Duke UNIVERSITY | BASS CONNECTIONS

Duke University

BASSCONNECTIONS

MESSAGE FROM LEADERSHIP

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This past April, hundreds of faculty, students, and community members packed into a hall next to Cameron Indoor Stadium to hear undergraduate and graduate students proudly share the outcomes of their year-long Bass Connections research projects. This noisy room of people from every corner of Duke embodied the dynamic and collaborative environment for interdisciplinary, faculty-mentored research that Bass Connections has created over the past four years.

Students described how they tackled important societal challenges that ranged from reforming Medicaid in North Carolina, stemming the opioid epidemic, and preventing school dropouts, to harnessing the ocean's energy, reducing the exposure of children and families to harmful chemicals in Latin America, and using memory studies to examine the complex history of race and social injustice right here in Durham. These teams developed prototypes, conducted archeological digs, produced policy reports and recommendations, collected data to aid future research, published papers, and created art exhibits.

For students, such experiences sharpen intellectual teamwork and communications skills while providing an intense introduction to applied interdisciplinary research. For faculty, these research teams create rich opportunities for mentoring and rethinking pedagogical approaches, while also opening up new vistas for long-term research and/or civic engagement.

This year, we focused more intently on enriching the educational pathways that complement our project teams. Increasing numbers of students also engage with Bass Connections through gateway courses, summer research experiences, interdisciplinary and team-based courses, and capstone research projects. Each of these experiences, to varying degrees, include signatures of the Bass Connections model: team-based inquiry; problem-centered learning; integration across student levels and with faculty; interdisciplinary exploration; and external engagement.

A key goal for the years ahead is to partner with schools across Duke to embed elements of the Bass Connections model into other offerings, providing the opportunity for students to benefit from collaborative and applied research regardless of whether they formally participate in Bass Connections. We will also broaden the program's reach by creating a new mechanism for faculty to propose year-long project teams that fall outside of our current five themes of Bass Connections, but that otherwise meet our criteria.

Bass Connections depends on the energy and ingenuity of our faculty, students, staff, and community partners, as well as the steadfast support of our donors. We are grateful to everyone whose hard work has shaped this new model of integrating education, research and outreach.

EDWARD J. BALLEISEN

Vice Provost for Interdisciplinary Studies
eballeis@duke.edu

HALLIE KNUFFMAN

Director, Bass Connections (through March 2017)
hallie.knuffman@duke.edu

LAURA HOWES

Director, Bass Connections (as of May 2017)
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THE BASS CONNECTIONS MODEL

Bass Connections bridges the classroom and the real world, giving students from across the university a chance to roll up their sleeves and tackle complex societal problems alongside world-class faculty.

Named in honor of founding donors Anne T. and Robert M. Bass P'97, the program exemplifies Duke's commitment to interdisciplinary research and teaching as a vital part of the university's mission. For more than two decades, Duke has linked collaborative inquiry across disciplines to the imperative of seeking out knowledge in the service of society. The Basses' $50 million gift sparked a new approach to the exploration of major societal challenges; by including a $25 million matching challenge, the donation has inspired dozens of others to support the undertaking.

Bass Connections equips students to become leaders, whether in the academy, government, business or the nonprofit world. It simultaneously seeds new research for faculty. Through this innovative program, Duke is further amplifying its culture of collaboration, its entrepreneurial spirit and its established record of structuring education around high-level research on pressing global problems.

Vision

To create a distinctive new model for education, predicated on collaborative and interdisciplinary inquiry, that actively engages students in the exploration of big, unanswered questions about major societal challenges

Themes

Bass Connections courses and projects are aligned with five thematic areas, each hosted by one of Duke's interdisciplinary institutes and initiatives.

BRAIN & SOCIETY
Duke Institute for Brain Sciences

INFORMATION, SOCIETY & CULTURE
Information Initiative at Duke

GLOBAL HEALTH
Duke Global Health Institute

EDUCATION & HUMAN DEVELOPMENT
Social Science Research Institute

ENERGY
Energy Initiative

Educational Pathways

Through project teams, courses and summer programs, students and faculty engage in interdisciplinary, collaborative research focused on societal challenges, often in partnership with community organizations. Many participants choose to take their research further through grants and other opportunities within Duke and beyond.

Outcomes take a wide variety of forms, such as:

- JOURNAL ARTICLES
- CONFERENCE PRESENTATIONS
- SUCCESSFUL PROPOSALS FOR EXTERNAL GRANTS
- REPORTS WITH STUDY FINDINGS AND RECOMMENDATIONS
- APPS
- MUSEUM EXHIBITIONS AND CATALOGUES
- PROTOTYPES
- PUBLIC PERFORMANCES AND TALKS
- THESES AND DISSERTATIONS

PROJECT TEAMS

Interdisciplinary research teams tackle complex societal challenges over two semesters (some teams add a summer component).

GRADUATE / PROFESSIONAL STUDENTS, FACULTY, UNDERGRADUATES, POSTDOCS

EXAMPLES

- How to Build Ethics into Robust Artificial Intelligence
- Enabling Precision Health and Medicine
- OSPRI Lab: Open Source Education Technology
- Exercise as a Therapy for Cognitive Aging and Alzheimer's Disease
- Environmental Epidemiology in Latin America

FOLLOW-ON STUDENT RESEARCH GRANTS

Bass Connections provides competitive funding for students who wish to continue an aspect of their team's work over the following academic year. With faculty mentorship, students can work individually or in groups. For proposed work that will continue into 2017-2018, we awarded grants to two graduate students, three undergraduates and two groups of undergraduates, with topics ranging from rehabilitation services for children to digital recording tags for marine mammals and genetics of migrants and nonmigrants in the Peruvian Amazon.

ONE-SEMESTER COURSES

Numerous courses highlight interdisciplinary thinking, collaborative assignments and interaction with community partners.

EXAMPLES

- **Music and the Brain**
- **Performance and Technology**
- **History of Global Health**
- **Open Knowledge and Education Innovation**
- **Environment and Conflict**

COURSE DEVELOPMENT FUNDS

We provide grants to support faculty in developing or modifying courses that will incorporate key elements of the Bass Connections model. In Spring 2017 we awarded three such grants:

- **Introductory Machine Learning for Data Science**
- **Women's Health and Technologies**
- **Applications of Genome Sciences and Medicine**

SUMMER PROGRAMS

Students spend six to ten weeks immersed in mentored research.

EXAMPLES

DATA+
Explore data-driven approaches to real-world challenges

Interdisciplinary teams of undergraduates with graduate mentors and project sponsors (faculty, staff or community partners)

STORY+
Bring humanities research to life through interpretive methods and dynamic storytelling

Interdisciplinary teams of undergraduates with graduate mentors and project sponsors (faculty, staff or community partners)

SUMMER NEUROSCIENCE PROGRAM
Jumpstart a senior thesis in Neuroscience

Undergraduates working individually with faculty mentors; group professional development seminars

GLOBAL HEALTH STUDENT RESEARCH TRAINING PROGRAM
Develop and implement projects addressing health disparities

Interdisciplinary teams of undergraduates with faculty leaders and community partners

CONNECTING EXPERIENCES

Many students who take part in one Bass Connections experience, such as a project team or course, **CHOOSE TO TAKE IT FURTHER THROUGH ANOTHER BASS CONNECTIONS OFFERING**, such as a summer program. These experiences can be ordered in any way. Beyond project teams, courses and summer programs, students extend their research through related theses and dissertations and through other Duke opportunities such as DukeEngage, DukeImmerse and Global Education.

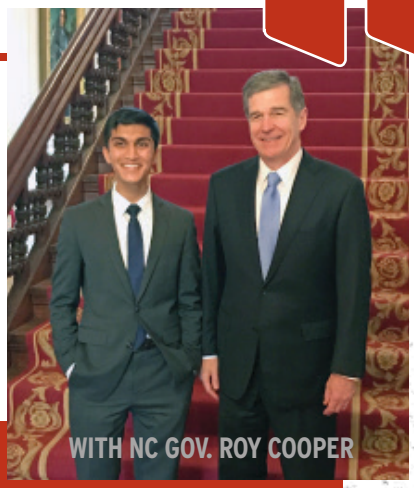
ADVISING

Advisors throughout the university guide students in **DEVELOPING THEIR OWN PATHWAYS OF PROBLEM-FOCUSED INTERDISCIPLINARY EXPERIENCES AT DUKE**. For undergraduates, Duke's Directors of Academic Engagement offer one-on-one sessions to help students integrate Bass Connections and other research, global and civic experiences into their academic careers. Ph.D. students in the humanities can consult with Duke's new Director of Graduate Student Advising and Engagement for the Humanities.

FIVE STUDENTS, FIVE PATHWAYS

Science and Policy Innovation

DUKE FOCUS PROGRAM: Genetics and Genomics
BASS CONNECTIONS: Innovation & Technology Policy Lab; Follow-on Student Research Grant to develop novel incentive structures for pharmaceutical innovation
BASS CONNECTIONS: NC Medicaid Reform Advisory Team; Follow-on Student Research Grant to apply hot-spotting analysis to high-risk patients in NC Medicaid
SANFORD SCHOOL: Innovation & Impact Fund grant for vaccine development intellectual property toolkit
SUMMER INTERNSHIP: Governor's Medicaid Policy Task Force



WITH NC GOV. ROY COOPER

As a student, I have always been most excited by intersections, finding the points where fields connect to be the areas ripe for real-world change. I chose to attend Duke because of its commitment to interdisciplinary and translational work.

KUSHAL KADAKIA '19, BIOLOGY AND PUBLIC POLICY, MINOR IN GLOBAL HEALTH

Global Mental Health and Business

BASS CONNECTIONS: Displacement, Resettlement and Global Mental Health
MASTER'S THESIS: Participatory Methods for Climate Change and Mental Health Research
SUMMER INTERNSHIP: Global Product Strategy, Genentech
CAREER: Founding Board Member, HeartMind International; Director of Product Development, Optum's Experience Design team at UnitedHealth Group

My participation on the Bass Connections team has further developed my creative problem-solving, leadership and cross-cultural competencies that will set me up for success in my future endeavors.

LIBBY KING MACFARLANE, MBA & M.S. IN GLOBAL HEALTH '15

A New Way of Looking

BASS CONNECTIONS: Art, Vision and the Brain
GLOBAL EDUCATION: Neurohumanities in Paris
HONORS THESIS: Being Within: Disruption and Disorientation in Carlos Cruz-Diez's Chromosaturation
PH.D. PROGRAM: History, Theory and Criticism of Art, MIT

Bass Connections remains at the crux of my Duke story, at the center of a web of experiences that will continue to grow beyond graduation.

INDRANI SAHA '17, PROGRAM II (COGNITIVE AESTHETICS)

Reimagining the Curriculum

BASS CONNECTIONS: Exploring the Intersection of Energy and Peace-Building through Film; NC Jukebox
FELLOWSHIP: Duke Center for Instructional Technology
LEADERSHIP: Emerging Leaders Institute
STORY+ SUMMER PROGRAM: Race and Ethnicity in Advertising (with Rubenstein Library)

Bass Connections has helped me grow as a critical thinker, relationship builder and project manager. It has also inspired me to pursue a career in interdisciplinary curriculum development and educational innovation.

MEGHAN O'NEIL, PH.D. STUDENT IN ENGLISH

Education from All Angles

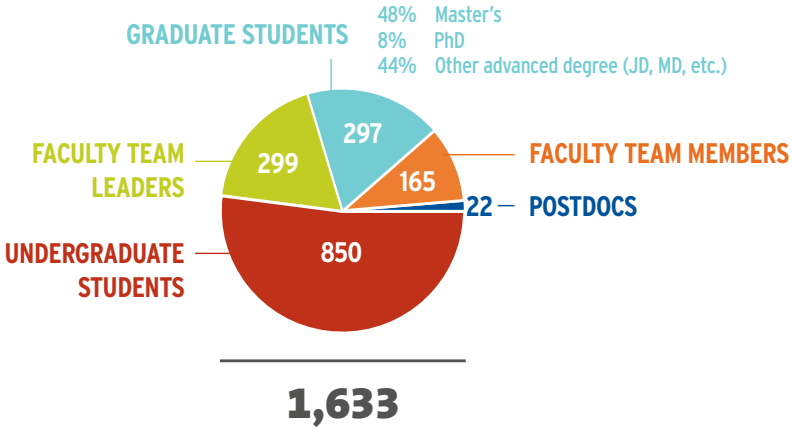
BASS CONNECTIONS: Project Bright IDEA: Finding Talent and Giftedness in Children of Diverse Backgrounds
INTERNSHIP: Education policy, HELP Committee, U.S. Senate
CONTINUED STUDY: Joint Law and Education Policy master's program, Stanford University

Bass Connections has the audacity to take on the big, "so complex they're scary" problems in society, while maintaining the flexibility to find solutions creatively. My experience inspired me to continue studying education policy from all angles.

RAY LI '15, POLITICAL SCIENCE AND PUBLIC POLICY, MINOR IN EDUCATION

Involvement of Faculty, Postdocs and Students at All Levels

Number of participants Fall 2013 through Spring 2017:



Faculty

Faculty across Duke's schools engage in Bass Connections at every level, from providing vital program guidance on the Faculty Advisory Council, to developing and leading project teams, engaging as course instructors, and mentoring students as they take their research further. Many faculty members have also successfully leveraged initial findings from their Bass Connections teams to obtain external grants.

It has been a very enriching experience to work with my faculty colleagues on this project. They have stretched me and helped me to connect my clinical interests to fundamental neuroscience. And the undergraduate students are so amazing.

HEIDI WHITE
ASSOCIATE PROFESSOR OF MEDICINE
MUSIC AND MEMORY IN THE AGING BRAIN

Postdocs

Postdocs can partner with faculty to lead Bass Connections teams.

Working with Neuroplicity, I developed better communication, mentorship and project management skills. These are skills that all postdocs need as they move into the academic or corporate job market. It was a truly rewarding experience and a great learning opportunity.

JILL WENTZELL, POSTDOCTORAL SCHOLAR IN BIOLOGY
NEUROPLICITY: LEVERAGING NEW MEDIA AND DIGITAL STORYTELLING TO CONNECT SOCIETY TO NEUROSCIENCE

Undergraduates

Bass Connections helps undergraduates to build research skills in a small group setting, develop a deep understanding of an issue of interest, engage with communities and organizations outside of Duke, explore career paths, apply coursework to a complex societal challenge and enhance thesis research.

Duke is really an institution that pushes its undergraduates to make a difference. Through programs such as Bass Connections, I am not held down by the fact that I am an undergraduate. I get to work with medical students, professors and graduate students on a project that we are all passionate about.

MAAZ MULLA '18, BIOLOGY
GLOBAL ALLIANCE ON DISABILITY AND HEALTH INNOVATION (GANDHI)

Graduate Students

Graduate and professional school students play a crucial role in Bass Connections—on project teams, as mentors for Data+ and Story+ teams and as research or teaching assistants for faculty who design and deliver Bass Connections courses.

Bass Connections provides these students with opportunities to develop career-oriented skills, including mentoring, project management, team-based research and sustained engagement with external partners and clients.

My participation in this project was one of the most meaningful and rewarding Duke experiences I have had. It not only helped me land my first job, but also helped me find my true passion.

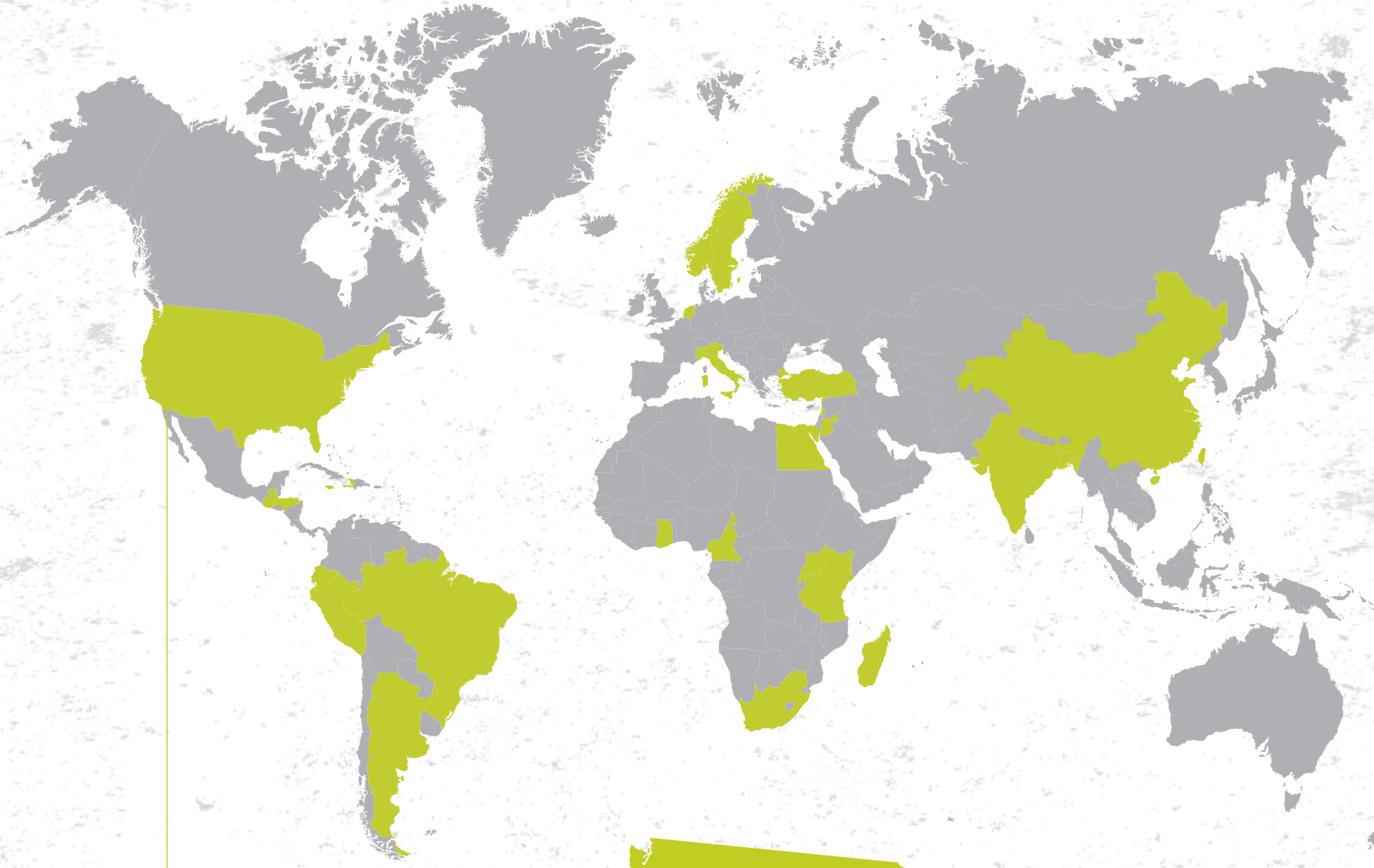
JUN WANG
PH.D. IN PHARMACOLOGY '16
EVALUATION OF SCALING INNOVATIVE HEALTHCARE DELIVERY IN EAST AFRICA

Community Partners

Most Bass Connections teams work with community partners outside Duke, including nonprofits, universities, school systems, hospitals, government agencies and private companies. **BASS CONNECTIONS TEAMS HAVE WORKED WITH 104 COMMUNITY PARTNERS IN 29 COUNTRIES ON FIVE CONTINENTS** in addition to many cities and towns around the U.S., the Carolinas and right here in Durham.

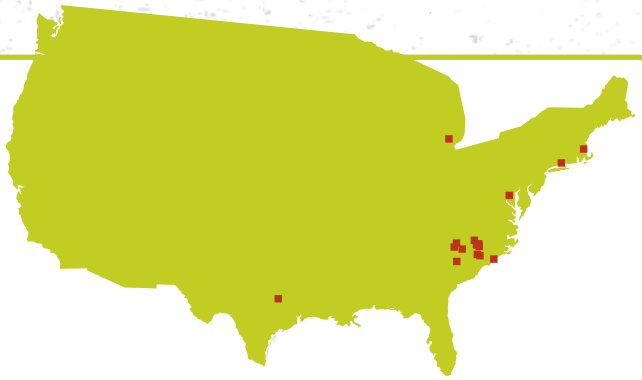
NONPROFIT	38%
ACADEMIC – U.S.	18%
ACADEMIC – INTL.	13%
PRIVATE COMPANY	9%
GOVERNMENT – U.S.	8%
HEALTHCARE PROVIDER	8%
K-12 SCHOOL	4%
GOVERNMENT – INTL.	3%

includes project teams and three summer programs (Data+, Global Health Student Research Training, Summer Neuroscience Program)



North Carolina
Alamance County
Asheville
Chapel Hill
Concord
Durham
Lumberton
Pembroke
Raleigh
Spruce Pine
Wilmington

Connecticut
New Haven
Massachusetts
Boston
Michigan
Detroit
South Carolina
Columbia
Texas
Dallas
Washington, DC



2016-2017 PARTICIPATION

As a university-wide program, Bass Connections reaches across Duke. In 2016-2017, 43 project teams brought together faculty, graduate students and undergraduates to tackle complex societal challenges. There were also 50 summer research projects in addition to numerous courses and other experiences.

Participation across Duke

NUMBER OF PARTICIPANTS IN 2016-2017

includes 2016-2017 project teams and three 2016 summer programs (Data+, Global Health Student Research Training, Summer Neuroscience Program)

155 FACULTY TEAM LEADERS

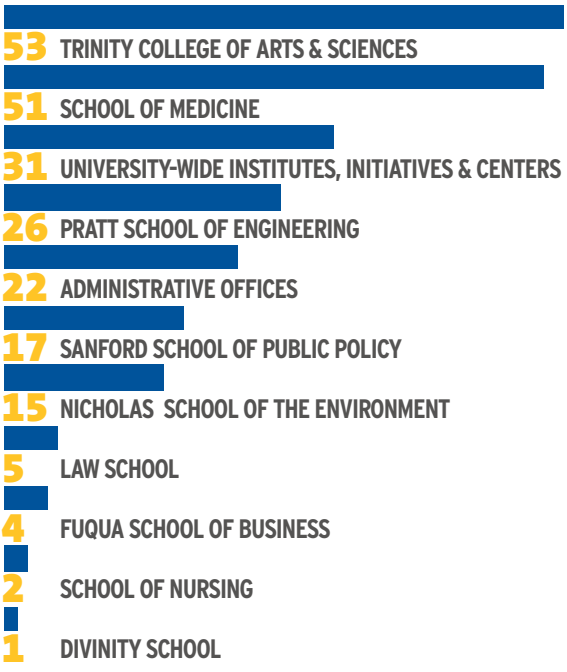
72 FACULTY TEAM MEMBERS

302 UNDERGRADUATE STUDENTS

112 GRADUATE STUDENTS

7 POSTDOCS

FACULTY PARTICIPATION BY SCHOOL



includes 2016-2017 project teams and three 2016 summer programs (Data+, Global Health Student Research Training, Summer Neuroscience Program)

ENGAGEMENT WITH COMMUNITIES BEYOND DUKE

86% of team leaders who responded to the end-of-year survey reported that their team engaged externally in some way, including having an external client or community partner, collecting data from participants outside of Duke and consulting external organizations for guidance.

Each Data+ team and Global Health Student Research Training team had a partner or client.

19 PROJECT TEAMS HAD ONE OR MORE FORMAL COMMUNITY PARTNERS OR CLIENTS, TOTALING **58** EXTERNAL AFFILIATES

2016-2017 LEADERSHIP

EDWARD BALLEISEN | Vice Provost for Interdisciplinary Studies
HALLIE KNUFFMAN | Director for Administration and Program Development (through March 31, 2017)
SARAH DWYER | Director of Communications, Interdisciplinary Studies
LAURA HOWES | Associate Director for Strategy and Operations (became Director of Bass Connections on May 1, 2017)

THEME LEADERS

BRAIN & SOCIETY
Walter Sinnott-Armstrong
Practical Ethics, Philosophy
Leonard White
Neurology

INFORMATION, SOCIETY & CULTURE
Robert Calderbank
Computer Science
Victoria Szabo
Art, Art History & Visual Studies

GLOBAL HEALTH
Mary Story
Community and Family Medicine

EDUCATION & HUMAN DEVELOPMENT
Thomas Nechyba
Economics

ENERGY
Lori Bennear
Environmental Economics & Policy

FACULTY ADVISORY COUNCIL

CHAIR: Lisa Huettel | Electrical & Computer Engineering
Rachel Brewster | Law
Martin Brooke | Electrical & Computer Engineering
Nicholas Carnes | Public Policy
Grainne Fitzsimons | Business Administration
Tsitsi Jaji | English
Lisa Keister | Sociology
Daniel Laskowitz | Neurology
Leigh Ann Simmons | Nursing
David Toole | Theology, Ethics, Global Health

STUDENT REPRESENTATIVES
Kushal Kadakia | Undergraduate Student, Representative, Duke Student Government
Billy Gerhard | Graduate and Professional Student Council Representative

EX-OFFICIO
Edward Balleisen, Vice Provost, Interdisciplinary Studies
John Klingensmith, Associate Dean for Academic Affairs, Graduate School
Steve Nowicki, Dean and Vice Provost, Undergraduate Education
Arlie Petters, Dean, Academic Affairs, Trinity College of Arts & Sciences

STUDENT ADVISORY COUNCIL

CHAIRS: **Meghan O'Neil**, Ph.D., English
Indrani Saha, Program II (Cognitive Aesthetics) '17

Kirsten Bonawitz, Neuroscience '17
Erin Choe, Biology '17
Mercy DeMenno, Ph.D., Public Policy
Samip Desai, Mechanical Engineering '17
Jemi Galani, Biology, Chemistry, Global Health '17
Anil Ganti, Ph.D., Electrical & Computer Engineering
Sophie Katz, Neuroscience '17
Helen Liu, International Studies, Global Health '17
Jessica Marlow, '20
Ashton Merck, Ph.D., History
Alexandra Oprea, Ph.D., Political Science
Bengisu Pay, Economics, Psychology '18
Eduardo Salgado, Neuroscience, Psychology '18
Zachary Smothers, M.B.S., Biomedical Sciences
Shengjie Xu, Ph.D., Immunology

FUNDING

As of June 30, 2017, Bass Connections raised $91.4M toward its goal of $100M.

GENEROUS SUPPORT FROM DONORS HAS CREATED 77 FUNDS TO SUPPORT:

2016-2017 SELECTED HIGHLIGHTS

This year's Bass Connections project teams, courses and summer programs produced a wide range of outcomes. The following illustrative examples provide just a hint of the richness of collaborative inquiry among faculty and students from across Duke.

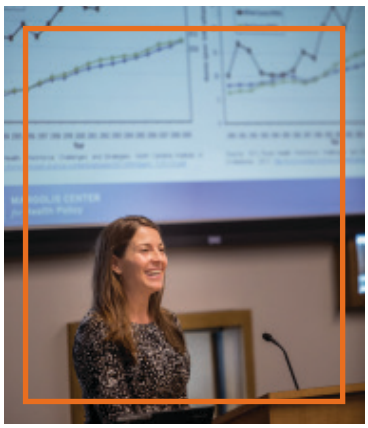
NC Medicaid Reform Advisory Team

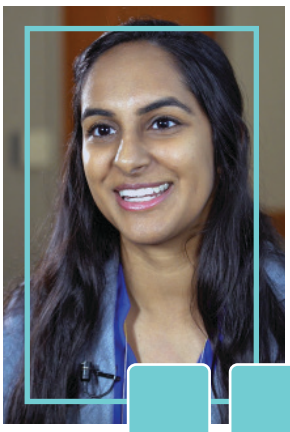
Project team

What is the best path forward for Medicaid in North Carolina? The question of how our society can provide quality healthcare at a sustainable cost poses one of the most important policy issues of the 21st century.

This project team drew on the interdisciplinary expertise at the Duke-Margolis Center for Health Policy to craft a Medicaid reform proposal that aligns with the constraints and demands of state politics. The team submitted its report to North Carolina's policymakers and citizens, hosted a discussion in Raleigh and submitted a public comment to the Department of Health and Human Services synthesizing recommendations from the report.

Four undergraduate team members received a grant to take this work further by applying a "hot-spotter strategy" to health policy, identifying the counties with the highest health expenditures and greatest Medicaid burden, as well as conducting interviews with officials, providers and patients to understand the challenges of current payment and delivery structures.





As a student of public policy, it's my goal to use evidence and research to inform changes to such a massive program like Medicaid that will inevitably affect a number of stakeholders. We're talking about the most vulnerable people in our state, from children to the disabled and the elderly. It's our responsibility to be the best stewards to those patients and make sure they have access to high quality, affordable health care.

MADHULIKA VULIMIRI
MASTER OF PUBLIC POLICY STUDENT

Integrating Environmental Science and Policy

One-semester course

Environmental challenges are inherently interdisciplinary, drawing upon principles from ecology, earth sciences, biochemistry, economics, political science and ethics. With a Bass Connections course development grant, faculty members Lori Bennear and Patrick Halpin redesigned a gateway course to incorporate elements of Bass Connections.

Employing in-depth case studies, the course fosters collaborative group-based research modules focused on environmental problem-solving. Dividing into 17 teams in the Spring 2017 course, 70 undergraduate and graduate students explored carbon sequestration, the changing Arctic and wind energy.

It's exciting to bring Bass Connections principles to more traditional courses. It gives more students the opportunity to experience project-based and team-based learning.

LORI BENNEAR
JULI PLANT GRAINGER ASSOCIATE PROFESSOR OF ENERGY ECONOMICS AND POLICY

Durham Neighborhoods

Data+ summer project

Durham has changed dramatically in the last two decades. A once-crumbling downtown is thriving, and neighboring communities have undergone major changes. How is this revitalization affecting residents?

This Data+ summer research team spent ten weeks working closely with the director of the Durham Neighborhood Compass, a city-sponsored tool for sharing public data on economic, demographic and quality-of-life factors. Team members analyzed numerous sources of data, developed new metrics for ambient stress and neighborhood change and created visualizations of these metrics. They presented their findings in community meetings and to Durham officials, and developed an app incorporating their metrics into the Neighborhood Compass user interface.

We've had great opportunities to meet with people from Durham and hear their thoughts on what is changing.

Doing research and seeing the tangible effects of our work really drew me to this project.

VINAI ODDIRAJU '18
STATISTICAL SCIENCE

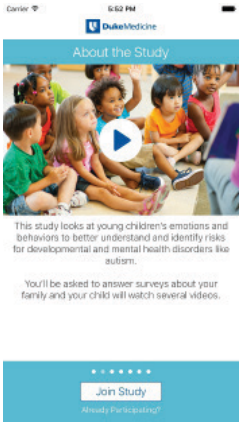
Autism & Beyond

Project team

I don't think this kind of thing could have happened at any other institution other than Duke. It's an attitude that we are not going to let any smart idea go by because it's challenging or we don't have the resources.

GUILLERMO SAPIRO
PROFESSOR OF ELECTRICAL & COMPUTER ENGINEERING

Most children with autism aren't diagnosed until age five or later. To foster earlier diagnosis and intervention, a team of Duke researchers from the university and the health system—including students in a Bass Connections project—created an Apple ResearchKit app called Autism & Beyond. The program tests the reliability of smartphone questionnaires and video analysis of facial expressions as a possible screening tool for autism and other developmental disorders.



In May 2017, the International Society for Autism Research presented the Cultural Diversity Award to a team from Duke and the University of Cape Town, in recognition of their collaboration to test how Autism & Beyond can be used in low-income communities in South Africa.

Pocket Colposcope

Project team and Global Health Student Research Training summer project

Cervical cancer affects half a million women each year, resulting in more than 270,000 deaths. The majority of these cases occur in low-income countries that cannot afford the diagnostic tools and treatments commonly available in the United States.

Researchers at Duke's Global Women's Health Technologies Center developed the Pocket Colposcope to screen for cervical cancer at far lower cost ($250 compared to $20,000) and with similar clinical performance to the existing standard-of-care colposcope. They have regulatory approval to introduce the Pocket Colposcope into Peru and East Africa.

Focusing on Peru, this project team conducted a global value chain analysis to identify the best strategy for adoption of the Pocket Colposcope. Team members conducted interviews and field research over spring break and identified six leverage points—such as midwife training and telecommunication—where specific actions can help increase the likelihood of adoption.

In collaboration with local healthcare organizations, team members refined their recommendations and produced a final report that identifies the key actors, policies and leverage points for implementation of the Pocket Colposcope in Peru.

There have been a few other attempts to come up with a better solution, but none of them have succeeded. With our handheld, low-cost design, we're hoping to redefine the entire procedure.

MERCY ASIEDU
PH.D. STUDENT IN BIOMEDICAL ENGINEERING

Image Processing Algorithms for Art Conservation

Project team

A hundred years ago, a 14th-century altarpiece by Francescuccio Ghissi was removed from its church, sawn into nine panels and sold to collectors. One of the panels, the final illustration of the life of St. John the Evangelist, subsequently disappeared.

For an exhibition reuniting the altarpiece panels, the North Carolina Museum of Art commissioned reconstruction expert Charlotte Caspers to paint a replacement ninth panel using 14th-century techniques and materials. The new panel's vivid colors and rich gold surfaces demonstrated how bright and sparkling these panels were in their own time. But adding this new work to the original panels would make those look dull and faded by contrast.

Partnering with the museum and Caspers, this project team developed image processing algorithms both to virtually age the new panel and to rejuvenate the old panels, allowing the museum to feature a rendering of the piece as it looked 650 years ago. Their techniques are being shared with conservators around the world.

As an applied mathematician, I love building and understanding mathematical tools to solve intricate real-world problems. In this project, I designed an algorithm to remove cradle artifacts from X-ray images of 17th-century European panel paintings so that art conservators can study X-ray images to obtain painting information such as crack locations, paint loss and existing restoration. My algorithm has been successfully deployed into a public software package and downloaded by over 100 art conservators around the world.

RACHEL YIN
PH.D. STUDENT IN MATHEMATICS

Spirituality and Chronic Disease in Southeastern North Carolina

Project team and Global Health Student Research Training summer project

Our fieldwork experience reinforced the notion that local is global. We were welcomed by the hospitality of the community and exposed to the richness of its culture and history, and we recognized how domestic health challenges equally deserve global health efforts.

HAN NGUYEN '18, PSYCHOLOGY AND GLOBAL HEALTH
JOYCE EN-HUA WANG '19, NEUROSCIENCE AND GLOBAL HEALTH

Robeson County, NC, has a diverse population of Lumbee American Indians, African Americans, Caucasians and Hispanics. The poorest county in the state, it ranks at the bottom for health outcomes, with a rate for end-stage kidney disease among the highest in the entire United States.

This project team and related Global Health Student Research Training summer team sought to understand more about why this population experiences chronic disease and how they deal with it. Spirituality has been shown to play an important role in the improvement of chronic disease outcomes among minority populations.

Team members assessed the spiritual and self-management practices of Robeson County adults living with chronic diseases, and assessed gaps, barriers and resources in the county regarding kidney disease. Living in the county over the summer, team members conducted quantitative and qualitative interviews with adults of all ages (with and without chronic kidney disease), led focus groups and tested participants for kidney disease. The long-term goal is to develop interventions to address residents' needs.

School Tracking and Students' Academic Identity

Project team

Tracking—the division of students into separate classes or groups based on perceived ability—has attracted criticism as a means of perpetuating achievement disparities in children from different racial, ethnic and socioeconomic backgrounds. Despite significant attention to tracking, we don't know enough about how tracking affects students' academic identity—the connection between personal identity and one's role as a student.

This project team conducted a study with sixth graders and teachers from four middle schools in Chapel Hill, North Carolina. Findings showed that being in the accelerated math track—but not in the regular track—was significantly associated with having a stronger academic identity. Students' positive perceptions of their teachers were also correlated with having a stronger academic identity.

> Tracking is endemic in all schools and can perpetuate disparity. Students are aware that they are tracked. That impacts how they view themselves and how teachers view them. And that affects how they'll perform in the classroom. If we can think of ways to help students learn the same material, there could be a way to reduce some of the disparities.
>
> **KAMILAH LEGETTE**
> **POSTDOCTORAL FELLOW, SOCIAL SCIENCE RESEARCH INSTITUTE**

The team submitted three papers to journals, presented findings and made recommendations to school officials for strengthening students' academic identity and reducing teachers' racial bias. They also applied for grants to continue this work with more schools. Student team member Nia Moore designed a spin-off study to conduct in Cuba over the summer to compare students in a communist society with those in a capitalist system.

Energy Data Analytics Lab

Project team and Data+ summer project

Duke's Energy Data Analytics Lab develops and applies tools to transform data into solutions for increasing the reliability, security and environmental sustainability of energy systems.

A Data+ summer team set out to estimate building and transportation energy consumption at a disaggregated level. The team built a dataset of satellite images, with footprints and heights for more than 40,000 structures, along with road annotations. Researchers can use the dataset to train algorithms to determine a building's volume from an image. This significant contribution to the broader research community has applications in urban planning, civil emergency mitigation and human population estimation.

A year-long project team (containing some of the summer students and adding new team members) took this work further. The team developed a new automated approach for estimating building-level energy consumption from high-resolution aerial imagery and U.S. Department of Energy building energy consumption data. This kind of information can be useful for cities in planning energy infrastructure and developing policy, but the time-intensive collection of the data has typically been cost-prohibitive.

Tested in Gainesville, Florida, the team's automated approach yielded promising initial results. Student team member Hoël Wiesner presented the team's work to North Carolina legislators at the State Capitol.

> This project was a unique opportunity to work on groundbreaking data science research as part of a talented interdisciplinary team, which was very useful in preparing me for a job in the energy industry where knowledge of sciences, economics and policies is crucial.
>
> **HOËL WIESNER**
> **MASTER OF ENVIRONMENTAL MANAGEMENT '17**

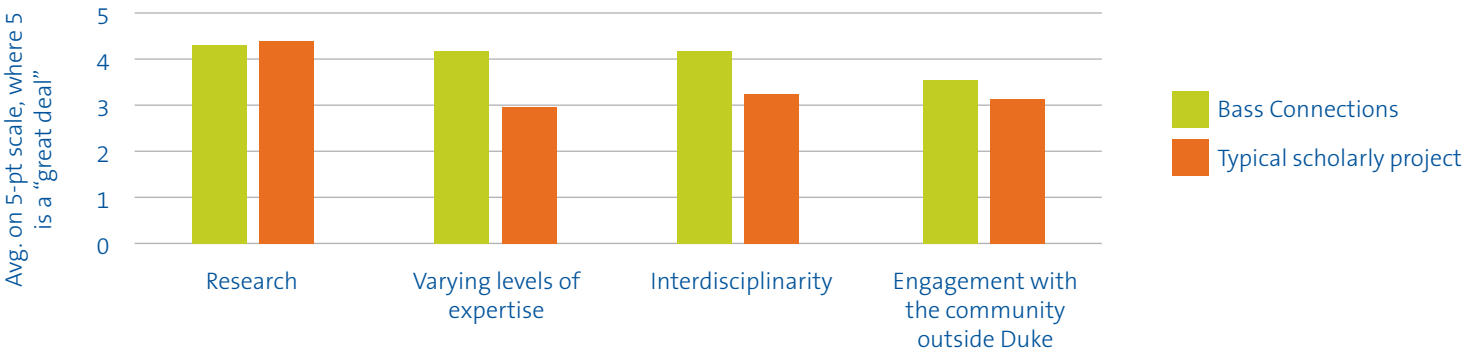
PROGRAM EVALUATION

An annual evaluation helps Bass Connections leadership to improve the program and to understand its impact on students, faculty and the societal issues addressed through the projects.

Highlights from the 2016-2017 Survey

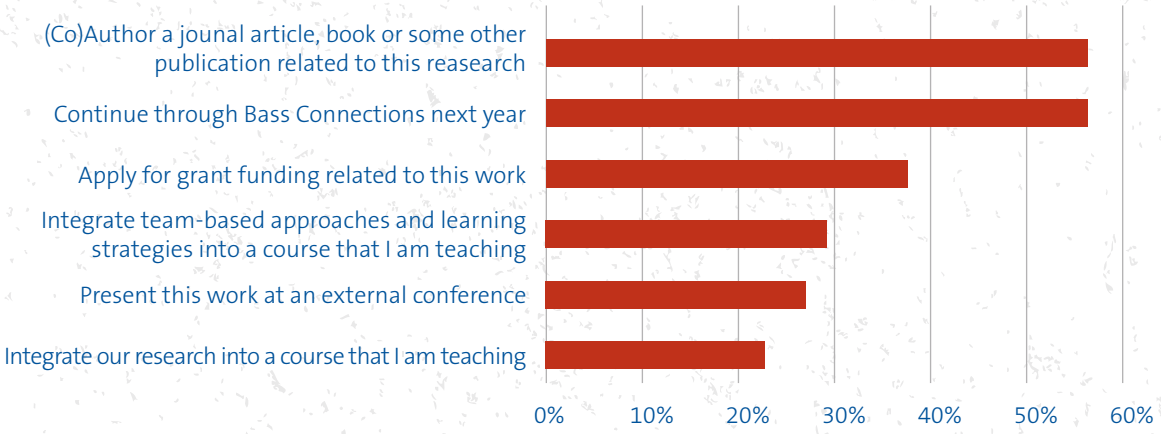
A DISTINCTIVE EXPERIENCE FOR FACULTY

PLEASE INDICATE THE EXTENT TO WHICH YOUR BASS CONNECTIONS TEAM/TYPICAL SCHOLARLY PROJECT INCORPORATES EACH OF THE FOLLOWING:



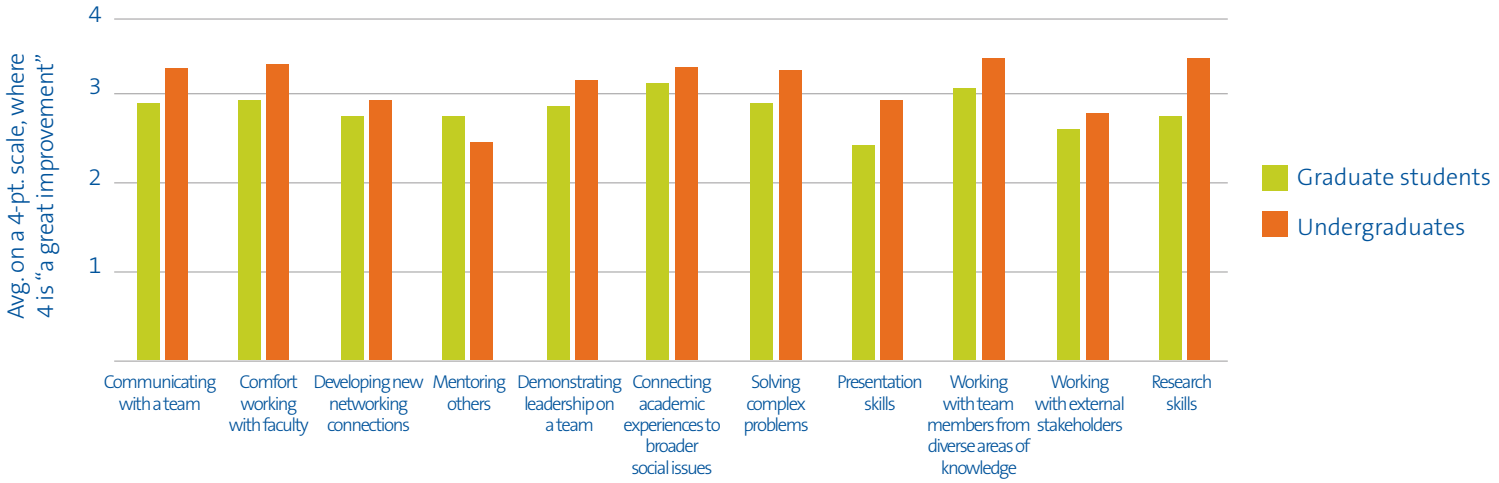
FACULTY PLANS TO CONTINUE WORK

DO YOU INTEND TO CONTINUE WORK RELATED TO THE TOPIC OF YOUR BASS CONNECTIONS TEAM IN ANY OF THE FOLLOWING CAPACITIES? PLEASE SELECT ALL THAT APPLY.



SKILL DEVELOPMENT

AS A RESULT OF BASS CONNECTIONS, TO WHAT EXTENT DO YOU BELIEVE YOU HAVE IMPROVED IN THE FOLLOWING AREAS?



DUKE SENIOR SURVEY RESULTS

In Duke's annual survey of graduating seniors, those who participated in Bass Connections were more likely than other seniors to report that their experiences at Duke helped them improve their ability to learn on their own, communicate well orally, create original ideas and solutions, develop global awareness, function effectively as a member of a team and plan and execute complex projects.

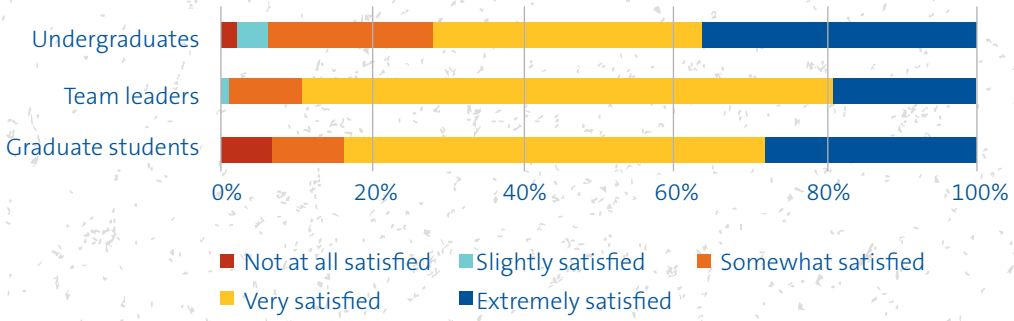
SATISFACTION

81% of undergraduates said that Bass Connections provided something unique to their learning experience at Duke by "a great deal" (50%) or "quite a bit" (31%)

93% of undergraduate and graduate students would recommend the program to a friend

96% of team leaders would recommend the program to a colleague

OVERALL, HOW SATISFIED ARE YOU WITH YOUR BASS CONNECTIONS TEAM EXPERIENCE?

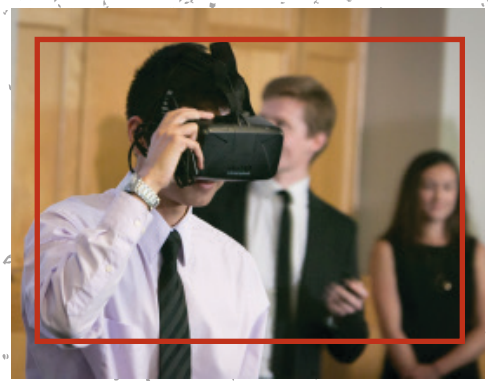


BASS CONNECTIONS SHOWCASE AND AWARDS

At the first annual Bass Connections Showcase, the 2016-2017 project teams shared their research with more than 300 members of the Duke community. The event was also an opportunity to recognize the winners of several awards and grants.

Talks

AN ENVIRONMENTAL APPROACH TO GLOBAL HEALTH	**Justin Lana and Luiza Perez** Environmental Epidemiology in Latin America
AUTOMATED BUILDING ENERGY CONSUMPTION ESTIMATION FROM AERIAL IMAGERY	**Eric Peshkin and Hoël Wiesner** Energy Data Analytics Lab
REUNITING AND REJUVENATING THE GHISSI ALTARPIECE	**Geena Gomez** Image Processing Algorithms for Art Conservation
VOICES TOGETHER: MUSIC THERAPY IN ELEMENTARY SCHOOLS	**Paulina Paras and Max Westerkam** Voices Together: Music Therapy and Autism in Elementary Schools
TACKLING CONCUSSIONS	**Maddie Bernstein, Edward Hsieh, Daniel O'Connell & Joost Op't Eynde** Oculomotor Response as an Objective Assessment for Mild Traumatic Brain Injury in the Pediatric Population



Grants and Awards

FOLLOW-ON STUDENT RESEARCH GRANTS

Anuhita Basavaraju '18 (Program II), Art, Vision and the Brain

Ashley Blawas '18 (Biomedical Engineering), **Brandon Dalla Rosa** '19 (Electrical & Computer Engineering), **Sam Kelly** '18 (Mechanical Engineering), History and Future of Ocean Energy

Kira Battle (Doctor of Physical Therapy), Global Alliance on Disability and Health Innovation (GANDHI)

Aakash Jain '18 (Biology and Economics), **Kushal Kadakia** '19 (Biology and Public Policy), **Jackie Lin** '18 (Biology), **Shivani Shah** '18 (Biology and Public Policy), NC Medicaid Reform Advisory Team

Adriana Lapuerta '20 (Computer Science), NC Jukebox

Luiza Perez '19 (Sociology and Global Health), Environmental Epidemiology in Latin America

Jeremy Spater (Ph.D. in Political Science), Studying the Real 'Slums' in Bangalore, Patna and Jaipur

OUTSTANDING MENTORSHIP

Tony Fuller (Doctor of Medicine),
Improving Neurosurgery Patient Outcomes in Uganda

Stephanie Reist (Ph.D. in Romance Studies and Master of Public Policy),
The Cost of Opportunity? Higher Education in the Baixada Fluminense

POSTERS

Judges' Selection: **Identifying the Needs and Barriers to Patient-Family Education to Improve Neurosurgery Patient Outcomes in Mulago National Referral Hospital, Uganda** (Joao Vissoci, Chinemerem Nwosu, Sandra Batakana, et al.), Improving Neurosurgery Patient Outcomes in Uganda

Audience Choice: **Automated Building Energy Consumption Estimation from Aerial Imagery** (Mitchell Kim, Sebastian Lin, Sophia Park, et al.), Energy Data Analytics Lab

PHOTOS

First Place: **Adaír Necalli** '19 (Linguistics),
The Cost of Opportunity? Higher Education in the Baixada Fluminense

Second Place: **Sarah Zimmermann** '18 (Statistical Science), Studying the Real 'Slums' in Bangalore, Patna and Jaipur

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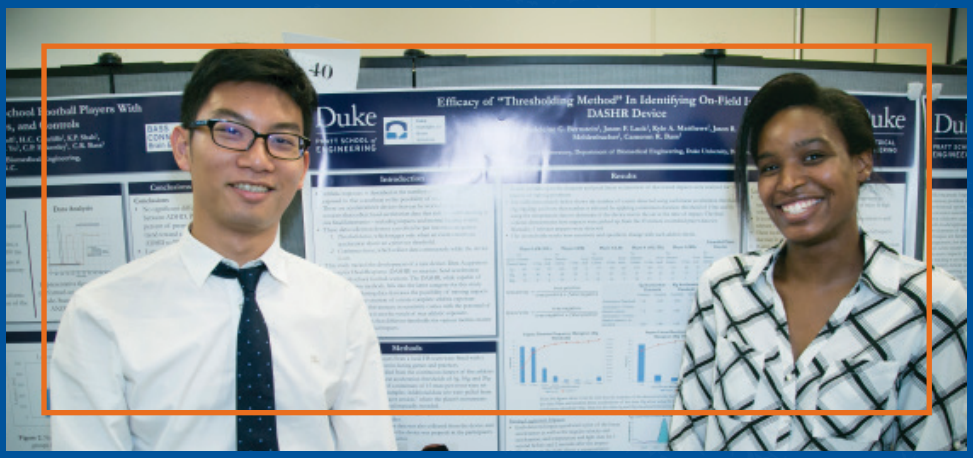

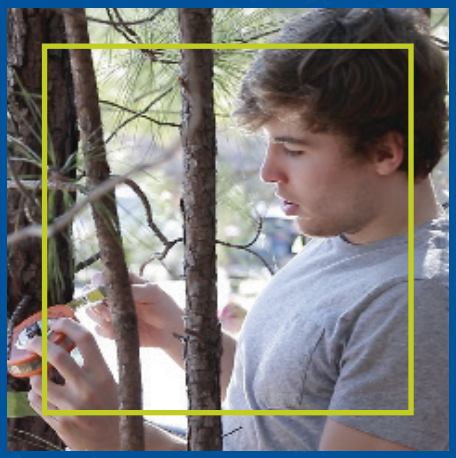

bassconnections.duke.edu