



TENNESSEE
STATE UNIVERSITY

DIVISION OF RESEARCH AND
SPONSORED PROGRAMS

Building a Strong and Sustainable Future Through Innovative Research

Research Horizons:
2024 Annual Report

tnstate.edu/research

A photograph of a multi-story brick building, identified as the Health Sciences Building at Tennessee State University. The building features large windows and a central entrance with a set of stairs. A circular seal is mounted on the brick wall above the stairs. The building is surrounded by green trees and a clear blue sky.

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Cover Photo: Interior of the Health Sciences Building, TSU Main Campus

ASSOCIATE VICE PRESIDENT FOR RESEARCH AND SPONSORED PROGRAMS AND
CHIEF RESEARCH OFFICER

DR. QUINCY QUICK

Dear Faculty, Staff, Students, Partners, and Stakeholders,

I am pleased to share with you the outstanding achievements of Tennessee State University (TSU) in fiscal year 2024. Once again, our university has set a historic milestone by surpassing over \$90 million in total grant awards. This remarkable accomplishment underscores the dedication, innovation, and collaborative spirit that defines the Tennessee State University research ecosystem.

Our research efforts have continued to push the boundaries of knowledge and innovation, resulting in significant contributions across various disciplines. From pioneering advances in agricultural sciences to cutting-edge developments in engineering and technology, TSU's research initiatives are making a profound impact both locally and globally.

Our faculty and staff's dedication to excellence is evident in the diverse array of funded projects that address critical issues such as sustainability, health disparities, and educational equity. Their contributions are not only advancing their respective fields but also enhancing the reputation of TSU as a leading research institution.

Students at TSU are integral to our research endeavors. Their enthusiasm, creativity, and hard work are essential to the success of our projects. We are proud to support their development as emerging scholars and innovators through numerous opportunities for hands-on research experiences, mentorship, and professional growth.

As we reflect on this historic year, I extend my deepest gratitude to each of you for your contributions to our collective achievements. Together, we are driving innovation, advancing knowledge, and making a difference in our communities and beyond.

Let us continue to build on this momentum, striving for excellence and setting new benchmarks in research and innovation. I look forward to the incredible advancements we will achieve together in the years to come.

Thank you for your unwavering dedication and support.

Sincerely,



Associate Vice President
Research and Sponsored Programs
Chief Research Officer
Tennessee State University



RESEARCH CENTERS AND INSTITUTES

Research Centers and Institutes at Tennessee State University

Agricultural Research and Education Center (AREC)

Biomedical Sciences Core Facility

Center on Aging Research and Education Services (TSUCARES)

Center for Entrepreneurship and Economic Development (CEED)

Center for Prevention Research

Center of Biomedical Sciences

Center of Excellence for Information Systems and Environmental Management (COE-ISEM)

Center of Excellence for Learning Sciences (COELS)

College of Agriculture Cooperative Extension Program

Institute of Agricultural and Environmental Research

Nanoscience and Biotechnology Core Facility

Otis L. Floyd Nursery Research Center at McMinnville

SMART Innovative Technologies Division

Tennessee Small Business Development Center

TSU Interdisciplinary Graduate Engineering Research (TIGER) Institute



Center on Aging Research and Education Services 2024 CARES Conference



Agricultural Research and Education Center (AREC)



SMART Innovative Technologies Division

UNIVERSITY RESEARCH CAPACITY

Founded in 1912, Tennessee State University (TSU), a Historically Black College and University (HBCU), fosters scholarly inquiry and research, lifelong learning, and a commitment to service. This 1890 land grant institution with three farms is Nashville's comprehensive public university, as well as a Carnegie R2 Doctoral – High Research Activity institution. Tennessee State University has a diverse range of research capabilities across STEM disciplines (Engineering, Computer Science, Physics, Biology, Chemistry, Math, Agriculture), with approximately (300) faculty who conduct cutting edge research in their respective fields.

Research facilities include over (100) basic science research laboratories and (15) research centers, institutes, and core facilities equipped with state-of-the-art equipment, that include high-performance computing capabilities, advanced imaging technologies, and analytical instrumentation.

Tennessee State University's research capacity is further strengthened by its partnerships with federal agencies, industry partners, and academic institutions. These collaborations enable TSU to expand its research spectrum and provide opportunities for cross-disciplinary research.

Faculty and staff have secured research grants from various sources, that include the National Science Foundation, Department of Health and Human Services, Department of Energy, Department of Defense, Department of Education, the State of Tennessee, and the U.S. Department of Agriculture.

Tennessee State University's research activity and portfolio are reflected in our diverse academic program offerings that include (38) Bachelor Degree Programs, (24) Master's Degree Programs and (9) Doctoral Programs.

Strategic Research Priorities

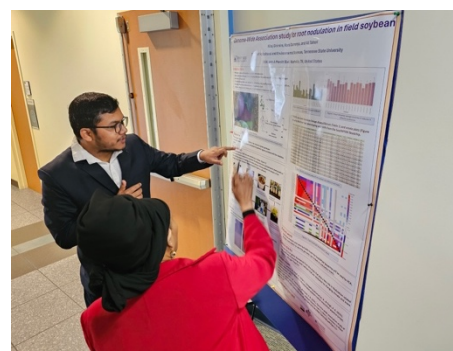
Tennessee State University delivers solutions from local to global challenges through strategic priority areas:

1. Cybersecurity, Cyber Physical Systems, Bioinformatics, & Interoperability
2. Renewable Energy
3. Big Data Analytics
4. Education Innovation and Leadership
5. Food Supply Security and Sustainability
6. Plant and Animal Genetics
7. Health Disparities and Disease Prevention/Treatment
8. Workforce Pipeline Development
9. Early Childhood Education
10. Rural Economic Development and Urban Planning
11. Biotechnology, Nanosciences, and Advanced Materials
12. Astrophysics
13. Transportation Systems
14. Advanced Manufacturing
15. Autonomous Vehicles
16. Robotics and Mechatronics

Research Methods and Techniques

The university offers an array of techniques, approaches, methodologies, and services for solving the world's most pressing issues and aiding communities. Common approaches include Feasibility Studies, Economic Impact Modeling, Simulation Testing, Prototype Development, Data Mining, Trend Analysis, Market Analysis, Stress Testing, Automatic Target Recognition Testing, Learning and Behavioral Assessments, Confocal Imaging, and Needs Assessments.

For more information, contact the Office of Research and Sponsored Programs at research@tnstate.edu.



TSU QUICK FACTS: 2023 - 2024



 Carnegie Classification: Doctoral Universities: High Research Activity (R2)

 360 Full-time Instructional Faculty

 Student-to-Faculty Ratio: 12:1

 71 Majors in Eight Undergraduate and Graduate Colleges and Schools

 520 Campus Acres, Two Campuses, Three Farms

 Fall 2023 Undergraduate Student Enrollment: 6,765

 Fall 2023 Graduate Student Enrollment: 1,433

COLLEGES OF THE UNIVERSITY

College of Agriculture and Human Sciences

The faculty of the College of Agriculture are engaged in conducting innovative research and communicating new knowledge through Extension activities in the agricultural and environmental sciences and human sciences. The College of Agriculture addresses the needs of humankind, focusing on finding solutions to challenges faced by socially and economically disadvantaged groups, and contributing to the prosperity of the citizens of Tennessee, the nation, and the world. Research areas include agricultural economics and rural communities; agriculture systems and technology; animal health, production, and products; bioenergy, natural resources, environment; food safety, nutrition, and health; plant health, production, and products; family well-being and youth development.

College of Business

The College of Business (COB) is uniquely poised as a strong, robust, and expanding educational options with the Accelerated and Executive MBA programs. These graduate programs provide convenient and flexible options for working individuals and students taking the next step in management. Preparing students for the corporate environment or entrepreneurship, the COB is positively impacting the entrepreneurial and economic tapestry of Nashville, the State of Tennessee, and the world. The faculty are engaged in conducting applied, discipline-based, and pedagogical research in accounting, business management, economics, finance, and information systems and technology.

College of Education

The College of Education faculty are engaged in research that examines disparities in education and student learning. They strive for developing, and implementing, innovative models of programs, instruction, and assessment along with integrating technology to influence student learning outcomes; elevating teaching and leading; designing clinical experiences to transform human capital pipeline, developing strategic partnerships; using data to inform program development, and applying human capital decision making processes; strategies for developing pathways to excellent teaching; and more

inclusive models of student academic success that are designed to impact student retention.

College of Engineering

The College of Engineering faculty are conducting research in nanomaterials, signal and image processing, intelligent control systems, robotics and mechatronics, artificial intelligence, bioinformatics and big data, health monitoring, systems engineering, wireless communication, and cybersecurity across various systems and software. Our engineering programs house Masters and Ph.D. degree opportunities.

College of Health Sciences

The faculty of the College of Health Sciences, our largest college, are engaged in conducting research that includes speech pathology and audiology, behavioral science approaches to reduce health disparities, obesity, diabetes, and breast cancer prevention and treatment. The COHS is housed in our new 100,000 sq. ft. facility. The college also houses the Tiger Community Rehabilitation Clinic, a student-run occupational and physical therapy clinic.

College of Liberal Arts

The faculty of the College of Liberal Arts are engaged in conducting research in areas that reflect knowledge and potential of new interdisciplinary fields while continuing work in the traditional academic disciplines at the heart of a university. The research includes studies in geosciences and environmental justice; global perspectives on civil rights and justice issues; African American history, literature, and culture; education in music, history, literature, and language; global perspectives in art; and criminal justice.

College of Life and Physical Sciences

The Department of Chemistry is dedicated to cutting-edge research spanning environmental science, cancer, viruses, drug design, the synthesis of novel inorganic materials, and the intricate interactions within various biological systems and membrane constituents. The Department of Biological Sciences, comprising a faculty deeply immersed in cellular and molecular biology, conducts research ranging from the

effects of plant extracts on cancer cell growth to exploring the role of D3 receptors in neuronal development, delving into collagen assembly and trafficking, and addressing issues in global change ecology. The Department of Mathematical Sciences hosts faculty members with diverse research interests encompassing applied mathematics, mathematical modeling, functional and numerical analysis, algebra, mathematics education, wavelets, physics, and astronomy. Together, these departments contribute to a vibrant and interdisciplinary research environment at the university.

College of Public Service

The faculty of the College of Public Service are engaged in conducting research specific to leadership; intergovernmental relations, public

finance, public policy; policy and economics of education; environmental policy and justice, urban planning and policy, economic development, gentrification, non-profit management and community revitalization; public administration and policy analysis; state lottery policy; health policy; social work; and aging.

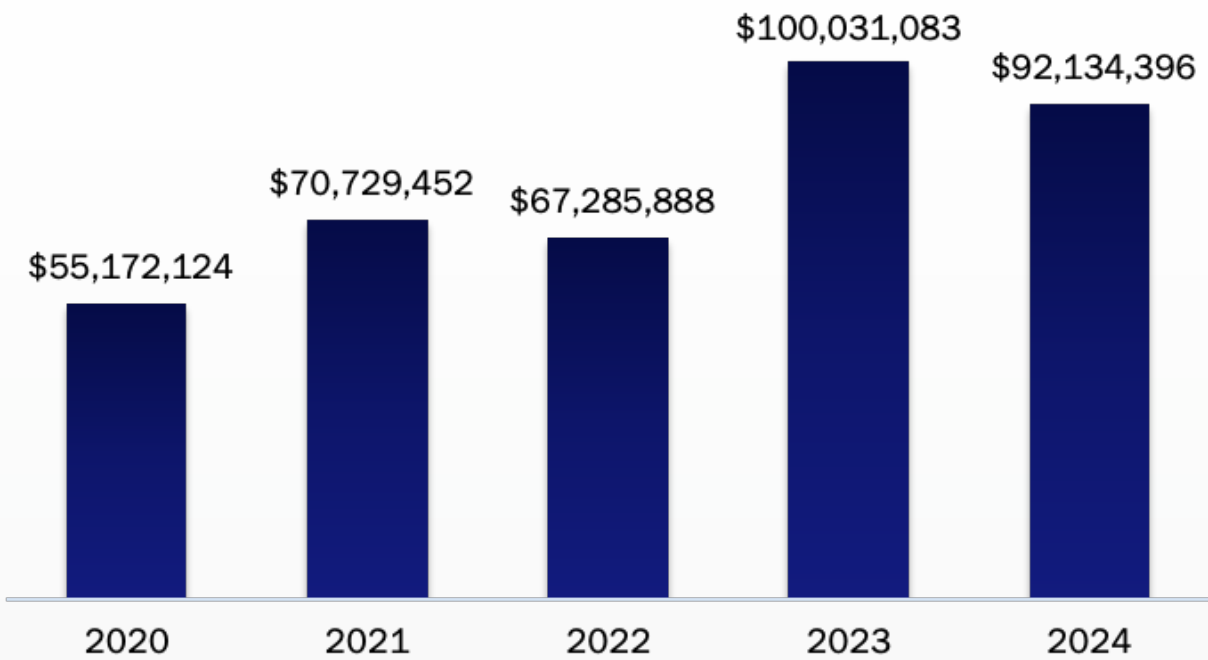
University Honors College

The University Honors College (UHC) provides an especially rich and challenging set of academic offerings to talented and highly motivated students at Tennessee State University. Through special courses, a vigorous intellectual community, and emphasis on undergraduate research, the Honors College enables students to reach new heights of excellence.



RESEARCH AWARDS: 2023 - 2024

Annual Research Awards: Five-Year Results



High-Impact Funding Highlights



During fiscal year 2024, the University was awarded over \$92 million in grants and contracts, the second highest total in awarded grants and contracts to date.



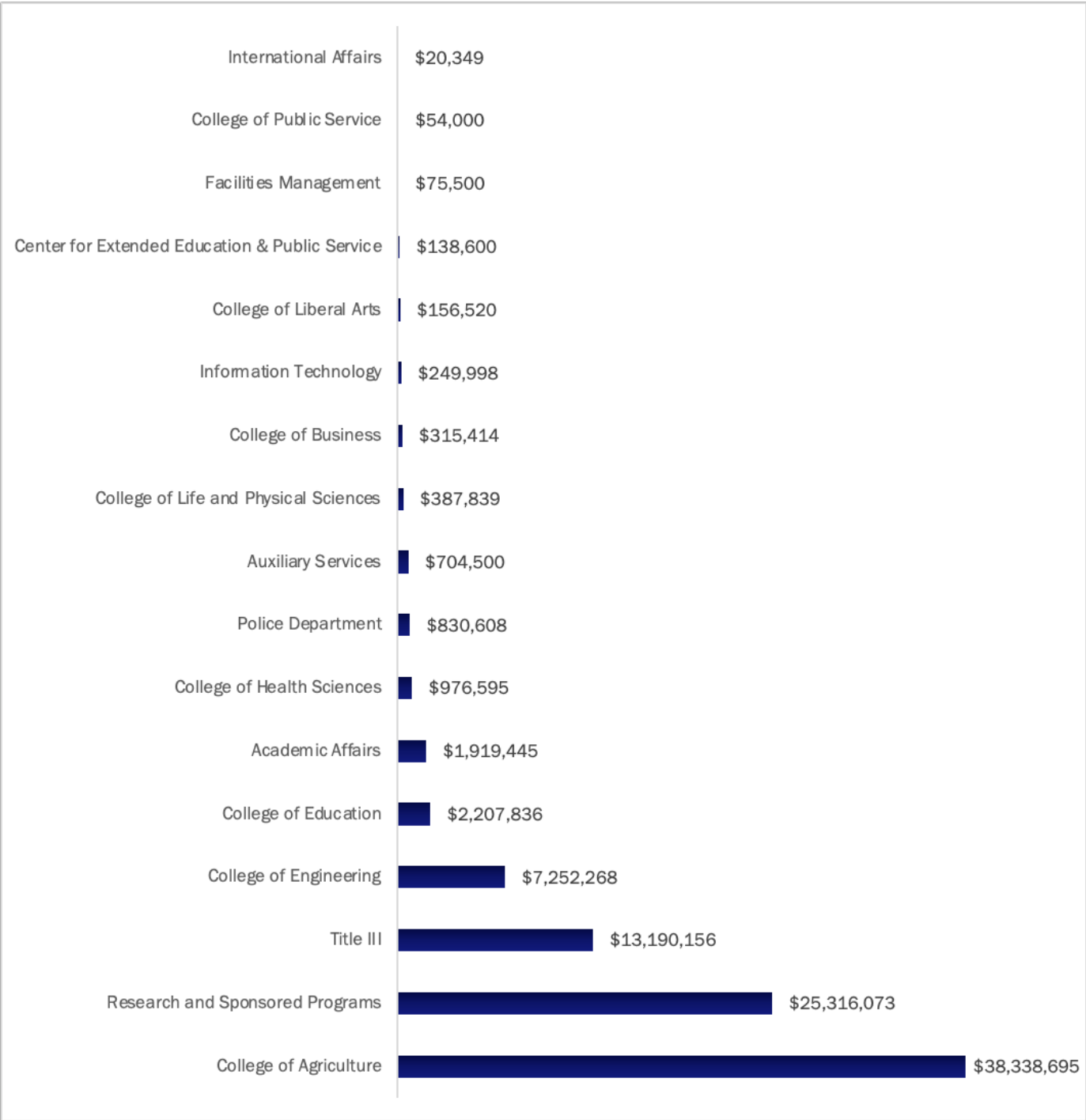
Faculty and staff submitted 222 proposals, resulting in 189 awards. The total value of the proposal requests equaled \$216,310,296.



Total funding from grants and contracts has increased 67% over the last five years.

RESEARCH AWARDS: 2023 - 2024

2024 Awards by College, Division, or Center



FACULTY RESEARCH HIGHLIGHTS

ASSISTANT PROFESSOR

DR. KAMRUL HASAN

Empowering the Next Generation of Minorities in Data-driven Cybersecurity of Critical Infrastructures

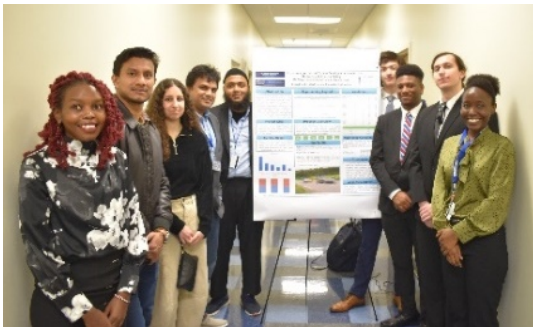
Dr. Kamrul Hasan is an Assistant Professor in the Department of Electrical and Computer Engineering at Tennessee State University and joined in Spring 2021. Dr. Hasan is a leading Cyber-Physical Systems (CPS) researcher, focusing on enhancing critical infrastructure security, resilience, and efficiency. His current projects, funded by the National Science Foundation (NSF) and the United States Department of Transportation (USDOT), significantly contribute to transportation, telecommunications, power grids, and more. As of recent estimates, the shortfall of cybersecurity professionals in North America is approximately 522,000, reflecting a 19.7% increase from the previous year. This gap is attributed to the [increasing digitalization of industries and the rising frequency and sophistication of cyber threats](#). The workforce shortfall is even higher in underprivileged communities.



Dr. Kamrul Hasan is an Assistant Professor in the Department of Electrical and Computer Engineering.

One of Dr. Hasan's key projects, **Cloud-Edge Artificial Intelligence in Cyber-physical Systems**, addresses the challenges of securing CPS in critical infrastructure sectors such as transportation and power grids. This project utilizes edge computing to enhance these systems' real-time processing capabilities and cybersecurity. By aligning with the directives of the National Security Memorandum (NSM-22), which emphasizes the importance of securing critical infrastructure, Dr. Hasan's work ensures that these vital systems are robust against cyber threats and resilient in the face of disruptions. Two of four graduate students from historically black communities are working on the project.

In another groundbreaking project, **Leveraging Advanced Data to Deliver Multimodal Safety and Security (LADDMSS)**, Dr. Hasan focuses on developing intelligent transportation systems (ITS) that are both secure and privacy-preserving. This initiative is part of the National Strategy to Advance Privacy-Preserving Data Sharing and Analytics, reflecting a commitment to safeguarding sensitive data while enabling advanced data analytics for transportation safety and efficiency, which is crucial for developing autonomous vehicles and smart city applications. Two of three graduate students from historically black communities are also working on the project. By implementing innovative safety models, such as near-miss analysis, Dr. Hasan's work is paving the way for safer, more efficient transportation networks.



Dr. Hasan and his students in the 46th Annual University-wide Research Symposium.

Dr. Hasan's work on the project **Zero Trust Security Architecture for Industrial Internet of Things (IIoT)** further underscores his dedication to security in CPS. This project explores Zero Trust Security frameworks and secure slicing techniques for industrial Internet of Things (IIoT) applications. This research enhances industrial systems' overall security and reliability by predicting network resource requirements and ensuring secure communication slices within CPS. One of the two graduate students is a woman working on the project.

A strong proponent of collaborative research, Dr. Hasan believes that internal and external partnerships are crucial to the success of research projects. He advocates for a research-oriented pedagogy, emphasizing that such an approach fosters societal positivity and technological advancements. Through his innovative projects and collaborative efforts, Dr. Hasan continues to lead the way in securing and enhancing the nation's critical infrastructure.

FACULTY RESEARCH HIGHLIGHTS

PROFESSOR

DR. TINA T. SMITH

Enhancing Students' Knowledge and Skills Through Collaboration

Dr. Tina T. Smith, Professor and Chair of the Department of Speech Pathology and Audiology, is committed to training students to deliver outstanding services to persons with disabilities. Dr. Smith believes that using a collaborative approach in teaching and research is necessary to prepare today's healthcare professionals. Thus, Dr. Smith conducts research with colleagues within and across several departments at Tennessee State University.

There is a severe shortage of ethnically and racially diverse speech-language pathologists, special education teachers, and physical therapists in Tennessee to serve children with disabilities. Dr. Smith, along with Dr. Terrie Gibson, Department of Speech Pathology and Audiology, Dr. Kisha Bryan Jordan, Department of Teaching and Learning/Special Education, and Dr. Patricia King, Department of Physical Therapy, have received \$1,250,000 in grant funding from the US Department of Education to help reduce the shortage. The goal is to increase the number of speech-language pathologists, special education teachers, and physical therapists from underrepresented groups, to provide culturally and linguistically responsive, effective and equitable instruction, interventions, and services designed to improve the educational outcomes for children with disabilities. The expected outcome is that grant scholars from the Departments of Speech Pathology and Audiology, Special Education, and Physical Therapy will obtain graduate degrees in their respective areas and become licensed and prepared to serve culturally and linguistically diverse students with disabilities using an interprofessional team-based model.

Dr. Smith is passionate about improving student learning and retention of knowledge. Students must achieve specified knowledge and skills outcomes in all areas of speech-language pathology to become competent speech-language pathologists. Dr. Smith's research in retention shows that students may have difficulty retaining concepts and skills after the initial learning if the information is not applied. Therefore, Dr. Smith works collaboratively with academic and clinical faculty to implement strategies designed to help students retain and transfer knowledge and skills learned in the classroom to the clinical setting.

Dr. Smith, along with Dr. Terrie Gibson, academic faculty, and Ms. Tashaundra Bailey, Ms. Lakeysa Hampton, and Ms. Nicole Jenkins, clinical supervisors, presented their research findings at the National Black Association of Speech-Language-Hearing Conference to show how active learning strategies such as spaced practice, retrieval practice, elaboration, interleaving, concrete examples, and dual coding can improve student retention of knowledge and skills. The take away is that collaboratively using student-centered approaches to enhance learning can help students apply, interpret, and synthesize information from various sources and perspectives in both classroom and clinical settings.

Dr. Smith is dedicated to preparing students to work collaboratively. She believes that interprofessional education and practice are the key to successful service delivery.



Dr. Tina T. Smith is a Professor and Chair of the Department of Speech Pathology and Audiology



Research team Dr. Kisha Bryan Jordan, Dr. Terrie Gibson (back), Dr. Patricia King, and Dr. Tina Smith (front) are working together on a US DOE grant.



(L to R) Dr. Terrie Gibson, Ms. Nicole Jenkins, Ms. Tashaundra Bailey, Dr. Tina Smith, and Ms. Lakeysa Hampton presented at the National Black Association of Speech-Language-Hearing Conference.

OFFICE OF TECHNOLOGY TRANSFER

The Tennessee State University Office of Technology Transfer and Innovation's mission is to support commercialization, start-up creation, and protection of intellectual property for the Tennessee State University community. We work with faculty, staff, and students to support the flow of research and innovation at TSU from the lab to the marketplace to create new products, services, and businesses for the benefit of society.

The office hosts a number of federal and state programs to advance innovation and commercialization at TSU including the NSF I-Corps Midsouth I-Corps Hub, the Tennessee Technology Advancement Consortium (TTAC), and NSF Regional Innovation Engines.

Services include filing patents, copyrights, trademarks, business formation, identifying corporate pilot, and sponsored R&D programs, assisting with SBIR/STTR grant proposals, assisting with fundraising and Venture Capital, and commercialization training and professional development.

For more information on programs or services of Technology Transfer and Innovation, contact Robert Turner at rturne10@tnstate.edu.



Robert Turner is the Technology Transfer and Innovation Manager in the Office of Research and Sponsored Programs.



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Support the Journey to R1

Tennessee State University is working to elevate our Carnegie Classification from R2 to R1, an important recognition of the highest level of research activity and impact.



Research and Sponsored Programs is here to provide comprehensive support throughout your pursuit of research excellence. Join us in this transformative journey and be a part of our legacy of innovation and discovery.

Why R1 Matters:

- Achieving R1 status will expand our capacity for research, enabling more innovative projects improving Tennessee's economic development.
- With R1 designation, we attract more grants, contracts, and partnerships, improving our academic and research excellence.
- Our research will have a wider reach and contribute to recruitment and retention of outstanding faculty, undergraduate, and graduate students.

How You Can Help:

- Spend to \$0: Ensure we reach our research expenditure goals with consistent use of current research funding.
- Apply for Grants: Your timely submissions contribute to enhancing our research infrastructure, faculty recruitment, and student support.
- Learn More: Attend research seminars and training events to learn more about applying for grants and submitting winning proposals.



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