The essence of Integrating Research, Engagement, Assessment and Learning (iREAL) is to elucidate the difficult relationship between University economics and the mission of higher learning, and realize the potential opportunities this provides. As befits FIU, three of the four parts of the iREAL acronym stand for evidence based institutional practices associated with higher learning.

The fourth part of iREAL, Engagement, has historically been one of our strengths, as FIU has grown up at the crossroads of myriad cultures and national economies. In addition our unique environment facilitates countless opportunities to be global leaders in the quest to deal with climate change and the changing global economy. We see a strong future, as interdisciplinary collaborations will be needed to address the multifaceted issues facing our planet.

Just as Miami is the epicenter of global change, FIU should be an epicenter of global change studies. Our responses to the questions posed for the new strategic plan aim to address the ample opportunities we have for sustaining and augmenting our growth, intellectual capital, and prominence as leaders and innovators in a changing world.

I. Education and Pedagogy (Questions 1, 2 & 3)

Today's societal, scientific, and technological changes are transforming the nature of teaching and learning. Phenomena ranging from the digital revolution and globalization to emerging knowledge about the mind/brain should inspire FIU to re-imagine what matters most to learn, by whom, and how, in order to thrive in today's world. Additionally, traditional life long career paths have become more challenging as the job market becomes more dynamic in response to a rapidly-changing world.

We should seek to advance new learning concepts, explore their implications for educational practice, and nurture a generation of informed scientists and education visionaries. An environment that addresses the needs of our non-traditional student base will help improve 6-year graduation rates and result in successful job placement. This environment should capitalize on group-learning principles and digital technology to prepare leaders in science for their changing role in the 21st century.

<u>Change in delivery of education:</u>

1. Larger numbers of students, rising costs, declining state support, fewer professor-student interactions, massive open online courses (MOOCs), a challenging job market upon graduation—our students are experiencing a rapidly-changing world, and a job market that is more dynamic and uncertain than ever before.
2. These changes have been intensified by the exponential speed of technological advancements. Education delivery and assessment must reflect the interaction between the physical and virtual worlds our students increasingly face and embrace.
3. As leaders in education and research, and in light of global change, we must be bold enough to evaluate whether or not we are preparing our students for the world of tomorrow. A recent poll indicated that while 96 percent of university chief academic officers said they were

confident in their institutions ability to prepare students for success in the workforce, only 11% of business leaders strongly agreed (http://www.usnews.com/news/articles/2014/02/25/education-leaders-say-its-time-to-rethink-what-a-college-degree-promises). While this is a complicated issue that cannot be captured in a single statistic, this level of apparent disconnect should be troubling.

4. One major driver of change in the delivery of educational services is economics: the economics of sustaining the University and the economic reality our students face. We are at a critical crossroads for the continued success of higher education: visionary changes are needed in both what and how we teach in order to prepare students for an emerging job market (detailed in part 3, *Sustainability*).
5. Online courses and programs may serve a segment of our non-traditional student population, but the majority have a greater than average need for a high-touch educational experience. Institutional support for innovative pedagogy can result in a university experience that blends technology and meaningful personal experiences (detailed in part 3, *Sustainability*).

Change in assessment of education:

1. The major driver of change at all levels of the university revolves around a model based on continuous growth. However, this rapid growth plan is resulting in a dramatic decrease in faculty-to-student ratio with a direct impact on the ability to assess learning. In many cases, assessment has been reduced to multiple-choice exams, with the rare exceptions in small enrollment upper division courses that allow faculty to conduct thorough, individualized assessment of learning rather than, in the worst case, scoring rote memorization of disparate facts. In the context of rapid growth, assessment of learning will require the development of technological and pedagogical platforms and tools that will enable more complex evaluation of critical thinking skills.
2. An increase in enrollment may be realized by offering university credit to students for successful completion of on-line courses taken before matriculating into a state university system. This could jump-start the learning process and draw more students into undergraduate degree seeking programs. If adequately assessed, these on-line courses could fall under the same category as Advanced Placement (AP) credit for approved courses taken in high school. Used this way, on-line courses may add incentive for enrolling into a degree-seeking program, while decreasing the financial burden and length of time for degree completion. However, just as advanced placement does not replace in-person interactive instruction by university professors, neither can nor should on-line courses attempt to do so.
3. Older non-traditional students who need to retool their skill set to compete in today's job market may increase total enrollment, if given the incentive of credit for prior learning and competency-based assessment.
4. Create assessment tools that measure learning of skills required to perform jobs in current and emerging markets (e.g., online literacy, molecular and cellular biology, bioinformatics, global economics, climate and environmental change solutions and mitigation, ecologic and/or market unpredictability, etc.). Ongoing assessment of this nature will allow us to adapt our courses to an ever-changing world.

5. Facilitate a cross-disciplinary collaborative process: Initiate a dialogue with colleagues whose research on the changing nature of learning embodies perspectives ranging from biology, anthropology, cognitive development, and neuroscience to new media studies and design. We can create a design environment to function as a modest trading zone for faculty ideas (Gardiner 2014). This type of collaborative exchange will likely result in more effective assessment strategies than that of any single department.

Innovations to improve graduation rates:

1. Acknowledge our atypical student population: Establish a half-time pool for students who work full time or have other obligations. Requiring such students to take a full-time course load greatly increases the risk that they will not complete their degree (Orszag et al. 2001). To remedy, facilitate scheduling and financial aid for half time students. Although this pool of students could not be expected to graduate in the four-six years expected of residential college students, this adapted metric of graduating within 8 years would be more realistic and could substantially increase subsequent career success.
2. Adopt a translational approach: build on available research on the Scholarship of Teaching and Learning (specifically active learning and group and digital learning environments), adapting to meet practical instructional goals (Hassard 2005; McNeal and D'Avanzo 1997). Encourage and reward teaching that enacts these innovations.
3. Disseminate resources on the future of learning and innovation: because of its very focus on the changing nature of learning, group-learning endeavors should have a space (e.g., Google docs or Google drive) populated with documented examples of research-informed and learner-centered instructional innovations, videos and assessment tools. This can serve as a resource center for faculty to share successful strategies to increase student learning.
4. Create an enhanced first year experience course that would be an innovative orientation to higher learning. This would begin to contextualize the interconnectedness of the varying disciplines and introduce students on how to think rather than on what to think.
5. Develop gateway courses to promote success in foundational and more advanced STEM courses.
6. Expand apprenticeship and research opportunities for students to build a learning community and establish supportive relationships with other students and faculty. Stimulate networking in students' professional communities of interest. This may be imperative for first time in college (FTIC) students who have not had role models in the professional arena (Arum and Roksa 2011). Seek ways for such experiences to provide part-time income, so that working students can also participate. FIU has a diverse student body and has a large number of underrepresented STEM-interested undergraduates. Practical and interpersonal experience decreases attrition of minority students and increases their productivity years after graduation (Eisen et. al., 2005).
7. Redesign classrooms to facilitate group learning.
8. Set up learning centers for high enrollment courses, along the lines of those at UC Davis. There, each introductory biology course (BIS 2 series) has a dedicated room where all professors and TAs hold office hours. Each of these learning centers has multimedia

teaching aids, sample lab practical exams, and living and preserved biological materials available for hands-on use.

9. Maintain and support a variety of teaching modalities to increase our 6-yr graduation rate of FTIC students. Multimodal pedagogy enhances learning by increasing concept resonance and retention (Gruenwald 2003; Fink 2003). Expand the offerings of the Center for Advancement of Teaching, and offer incentives for faculty (e.g. teaching credit for lecturers) to learn and implement innovative and effective teaching methods.

II. The Economics of Education (Questions 4, 5 & 8)

Traditionally universities were built on instructional revenues. However, dramatic changes in the ratio of administrators, faculty and staff (Nissen and Zhang 2011), in conjunction with a trend of diminishing state appropriations (Curtis and Thornton 2013), warrants the restructuring of a system that can no longer bear its own weight. In the report, *How FIU Spends Its Money*, Nissen and Zhang (2011) identify the changes in FIU's university personnel profile. A few pertinent numbers follow.

FIU at large:

- "The rate of growth in total faculty salaries 9%... admin salaries 11.8% from 2008-09 to 2010-11, and nowhere near enough to undo the massive shift in monetary resources to administration (257.7%) in the previous decade."
- Percent change over 13 yr. period (1997-98 to 2010-11):
  % growth in # administrators: 160.6%
  % growth in # faculty: -2.6%
  % growth in # students: 60.9%
- Percent change over 2 yr. period (2008-09 to 2010-11):
  % growth in # administrators: 10.2%
  % growth in # faculty: 4.2%
  % growth in # students: 10.7%

CAS numbers for the Department of Biological Sciences:

- AY 2006-07 48 faculty 978FTE # students 1821
- AY 2013-14 51 faculty 1,422 FTE # students 4219
  % change in faculty……..6.25%
  % change in FTE……45%
  % change in students…...132%

In addition to changes staff allocations, state support for education is being reduced to unprecedented levels. Over the years from 2008-2013, the State of Florida experienced a net change in state appropriations of -31.3%, the 4th worst in the nation (ahead of Arizona, Louisiana and Alabama; Curtis and Thornton 2013). A nation and society generally become stronger and more competitive on a national level when its citizens are educated, yet state funding continues to decline. Given the change in university composition and the pressures of state funding, new innovative ways of raising much needed capital are necessary in order to sustain the university as

an institution of higher learning and an essential educator of future leaders and thinkers of our country.

The focus should not be on validation in "less expensive ways than ever before" but rather in understanding the necessary shift in paradigm and restructuring of a system that must adapt to changing environs while continuing to be an institution of higher learning.

While pedagogic strategies are addressed elsewhere in this document, the framework to actualize the changes needed to retain and improve student performance lies in the economic structure of the institution. Resources lost when students drop out are irreplaceable. In addition, the impact FIU can have on our community, both locally and globally, is diminished. In order to support pedagogic reform and assessment, teaching that will be effective and have an increasing impact on students learning needs to be incentivized and rewarded throughout the administrative hierarchy.

Changing economic model:

1. The university cannot survive under the cost-cutting model. Research and teaching for learning simply doesn't pay off in a way that is consistent with this economic model. A broader social commitment to educate critical thinkers and global leaders is essential to establish the health of our university, society at large, and the planet.
2. There is a fundamental trade-off between inexpensive degrees and a high quality product. We invariably face a compromise, and must choose wisely.

Potential solutions:

1. Improve 6-year graduation rate by improving learning and student engagement. Much attention has been given to the national push to improve 6-year graduation rates as one way to improve the health of higher education. Yet realities expressed in the President's Council of Advisors on Science and Technology (PCAST 2012) indicate that fewer than half the students who enter college majoring in one of the STEM disciplines will graduate with a STEM degree. Of those leaving STEM, the majority will be women and minorities. In light of these disturbing statistics, several universities nationwide (University of Maryland, UC Berkeley, Northwestern University) have initiated programs aimed at increasing retention of STEM students. These successful programs have three things in common:
    a. Early research experiences
    b. Active learning in introductory courses
    c. Fostering STEM learning communities (Graham et al, 2013).
2. Increase revenue using the expertise of administrators. Given the incredible pressures created by changes in research funding and the dramatic increase in the student body combined with a less than modest increase in faculty, the task of fund raising needs to fall squarely on administrators (who will also be better prepared to perform this function).
3. FIU is in a unique position for raising funds to support innovative teaching and learning because of:

a. FTIC (first time in college) students who will go on to be productive, contributing members of our community

b. Diversity of our student population – allow possibility of many different types of liaisons and varied interests for different types of fund-raising opportunities in the future

c. Diversity of our students' parents – same as above

d. Diversity in population implies a wide range of income levels, requiring a variety of fundraising strategies.

4. But…in order for these opportunities to be available to us, we (the faculty of FIU) must be supported in our efforts to provide a meaningful educational experience to our students. This will create loyalty and gratitude to the institution that helped them develop during formative years. As recently seen in the English department, the relationship between a student and a faculty member resulted in a gift of $400,000.
5. In implementing a sustainable campus, FIU would realize substantial savings in energy costs, and potentially huge increases in income in the form of grants and donations to support this cutting edge transformative model. There will be plenty of entrepreneurial opportunity as well in such a model—with shared profits and the desire to give back to and sustain the institution that made it happen.

III. Sustainability (Questions 6, 7, 9 and 10)

FIU is ideally situated to be an epicenter of global change studies because Miami *IS* an epicenter of global change. Numerous urban theorists have identified Miami as a city that is highly sensitive to global processes of change (Nijman 2007, Taylor et al. 2003), characterized by a unique and paradoxical set of conditions and forces. Situated at the southern, subtropical portion of the Florida peninsula and bordered by two national parks, the area boasts unusually high levels of endemic biodiversity. Rapid urbanization, however, has produced "one of the highest concentrations of species vulnerable to extinction in the U.S." (Brody 2008). Our coastal, subtropical location has in many ways fueled Miami's phenomenal growth, yet it is also the city's Achilles' heel. Miami is a "gateway" city, the primary world city through which Latin America and Caribbean nations connect to circuits of global trade, banking, and corporate decision-making. Yet the Organization for Economic Cooperation and Development ranks Miami as the world's most vulnerable urban region in terms of assets exposed to coastal flooding and fourth in the world in terms of population exposed (Nicholls et al. 2007). Projections for global warming and sea-level rise indicate an intensification of these vulnerabilities.

Despite this vulnerability, we have not yet begun to prepare, locally or globally. Climate change is the greatest challenge we have ever faced as a species. The relentless reports of record-breaking global temperatures, sea level rise, and extreme weather contrast with business-as-usual by governments and corporations, and denial by a majority of the US public. Meanwhile, unsustainable and economically costly biodiversity losses continue, accelerated by climate change and ultimately, by our current lifestyles and daily practices.

Our lives, and especially the lives of our students, will be affected profoundly by these global changes. The choices we make in the coming years will determine the future of our planet, and perhaps whether our civilization survives. As a major educational institution on the local and, increasingly, national and international levels, **FIU can be a leader** in educating our students and community about the magnitude of the changes that are expected, and in proposing, discussing, and testing innovative and entrepreneurial solutions. A major component of the 2016-2020 master plan should be to **develop FIU as a living laboratory for climate change and biodiversity research, education, and solutions**.

Next Horizon research:

1. Hire and train the next generation of sustainability scholars in all disciplines—not only natural science, environmental science, and technology, but also statistics, complex systems, sociology, urban studies, architecture, engineering, psychology, anthropology, political science, economics, journalism, business, law, arts, and literature. Encourage interdisciplinary research and teaching through establishment of global centers and interdisciplinary degrees.
2. Establish an innovative, interdisciplinary sustainability research institute along the lines of the famous Xerox PARC (Gladwell 2011) or Santa Fe Institute (Waldrop 1992)—to explore truly cutting edge sustainability ideas like living solar panels (Rosenbaum 2005) or CO_2 sequestration as graphene (Chakrabarti 2011), as well as the major societal and economic changes needed.
3. Emphasize advanced biofuels research:
    a. Grow and test various species of algae for biofuel production, both coastal and offshore (BBC), and in bioreactors and open ponds. Focus on innovative, locally useful (e.g. tropical) approaches not being studied elsewhere.
    b. Grow and test advanced terrestrial biofuels that would not need irrigation or fertilizer, could grow on marginal (non-agricultural) lands e.g. as street trees or on brownfields, and would not be food. Examples: Jatropha (*J. curcas*), Honge (*Pongammia pinnata*). Identify and test promising new tropical and subtropical urban biofuel crops.
    c. Establish a demonstration farm or plot on campus (or at another location) for education and outreach.
4. Rapidly develop a major interdisciplinary research initiative to study sea level rise and saltwater intrusion—to explore both stopgap (e.g. through effective Everglades restoration) and long term options for ameliorating the effects of rising sea level. South Florida is ground zero for sea level rise, so it is both logical and economically imperative that we lead in this research.
5. Support tropical disease research: being at the crossroads of international travel in the tropics and already having innovative research in the area of tropical diseases and their transmission, FIU is the ideal location for maximizing results and benefits in this arena.

Living Laboratory solutions:

1. Generate all energy used on campus by renewable means by 2020. Solar panels on rooftops, windmills (especially for sites near the coast such as BBC). Power all campus vehicles with sustainable (advanced or 3rd generation) biofuels.
2. Conserve fresh water on campus. Capture rainwater in cisterns. Recycle all wastewater using biological treatment e.g. Living Machines (Chen 2008). Use gray wastewater to water plants, as is routinely done in Southern California.
3. Design all new buildings and adapt old to withstand frequent flooding, to prepare for likely scenarios and to serve as an example for flood-prone regions worldwide.
4. Make all campus buildings energy efficient, and realize maximum energy cost savings. Meet—and exceed—top LEED standards where possible, with e.g. windows that can be opened, ceiling fans, and air conditioning used selectively. Install advanced energy saving and smart lighting such as LEDs. Conduct economic analyses, followed by monitoring and evaluation as buildings are updated, to show breakeven points and return on investment.
5. Grow all food that is consumed on campus organically and sustainably—some right on campus, and the rest contracted to local start-up urban farms. Plant crops and fruit trees on all available unused spaces on campus (See Green Diary 2014 for a NYC version of this idea). Enlist community organizations e.g. TREEmendous Miami to plant the trees. Implement aquaculture and explore alternative protein sources, e.g. micro- and macro-algae, duckweed (*Lemna* spp.), and insects (Van Huis et al. 2013).
6. Convert surface parking lots to agriculture as the use of cars is consolidated and reduced (see #8 below). Use and demonstrate agroforestry, edible landscaping and integrated food production systems.
7. Rethink mass transportation to campus and regionally. Do computational network analysis to improve service by mapping out a new system of low cost Bus Rapid Transit (BRT; Goodman et al. 2007), including express routes to FIU. Business and SIPA faculty and students explore innovative funding, e.g. for immediate BRT and a workable long term plan to resurrect the Metrorail expansion, trolleys, etc. Collaborate with community groups e.g. the Purple Line (FAU 2013).
8. Minimize driving to campus by promoting and providing incentives for carpooling, and use of mass transit.
9. Actively involve students at all levels: research, development, and implementation.

<u>Entrepreneurship</u>:

1. Make the existing FIU "Eugenio Pino and Family Global Entrepreneurship Center" more active and visible. Increase education and mentorship of students, staff, and faculty.
2. Focus on innovative startups (urban farms, renewable energy, etc.), especially those run by students. Provide logistical support and business advice to the community of aspiring and active green entrepreneurs. Develop connections to funding agencies, "green and clean tech" venture capitalists, crowd funding, and microloans.
3. Organize yearly fairs in which students, staff, faculty, alumni would present their sustainable business ideas with outreach and networking within the business community.

4. Offer existing and new interdisciplinary business courses to science majors and others. Educate students on how to become an entrepreneur, and how an invention or an innovative approach to solving environmental (and other) problems can become a source of income.
5. Encourage and speed up commercialization of sustainability inventions and solutions by mentoring researchers, along the lines of the Purdue Deliberate Innovation for Faculty (DIFF) program (Purdue 2014).
6. Encourage a true entrepreneurship, where units within the university that take risks and put in the effort also reap a significant part of the financial rewards. This alignment of interests creates an environment where hard work and innovation are encouraged and rewarded. This might include, for example, return of a portion of IDC to Departments whose faculty are being awarded grants. Another example might be sharing the rewards of online course development. At Oregon State University (http://ecampus.oregonstate.edu/faculty/business.htm), they encouraged online course development by sharing the rewards to departments and colleges. In their E-campus funding model 10% of the profits go the central administration, 10% to course development with the remaining 80% going to the college and departments. In Zoology, for example 67% is returned to the Department. Not surprisingly, the Departments have responded very enthusiastically, the program has grown rapidly, and the money they accrue is used to build infrastructure, hire instructors, and enhance start-up packages for faculty.

Education and outreach:

1. Organize a major international symposium including high profile science contributors (e.g. James Hansen, James Lovelock), leaders (e.g. Al Gore), and social visionaries.
2. Create an interdisciplinary Global Learning course required for all FIU students, to explore global change causes, consequences, and solutions, and the conservation of biodiversity and ecosystem services. Include examination of the requisite change in culture.
3. Offer a Certificate or MS degree in Climate Change and Biodiversity Solutions. Cultivate the critical thinking skills needed to enact sustainability under unpredictable scenarios.
4. Develop a University Project to transform our approaches and culture related to energy and resource use. Incorporate the value of ecosystem services (e.g. Duarte 2008) into all economic planning and decision-making.
5. Preserve and create examples of natural and nature-friendly ecosystems on campus, and use them for education and outreach to help transform attitudes (Miller 2005). Continue the improvements to, and educational expansion of, the FIU Preserve. Make campus 'ponds' into Everglades mesocosms, complete with native plants, fish, and water birds.
6. Facilitate hands-on workshops for all students, faculty, and staff to learn sustainable skills such as agroforestry, urban farming, water re-use, energy savings, etc. that can be applied at home and in our neighborhoods. Taught by faculty, students, and staff in a "free university" model. Collaborate with the Pino Center for entrepreneurship workshops.
7. All research and solutions projects will have education and outreach components, with students as docents and organizers. Establish a major collaborative effort with Miami Dade schools, along the lines of (or in collaboration with) the Fairchild Challenge. Organize a

major sustainability fair each year as an open house to the community, to demonstrate ideas and educate, along the lines of Picnic Day at UC Davis.

8. Pursue outreach to identify, collaborate with, and seed similar programs at other universities and in other communities. Build on our strong connections with Latin America and the Caribbean in establishing such collaborations.

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