spitzer, B., Trzesniewski, K., Powers, J., & Dweck, C.S. (2014). The far-reaching effects of believing people can change: Implicit theories of personality shape stress, health, and achievement during adolescence. Journal of Personality and Social Psychology, 106, 867-884; Yeager, D.S. & Dweck, C.S. (2012). Mindsets that promote resilience: When students believe that personal characteristics can be developed. Educational Psychologist, 47, 1-13; Carol S. Dweck, Mindset: The New Psychology of Success (New York: Random House, Inc., 2006).

we do, because we're duplicating effort, we're doing things where the rubber doesn't hit the road, and we're creating noise where we really actually want a very strong signal. I would say the gaps are in communication, at a very high level

I wonder if the gap is not so much in what's out there, but in tying it all together, and making it a little more coherent, and make it to where students are more aware of it and what their options are. It's actually not just an UNM problem it's sort of a national problem. I was on some panel that was advising the Secretary of Education for the U.S. This was ten years ago. Anyway, we were discussing these sorts of programs to help STEM students succeed. I just said, "You know, the one thing that's lacking is coherence nationally." Sandia has a little program, and Lockheed Martin does this, and fund it here and there. Intel has their stuff going on here and here and here, and there's all these things all over the place. NSF funds this, and the Department of Energy, and it's all great, but it just seems like the sum of the pieces does not come together into a whole that really is coherent and makes sure everyone gets something.

Every now and then, someone starts telling me about something, and I'm like, "Oh, I had no idea that was going on." I wish there was a way to make that a little bit more coherent, and I'm not sure what it is and what it would take to do that. Of course, we're all doing our own thing, and we think we're doing a good job, and we don't want somebody to come tell us what to do. A little bit more coordinated outreach, because again, everyone's doing their own thing, and it's kind of hard.

Others directed their assessment of the gaps in context of the students. These comments range from still being young and not fully aware, to their socioeconomic status.

I'd say that the biggest gap is early on, helping the students figure out what STEM is, besides a major. Later, we have more grant-supported programs, IMSD, MARC, McNair, LSAMP. There are a number of programs that will help junior and senior students, and not programs that will help the earlier students.

Sometimes I worry [about] the socioeconomic gap. If you don't check off some other box, you just are born poor and didn't go to a good school, I think sometimes there are gaps for those folks. There's all sorts of other services, if you can check this box or that box. CEP [College Enrichment Program] is very open. They'll serve anyone, but sometimes maybe [with] the outreach to students who [are] first generation, there continues to be a gap in dealing with those first generations that don't know how to navigate college.

I think there could be more undergraduate research opportunities for students in STEM. I think, in general, the weakness of UNM, as a whole, [and] would probably bear out in STEM, is that there's a lot of siloing.

The next gap…is about a discussion about what STEM students really need. In that respect, they have to have people who have been faculty, and who have very high-level experience in STEM, and who can help them translate….Then, I would just say the most recent thing has been our advising. In the beginning, there's a great underestimation of what the student can do. I'm not sure our advisors have the ability to determine that. I see a lot of kids that are lowballed, in terms of their major or the kinda math programs they're on and that kind of stuff. Once a kid gets lowballed, he can take on that persona and not do as well as he could

I think a gap is in information flow. [Another staff member] and I gave the morning talk at the STEM day. We're so stupid. We said, "Oh, yeah, you want any questions, you just ask us! You just ask anybody with a name tag! We're here to help." [She] and I are walking out [and] some students come up to us and ask questions about how do I get involved in research? How do I do this? We're like, "We don't really know!" [Chuckles] Students will ask me. What's the way to join this organization or do they have an organization for fill in the blank?

Overlaps

The issue of overlaps is parallel to that of gaps and received similar focused comments. One focused on the redundancy of orientations, which the university has eliminated. While another commented on the lack of a uniform system to ascertain gaps in student preparedness and the need to move away from the mindset that a lack of preparedness is a personal deficiency. Finally, one interviewee considered the large number of various services, such as tutoring, to be a waste of resources that needed better clarification of need and coordination of communication to diminish confusion surrounding their appropriate use.

I think it's getting better, but we have—one of the biggest things that we've had to overcome here were all the silos that we have and who's owned something previously. We had a huge issue over new student orientation. When the president first came in, we had two separate ones ongoing, and it was years' effort just trying to get people to work collaboratively with that. I think part of the issue there is that this push for student success—[which] the president came in with… wasn't necessarily here as strongly as previously….That's changed nationally.

I think the first thing that I'm hearing about is that there's not a uniform approach to identifying students' level of preparedness. I think that some of the testing that is available rather than just doing across-the-board screening testing, sort of that idea of a placement test, I think that's one thing that I'm not aware exists. I think it exists, but it's not universally applied. I think that needs to be generalized. If we wanna truly promote the professions that are STEM based then what you have do is when you identify these students with deficiencies and they are not personal deficiencies, they are deficiencies that arise because of the educational experience these students have had up until that point in time. That's critical to get over that mentality. These are not students that are incapable of doing the work.

I don't think there are gaps but instead I see they're overlapping that sometimes could end up with waste of resources. I'd like to see more integrated effort. For example, tutors. I think there is so many different departments that are offering the tutors, tutoring services. To the point that sometimes I'm really confused. Where should I send a student? What's the difference? I don't know who should take the lead to streamline the efforts. Maybe CAPS.

The University of New Mexico is a complex social system and as such to appropriately deal with the problems or gaps and overlaps related to programs, services or organizations, it would be necessary to approach the organization from a social systems analysis framework. Obviously, that is outside the scope of this report but it does provide a suggestion for further work that can be accomplished in conjunction with the improvement of undergraduate STEM education.

Recommendations to Improve STEM Undergraduate Education at UNM

One of the final questions posed to interviewees was directed towards recommendations they could make to improve STEM education at UNM and to short comments that the students would offer the university president. A selection of paraphrased key recommendations follows.

1. Develop a general philosophy of the type of student that UNM wants to produce and what the university wants them to do.
2. Restructure work study awards to integrate undergraduates more quickly into the disciplines they are pursuing
3. Develop an efficient structure to support the employment of Peer Learning Facilitators (PLFs)
4. Incentivize excellence in teaching.
5. Develop a summer math "boot camp" to support entrance of incoming freshman.
6. Provide intensive and holistic achievement.
7. Expand College of Engineering model of career development to other disciplines and lower division course.
8. Provide much more career exposure to undergraduates.
9. Institutionalize effective approaches that have received grant funding into the UNM organizational structure.
10. UNM needs to establish a goal orientation structure.
11. Hire more faculty.
12. Establish the STEM Collaborative as a formal mechanism within UNM as a visible and integrating presence.
13. Take concrete steps to correct the math under-preparedness of entering freshman.
14. Change the tuition model tied to the Lottery Scholarship, allow temporary opt out instead of full loss when faced with either a personal or family emergency.
15. Develop a well-structured, competently staffed, and adequately funded math testing/placement center.
16. Develop a mechanism to intervene for students in the wrong major and provide guidance to get them into a field with better alignment to the capabilities and competencies.
17. Create or make more accessible various databases on student performance that can inform instruction and grant writing efforts.
18. Provide more release time for professors to engage in team building and faculty learning communities.

Student Comments to the UNM President

In closing out the focus groups, students were asked to make a comment to UNM President Frank, not all students provided one.

1. Make more opportunities available to non-citizen students. Introduce us to various working environments and reduce the focus on classroom activities.
2. Make more scholarship funding opportunities available to non-citizen students.

3. Revamp the curriculum of the Psychology Department. I am currently in my senior year and taking four courses that overlap topo much.
4. Provide more financial aid. Even though UNM is a major bargain compared to other schools it is still expensive to attend.
5. Provide advisors who can help students in ways beyond just monitoring course sequence and completion, especially for pre-med students.
6. As part of the orientation experience have students be clear about what degree they want to pursue and why. Provide more grounding experiences to students to ensure the fit is right.
7. Expand online and summer course offerings.
8. Reduce the math and science requirements for social science majors.
9. Provide more support for people going into STEM fields because they are rigorous courses and sometimes can be overwhelming.
10. If a student is going to major in a science they need to have proper advisement to make sure they are on track to graduate in four years. (From a fourth-year student who received incorrect advisement when they first started at UNM).
11. Fix the UNM website, it is too cumbersome to use, especially during registration.
12. Make more scholarship funding opportunities available to out-of-state students.

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