GENESIS TO THE DEMOCRATIZATION

OF A

NATIONAL RESEARCH AGENDA FOR, BY, AND ABOUT SCHOLARS OF COLOR:

TRANSCULTURAL TRIANGULARITY IN SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS

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A Concept Paper for Discussion

ABSTRACT

This essay calls for a *national democratized research agenda* to: First, expand opportunities for research by minorities in science, technology, engineering and mathematics (STEM) among three *transcultural* alliance of institutions of higher learning with the *triangular* representation of African-Americans, Hispanic/Latino Americans and Native American Indians; Second, facilitate the involvement of minority-serving institutional faculty and students in grant development, faculty development, curriculum planning, and published scholarship in science, technology, engineering and math (STEM) disciplines; Third, provide opportunities for triangular institutions to enhance intellectual diversity and collaborate on efforts to advance educational, economic and entrepreneurial advancement throughout the United States; Fourth, provide opportunities for minority-serving institutions to develop a national research agenda and create faculty-student mechanisms within the workgroup triangles; And fifth, develop everlasting geneses, vitality and sustainability toward the full spectrum of teaching and research opportunities for students and faculty at minority-serving institutions initially throughout the United States and, ultimately, throughout the world. This entails the culmination of all five areas to result in a national research agenda. The essay recommends measurable metrics and plans with anticipated demonstrable results of potentially *ten deliverables as stretch goals for implementation success*.

I

In Science, Technology, Engineering and Mathematics

The American Association for the Advancement of Science (AAAS) and the National Action Council for Minorities in Engineering (NACME) recently sponsored a national forum in Washington, DC to identify strategies for improving and sustaining the representation of ethnic minorities particularity those of economically disadvantaged background, and in the disciplines of science, technology, engineering and mathematics (STEM). Among the calls for action that emerged from the forum were: (a) improving research methodology in the STEM disciplines; (b) improving research linkages in the STEM disciplines; and (c) exploring new research areas for the STEM disciplines. The forum highlighted the devastating implications and devastating impacts of continued ethnic minority under-representation in STEM, in light of the recent U.S. Supreme Court rulings on affirmative action. This essay suggests a national intervention by national associations and other concerned groups representing the K-12 sector, academia, technology, business and industry, global commerce and public policy. This essay calls for a *National Consortium for Transcultural Triangularity in Science, Technology, Engineering and Mathematics* **(NCTT-STEM)** that could emanate from a series of collegial communications, and from the national forum. Principal academic and administrative representatives would participate from three different "types" of premier institutions for higher learning, representing three key but different, "sectors" populations: a historically Black institution, a Hispanic serving institution; and, a tribal college. This essay is presented at a time when federal agencies and corporations are increasingly placing a high premium on collaborative research and development initiatives submitted by "peer" (historical/cultural) and "parallel" (Carnegie-classification) minority-serving institutions, to support consortial-type alliances for academic, scientific, and technological infrastructure development. These three different institutions would be pioneers toward the advancement for, by and about future scholars of color. Additional partners could be added over time as this national movement

develops. The term "transcultural triangularity" also describes a curriculum transformation initiative at Jackson State aimed at providing faculty development incentives to professors who infuse three cultures into course syllabi and classroom instruction. Although this essay illuminates the microcosmic dimensions of a "national" context in its initial conceptualization, following implementation of the proposed Institutes, a second project could be formulated to extend to collegiate populations in "transnational and international" venues. In both cases, the premise is that postsecondary institutions work better in concert than in competition.

Such synergistic and collegial alignments should be consistent with each institution's mission and commitment to providing stimulating and engaging learning and research environments for diverse students and faculty. Concerned stakeholders from each institution would interact, to formulate alliances to shape progress within the STEM pipeline, curriculum, programs, activities and related services for underrepresented, under-prepared, and underserved minorities. Each participating partner institution would represent diverse perspectives, frames of reference, ethnicities, ideologies, and socio-economic backgrounds. Each institution should be required to have a balance of complementary academic programs, trans-disciplinary approaches, and co-curricular and extra-curricular activities that are designed to optimize academic, personal and professional development of both students and faculty. The faculties and administrators at the institutions must be dedicated to assisting, guiding and mentoring students of color in the sciences, as well as in the liberal arts, which provide the foundation and axiological anchor for scientific thinking. Towards this end, measurable objectives and action plans should be developed for trans-cultural curricular infusion and research exploration.

Measurable Goals and Metrics

This essay focuses on primary stretch goals, with accompanying measures, to mitigate the severe under representation of ethnic minorities in STEM and provide the basis for sustaining representation of ethnic minorities in the STEM academic pipeline. First, the design, development and implementation of curricular-centered articulation agreements among the sectors for student matriculation from the undergraduate to graduate levels in STEM disciplines. To this end, "points

of progress" should be distinguished as: (a) recruitment to retention; (b) matriculation to retention; ©) matriculation to graduation; and (d) graduation to placement in graduate/professional school, the American workforce or the professoriate. The goal in this regard is to develop articulation agreements by HBCU, HSI and Tribal College students from undergraduate to graduate levels. Second, the design, development and implementation of credit-bearing programs and services, based on intra-institutional capacity, comparability and capability, that lead to the points of progress through awarding degrees at the (a) associate degree level; (b) bachelor of arts and/or science level; (c) master's or specialist level; (d) the terminal doctoral level; and (e) the post doctoral-level. Finalized agreements or memoranda of understanding (MOU) should identify all requisites for the culminating success of students who are enrolled in these upward, hierarchical agreements and for the faculty who teach in specified STEM disciplines. This packaging (or alignment) should not be limited to in-class or on-site instructional deliveries within these collegial triangular arrangements. Off-site, online learning and other electronic or asynchronous networks will be included in the STEM areas and other liberal arts programs of study. The goal here is to design academic programs for HBCUs, HSIs and Tribal Colleges that lead to degrees at the AA, BA, MA, and Ph.D. level through clear articulation. All three sectors should use both the points of progress by students and faculty, and the packaging of academic programs as the business operations system for advancing a **national democratized research agenda**. Third, the design, development and implementation of a trans-cultural student and faculty grant proposal writing and exchange program to integrate all three sectors for mutual academic benefit, with particular emphasis on the creation of triangular agendas that focus on: (a) theoretical and applied innovation in STEM disciplines; (b) entrepreneurial strategies for research transitions from academia to patent status or commercialization; and (c) a practical framework and applicable template for facilitating the scientific design, methodology and manifestation of progressive research–ranging from applied and action orientations to pure and basic orientation. The goal here is to provide participating interactions among HBCU, HSI and Tribal College colleagues with the context of the compelling STEM areas that bridge research ideas with funding.

Cultural-Collegial Cohort Consortia

This conceptual essay suggests an analysis and subsequent development of a framework for STEM research studies for future investigation, discovery, inquiry, intervention and dissemination.

For this concept, a work-group of colleagues from each institution should initially assemble to discuss and explore how a transdisciplinary, results-based effort could augment current undertakings throughout the country in areas related to STEM participation, persistence, development and advancement. Once these colleagues have agreed upon the concept, they should begin to design a national action plan that would have everlasting, systemic and positive impact upon these institutions, their missions, campus life and their external constituencies. The impetus for these discussions should center on the following themes for public good–especially in urban communities with high density populations of ethnic minorities and people of color:

- National/Homeland Security and Global Positioning
- Economic Advancement and Workforce Development
- Social Justice and Educational Disparity
- Health, Welfare, Service and Community
- Intellectual Capital and the Future Professoriate

The last area has a direct link to under-presentation in STEM. The discourse surrounding these themes will mean that various tasks and inquiries must be completed related to research planning and administration. Colleagues will eventually have to review and discuss national data and related information resources regarding accelerating science issues and related emerging technological impacts.

Response to a Call For Action

In these times of war and global conflict, the quality of academic life of the modern institutions of higher learning is determined, to a large extent, by their success or failure in laying a foundation for research-based critical thinking and data-driven or diagnostic decision-making particularly in but not limited to, the sciences and technology, amid the compelling demographic forces and issues

affecting minorities. For decades, researchers have forecast and forewarned institutions of the increasing diversification of students, as potential faculty and industry practitioners, in American higher education as the result of social, economic and environment. These oscillations, indeed, fundamentally relate to the nation's capacity and capability to function in a global and pluristic economy. Without a response to the earlier mentioned forum by national groups, and the thematic tenets of discussion by colleagues involved in this national movement, all of America's institutions are compromised and, indeed, jeopardized for progress in the future. Investing in intellectual and human capital is paramount. Untapped and unrealized ethnic minority populations can raise new issues for research innovations, investigation of new research angles, and contributions to the creation of new research and knowledge bases in the modern sciences and related technologies. This national concept should be at the axis of public policymaking and higher education planning in a world where all people must live, learn and *le a d* together.

In Probable Futures: How Science and Technology will Transform our Lives in Twenty Years, Marvin Cetron and Owen Davies (1997) projected some interesting conditions that could provide the genesis for compelling dialogue among transcultural scholars. They were as follows:

- A significant portion of energy usage will be derived from alternative sources, such a geothermal, hydroelectric, solar/photovoltaic
- Fuel cells, converting fuels to electricity will be commonly used
- Biological materials, such as crops, trees, and other forms of organic matter will be used as significant energy sources
- Fission, fusion and hydrogen sources will increasingly become energy and power sources
- Most manufacturers will adopt "green" methods that minimize environmental pollution
- One-half of the waste from households in developed countries will be recycled
- Genetic engineering techniques will be routinely used to produce new strains of plants and animals
- Automation of farming methods, using technology and robotics, will become more

common

- Urban production of fruits and vegetables using green houses and/or other intensive production system will become more common
- Super computers using massive parallel processing will become more commonly used
- More optical computers will enter the commercial marketplace
- Bio-chips that store data in molecular bonds will become more commercially available
- More communications systems in industrialized countries will adopt a standard digital protocol
- Material compositions will replace the majority of traditional metals in production design
- Gene therapy will routinely be used to prevent and/or cure an inherited disease

Given the proportion of ethnic minorities and people of color affected by cancer and AIDS, it is interesting to note that the authors predict "a cure or preventive for a major disease such as cancer or AIDS" will be found by "2015."

The World Watch Institute (2003) in Future Survey similarly highlights some world trends that affect STEM research:

- A world in which increasing numbers of people lack the means for a decent life
- A world in profound geochemical flux, where certain forms of pollution are altering the global chemical cycles that regulate ecosystems
- A world increasingly burdened by growing risks of toxic chemicals
- A world subjected to an unprecedented degree of biotic mixing
- By virtually every broad measure, a world in a state of pervasive ecological decline

Forecasting International (2003) in the Futurist and Future Survey also projects the following trends:

- Artificial intelligence will help most companies and government agencies to assimilate data and solve problems
- There will be continued growth and demand for scientists, engineers, and technicians;

countries like India, China, and Russia will continue to suffer a substantial brain drain

- Jobs created by high-tech exports are more than replacing those lost to competition under NAFTA
- Medical knowledge is doubling every eight years; severe personnel shortages are expected in high-tech medical specialities

Finally, Technology Review (2003) offers several predictions that could stimulate research interests with regard to emerging trends relative to wireless sensor networks, injectable tissue engineering, nano solar cells, mechatronics, grid computing, molecular imaging, and glycomics.

The Primary Challenge and Ultimate Outcome

This essay primarily focuses on providing an answer and call to action to the following challenge: *"How could, and should, peer and parallel minority serving colleges and universities leverage their collective resources and intellectual capital to promote, prepare, propel and place students of color into a pipeline for progress and research success in science, technology, engineering, and mathematics"?*

This is a simplistic, but particularly perplexing question given that it seems there is distinctive parochialism that dominates institutions in American higher education, and minority-serving institutional in particular as they compete for the same often limited resources available for their respective niches in the academic marketshare. That is, an intellectual and social isolation that reduces the effectiveness of faculty and limits the vision of students. The initial three institutions, and other institutions added later, must work toward collegial interdependence to mitigate against isolation, while respecting cultural differences and building on institutional similarities relative to approaches for modern higher learning in an increasingly competitive marketplace. Student success must be at the core and center of ongoing development and growth. The success of this triangular response for a national agenda must be defined within the scope and parameters for points of progress through academic packaging of programs in the sciences and technology. The methodology suggested in this essay for facilitating points of packaging emphasizes transcultural

collaboration, training and development. During the first year, transdisciplinary *STEM Leadership Institutes* should be planned and established with academicians, graduate students and administrators, and led by national experts and scholars in STEM research and/or curriculum development. In subsequent years, over a cycle of three years, the institutions should expect the development and results of future cohorts. The Institutes would be administered on a different campus. The net result should be to develop the genesis for a national research agenda, placing all participating institutions at the forefront of academic innovation in STEM research development. These consortial efforts should serve as a "magnet" and precedent for drawing more and different Americans of color to debate, discourse, and deliberate about STEM scholarship and research. Research skills development, proposal writing and curriculum planning will aid the cohorts with developing frameworks and ultimately contribute to their success with formulating a national agenda. This type of transcultural triangularity could serve as a demonstrable prototype for other minority-serving, as well as predominantly non-minority colleges and universities. This outcome should be consonant with other national calls for action that seek to help students of color develop the capacity for scientific learning and the ability to adopt to changing technological conditions in a transcultural and interdependent world by insisting on the infusion of depth and breadth for critical thinking in the collegiate curriculum. These outcomes should be consistent with the creation of a much needed transcultural atmosphere that nurtures students and faculty, and are responsive to nationally-charged advocations for equity, quality, and access.

National Values, Under-Preparation, and Skills Development

The new, "modern academy," within the context of the new, "global economy," has been grappling with many complex educational, economic, environmental and technological challenges. The potential societal returns on dividends, benefits and manifestation in this national movement could serve as a pivotal nucleus for change in academic venues throughout the United States. Indeed, STEM research influences public policy, develops future leaders, improves quality of lives, and provides scientific aid to institutions, organizations, industry and government. The systemic development of ethnic minority representation in STEM is one of the most pressing needs in our

nation. But, STEM faculty at minority-serving institutions cannot educate students to learn basic research which is designed to discover the laws of nature, and applied research which is designed to put knowledge into practical use, unless faculty are properly prepared themselves. This proposal includes resources to achieve that balance. Faculty also cannot embark on STEM curricular reform that will improve systemic progress of students unless they have a common framework and/or template for research skills development. These skills should be addressed by the participating cohorts and should encompass the development of the teamwork, such as the following that apply to any group of students and institutions:

- What is a typical and fundable STEM research question or problem?
- What kind of plan is required for the course of STEM research design?
- What is a typical STEM research treatment or methodology?
- What is a typical sought-after hypothesis for STEM research?
- What facts and their meanings are related to a typical STEM hypothesis?
- What impact can research have on marvel, mystery and magnificence of STEM discovery in, particularly, urban settings?

These tenets arguably apply to academic investigation and cognitive exploration across all disciplines in the natural and social sciences. This framework will be determined by fundamental structures and premises with the goal of understanding them (basic research) in academia or structures and processes as they appear in practice against a narrow view of teaching. At its worst, this could develop students of color negative attitudes toward teaching and other cultures or perspectives. The teaching of STEM disciplines should indeed defy conventional and traditional academic boundaries, and faculty are thus challenged to consider scientific or technological problems that stretch beyond their preparation until this goal of developing knowledge which is directly useful for practitioners (applied research) in the workforce is achieved, given new concerns for national security and sustainability which have sparked immediate interests in STEM research.

Of note, most faculties today were educated in a system and social order unlike those in systems

today with modern human diversity. As a result, certain conventional teaching styles should be re-examined by the cohorts for today's students of color with varying learning styles. This essay suggests there are several other pressures that led the authors to branch out to other minority-serving institutions and develop conceptual cohorts for constructing systemic frameworks with trans-cultural triangularity. Structures of curriculum should be designed to make the overall student and faculty experiences optimal for maximum teaching, research and service. Thus, faculty should be flexible, have trans-cultural interests, and share commitments that extend beyond narrowly-defined disciplinary boundaries. In short, each institution's curriculum, learning environment, and organizational structures transcend the boundaries that may have been barriers to minority students' success at other conventional colleges and universities.

The STEM Leadership Institutes

The authors propose the conceptual organization of STEM Leadership Institutes for the cohorts as the main component of this national movement. The Institutes should focus on the sharing of cutting-edge, state-of-the-art approaches and strategies for fostering educational advancement in STEM disciplines through transdisciplinary investigation by many different ethnic, cultural groups. Faculty and administrators should create transcultural, "team taught" courses that focus on the latest programmatic, theoretical, or empirical developments related to the propensity of teaching and research in the STEM domains. Each week of the three-week Institutes should primarily focus on the area identified in the following themes: First, a workable STEM student/faculty research paradigm and framework on survival skills for the modern researcher in today's global society. Second, STEM research needed for today's urban environment and quality of life in the new global community. Third, research applications, definitions and treatments (historical, descriptive, developmental, case study, basic, quantitative, qualitative, quasi-experimental, true experimental, causal applied, correlational, etc.) developed in a typical STEM research project. Fourth, STEM research methods for improving conditions identified in Section III and the promotion of national interest through transcultural triangularity and diversification of ideas and innovations. Fifth, the important but different contributions of various ethnic groups

to the advancement of STEM research, and the recognition of different learning styles.

These themes will be addressed during three-week sessions of the Institutes, one issue each day, along with, and against, related components within the realm of research questions, priorities, or methodologies unique to different cultural groups. The format of each day should be the following:

Morning

(a) A seminar led by a recognized, national expert in one or more of the STEM disciplines.

(b) Subsequent group discussions among faculty and students led by one of the leaders from the cohorts who is knowledgeable about the specific area.

(c) A summary of group discussions regarding major elements of theory and practice.

Afternoon

(a) A review and examination led by a second cohort leader of the topic relative to a research area.

(b) A review and examination led by a third cohort leader of the topic relative to a research area.

(c) An evaluation of the day's program with focus on results for the measurable metrics.

These suggested Institutes must clarify the transcultural *and* transdisciplinary nature of STEM research and associated issues to matriculation and minorities in the STEM pipeline. To this end, the Institutes should integrate well into each institution transdisciplinary traditions that will underline the collective intellectual capital of each institution, as well as those intellectual and diverse reservoirs of knowledge and expertise for other minority institutions. These multiple, three-week Institutes will enable minority partnering institutions of higher learning to start major national movements toward systemic reform in STEM research. All faculty and students who attend the Institutes should be assured to receive an overwhelming, insightful, enlightening, and engaging learning experience in both research and transcultural development dimensions of academia. It must be emphasized that this trans-national approach to a national dilemma is long overdue for

academia.

The Institutes should create, perhaps for the first time, a direct synergy between points of progress, academic packaging, and research agenda development among minority-serving institutions that foster short and long term STEM student and faculty growth throughout the United States. Past experiences with similar Institutes indicate that these fora serve as catalysts for pedagogical integration.

Recap, Evaluation and Support

Complementary and consistent with the strategic agenda, mission, values and vision of most institutions, the suggested NCTT-STEM should be developed to achieve academic excellence through the academic program deliveries and research exploration. The NCTT-STEM should aim to create collaborative prototypes for improving research methodology, improving research linkages and exploring new research areas. The following describes demonstrable *indicators* that will ultimately serve as evidence when the participating institutions and other minority institutions know when and where they are successful:

- When more ethnic minority students have been recruited, retained and graduated from the participating triangular institutions in significant numbers.
- When more ethnic minority students have conducted STEM research that leads to publishable, scholarly work in peer journals in significant numbers.
- When more collaborative work has been designed and developed by the triangular faculty with regard to STEM curriculum planning and academic program articulation in significant numbers.
- When more ethnic minority graduate students have become faculty members in the STEM and contribute to the intellectual capital of America's future professoriate in significant numbers.
- When more ethnic minority students and faculty have participated in triangular exchanges, learned from each other's cultural experiences within sectors, and have conducted mutually beneficial research in the STEM areas in significant numbers.

The Institutes should be designed to facilitate ever-growing groups of colleagues who will seek to influence the awareness, opportunities, knowledge base, and relevant decisions at other minority-serving institutions. Faculty engagement in this integrative process should receive sufficient institutional advisement and support/supplementary resources from the participating institution. The Institute's agenda should aim to reach a broad-based consensus in shaping definitive plans of action toward developing America's future professors, scholars and researchers. These movements by the cohorts could further enhance efforts toward integrating research into both curriculum and laboratory activities. This effort should be especially significant, meaningful and substantive to overall systemic issues on the campuses. In addition to this type of curriculum impact, this NCTT-STEM could broaden the faculty ranks and enlarge the limited pool of available minority professors in the nation.

The stakeholder participants, as well as the cohort leaders, should evaluate each of the multi-theme days of the three-week Institutes. The evaluations should assess the success of each portion of the Institute and the effectiveness of the strategies, approaches and methodologies that are to be used. In addition, the faculty participants should evaluate the Institutes as a whole. These assessments will be invaluable for designing the second international, "macrocosmic" proposal. The Institute's principal investigators should evaluate the Institute's success indicators against calculated measurements, metrics, and milestones. The evaluation should include the design of pre-post instruments to measure the enhanced research competency and level of engagement among the cohorts. The evaluation plan will follow the usual accreditation guidelines. The results should be summarized annually and submitted for review by both internal and external evaluators. The proceedings from the Institutes should also be available to the public and disseminated to all minority-serving institutions in the United States. These reports, compendiums, and proceedings will be available on each institution's website. The Institute participants should produce and submit scholarly articles, regarding the NCTT-STEM, to appropriate professional and educational journals.

Each participating institution should also contribute the following toward the Institutes:

- Release time for the principal investigators.
- Priority will be given (release time) to support participating faculty research and scholarship.
- Support for scholarships of participating graduate students.
- Support for co-curricular and extra-curricular programming related to research.
- Support for growth in the relevant library resources and references.
- Support for purchase of related instructional materials, software, web-based supplements.
- Clerical support and secretarial assistance.
- Sponsorship of repository holdings of the Institute's deliberation.
- Sponsorship of facility, space, and physical plant support.
- Support for printing and duplication costs resulting from the Institute's reports and proceedings.
- Support for food service and housing for the three cohorts, every three weeks at the Institutes.
- Housing/storage of knowledge repositories for future generations.

As a democratized response to calls for action concerning STEM core values related to national/homeland security, economic and workforce development, social justice and educational disparity, the future professoriate and intellectual capital, and implications to health, welfare, service and community, the following measurement categories, and categorized goals should be targeted with expected deliverables. It should be noted that the goals must be *specific, deliverable, achievable, measurable, and time-based.* They are based on a format used at Lincoln University.

(1) By a specified time, the NCTT-STEM should complete formalized articulation memoranda of agreements (MOUs) among the participating institutions for minority student recruitment, from the associate degree or bachelors degree level to the postdoctoral level in STEM disciplines.

(a) Measurement Category: Quantity.

(b) Measurement(s): Increased enrollment, matriculation, graduation, and placement in STEM disciplines.

(c) Metric(s): Percentage of student persistence and progression.

(d) Milestone(s): Annual review of percentage rates (incremental).

(e) Deliverable(s): Formal STEM MOU'S.

(2) By a specified time, the NCTT-STEM should facilitate student and faculty exchanges among the participating institutions in specified and targeted STEM disciplines.

(a) Measurement Category: Quantity/Quality.

(b) Measurement(s): Increased number of exchange placements in targeted STEM disciplines and enhanced transcultural experiences.

(c) Metric(s): Number of exchange placements in targeted STEM disciplines and assessment of experiences.

(d) Milestone(s): Annual review of placement rates in STEM disciplines (incremental) and evaluations of exchanges.

(e) Deliverable(s): Student/faculty exchanges and transcultural experiences.

(3) By a specified time, the NCTT-STEM should complete formalized alignments of academic programs (on-line and in-class) that support the awarding of degrees at the associate, bachelors, masters, doctoral, and postdoctoral levels in STEM disciplines among the nine participating institutions.

(a) Measurement Category: Quantity/Quality.

(b) Measurement(s): Increased awarding of degrees of ethnic minorities to the STEM disciplines.

(c) Metric(s): Number of degrees awarded in STEM disciplines.

(d) Milestone(s): Annual review of graduation rates in STEM disciplines.

(e) Deliverable(s): Degree recipients in STEM disciplines.

(4) By a specified time, the NCTT-STEM should facilitate institutional collaborations for leveraging grant research and agenda development among the participating institutions in

the STEM identified research areas.

(a) Measurement Category: Quantity.

(b) Measurement(s): Increased number of grants and funding to support research.

(c) Metric(s): Number of grants and amount of funding.

(d) Milestone(s): Annual review of grant numbers and amounts (incremental).

(e) Deliverable(s): STEM funded grants.

(5) By a specified time, the NCTT-STEM should complete theoretical frameworks, prototypes or templates for successful STEM research methodology and execution of the applied/action or basic/pure levels. This should include the creation of a "knowledge repository" for collecting and organizing intellectual capital.

(a) Measurement Category: Quality.

(b) Measurement(s): Enhanced level of research understanding and increased number of frameworks, prototypes or templates.

(c) Metric(s): Scope and extent of framework application from theory to practice.

(d) Milestones: Annual review of students and faculty conducting STEM research.

(e) Deliverable(s): Research frameworks for STEM-specific application.

(6) By a specified time, the NCTT-STEM should develop action plans, among the participating institutions for innovative and entrepreneurial research that could lead to patents and commercialization.

(a) Measurement Category: Quality.

(b) Measurement(s): Enhanced level of research entrepreneurship, excitement and enthusiasm in STEM disciplines.

(c) Metric(s): Scope and extent of produced innovations that lead to application.

(d) Milestone(s): Annual review of students sand faculty working on entrepreneurial projects in STEM disciplines.

(e) Deliverable(s): Entrepreneurial research projects in STEM disciplines.

(7) By a specified time, the NCTT-STEM should develop transcultural teaching-learning style models (instrument), among the participating institutions that can be used to improve STEM instruction, research and service with ethnic minority students.

(a) Measurement Category: Quality.

(b) Measurement(s): Evaluation of STEM student performances, productivity and satisfaction.

(c) Metrics: Student evaluations of instruction.

(d) Milestone(s): Annual review of student evaluations and effectiveness of instruments.

(e) Deliverable(s): STEM teaching-learning model.

(8) By a specified time, the NCTT-STEM should prepare scholarly publications among the participating institutions for professional and educational journals in the STEM disciplines.

(a) Measurement Category: Quality.

(b) Measurement(s): Improved level of scholarly contributions in STEM publications.

(c) Metric(s): Scope and extent of accepted scholarship in academia.

(d) Milestone(s): Annual monitoring of planned scholarship.

(e) Deliverable(s): Published journal articles in STEM disciplines.

(9) By a specified time, the NCTT-STEM should develop survival guides and data bases for student and faculty conducting research in the STEM disciplines.

(a) Measurement Category: Quality.

(b) Measurement(s): Increased level of collegial collaboration and consensus.

(c) Metric(s): Number of student and faculty participation and contributions and the number of databases.

(d) Milestones: Annual review and discussions, drafted documents, and level of consensus.

(e) Deliverables: Published STEM books, monographs or compendium.

(10) By a specific time, the NCTT-STEM should develop a national blueprint for a democratized research agenda and a knowledge-based electronic repository that could serve as the impetus and genesis for stimulating interest, engagement and involvement among other minority-serving institutions, and storing related information resources relative to: STEM research and scholarship; student persistence in STEM academic programs; and placement of future professors in STEM disciplines or practitioners in the STEM field and workforce.

(a) Measurement Category: Quality.

(b) Measurement(s): Enhanced level of engagement of other minority-serving institutions for STEM student persistence, faculty research, and academia-workforce transition.

(c) Metric(s): Number of student enrollees, faculty involved in research, graduates to academia or the field from other minority seeking institutions.

(d) Milestones: Annual (or quarterly) review of success or progress at other minority-serving institutions.

(e) Deliverable(s): Participation and engagement of other minority-serving institutions and database repositories of tacit and explicit knowledge.

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