

STEM ACTIVE LEARNING VIGNETTE SERIES

Turning the TIDES

HOW WRIGHT STATE AND THE UNIVERSITY OF DAYTON
ARE TRANSFORMING TEACHING AND LEARNING FOR
UNDERREPRESENTED STUDENTS

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FINDING
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CHANGE



The Investment

Since beginning active grantmaking in 2008, the Leona M. and Harry B. Helmsley Charitable Trust has committed more than \$1.5 billion dollars to nonprofits and other mission-aligned organizations in the United States and around the world. Although no longer a focus for the Trust, from 2008-2016 the Trust's postsecondary education grantmaking focused on increasing the number of college graduates in science, technology, engineering, and math (STEM) fields — particularly female students and students of color.

The Trust's postsecondary grantmaking portfolio supported networks of higher education institutions committed to improving instructional practices, primarily for gateway STEM courses, and creating incentives to adopt model policies, practices, and systems that can help improve student retention and completion. Each network adopted one or more "active learning strategies," evidence-based teaching and learning approaches that can improve students' performance in STEM. While the Helmsley Charitable Trust's investment has concluded, most of the networks continue to move forward with implementing these strategies.

The Evaluation

As the STEM Active Learning Networks evaluation and learning partner, Equal Measure is tracking the impact of the Helmsley Charitable Trust's postsecondary grantmaking on faculty, departmental, and institutional change across networks. Since 2014, Equal Measure has examined the conditions that support progress at the institution, department, and classroom levels toward network goals. Using qualitative methods, we have documented the results of network efforts, including emerging outcomes at the institution, department, and educator levels. In 2017, Equal Measure visited five campuses representing four of the initial seven networks to delve into site-level implementation.



The American Association of Colleges and Universities' (AAC&U) Teaching to Increase Diversity and Equity in STEM (TIDES) network was one of the active learning networks funded by the Helmsley investment. TIDES partners have worked for the last three years, "to improve the learning outcomes and increase retention of students historically underrepresented in the computer/information sciences and related STEM disciplines."¹

In June 2017, Equal Measure conducted a two-day site visit to Wright State University (WSU) and the University of Dayton (UD) in Dayton, OH. In this vignette, we share lessons about how these two exemplary TIDES partners are pursuing their shared goal of transforming teaching and learning, while creating more access to STEM fields for underrepresented students. A key feature of the success of the schools' models is the trust that exists between the TIDES teams, their departmental peers, and their on-campus leadership (such as provosts and deans).

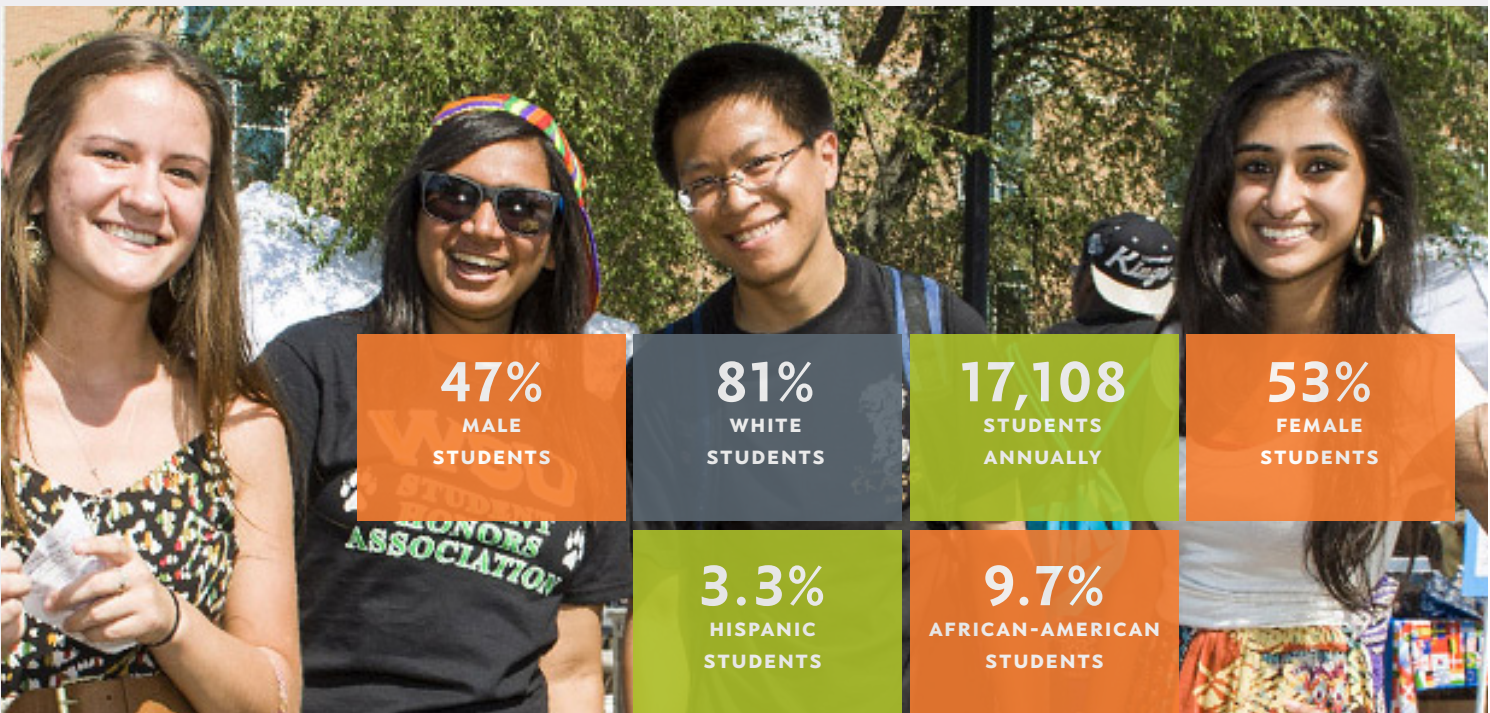
AAC&U TIDES Partner Schools

- Bryn Mawr College
- California State University, Northridge
- Connecticut College
- Fairleigh Dickinson University
- Fayetteville State University
- Howard University
- Knox College
- Lawrence Tech University
- Montgomery College
- Morgan State University
- Ohio Northern University
- Pitzer College
- Queens College CUNY
- Salish Kootenai College
- Smith College
- University of Dayton
- University of Puerto Rico- Humacao
- University of Wisconsin- Whitewater
- Westminster College
- Wright State University



About The Sites

WRIGHT STATE UNIVERSITY



WSU Demographics³

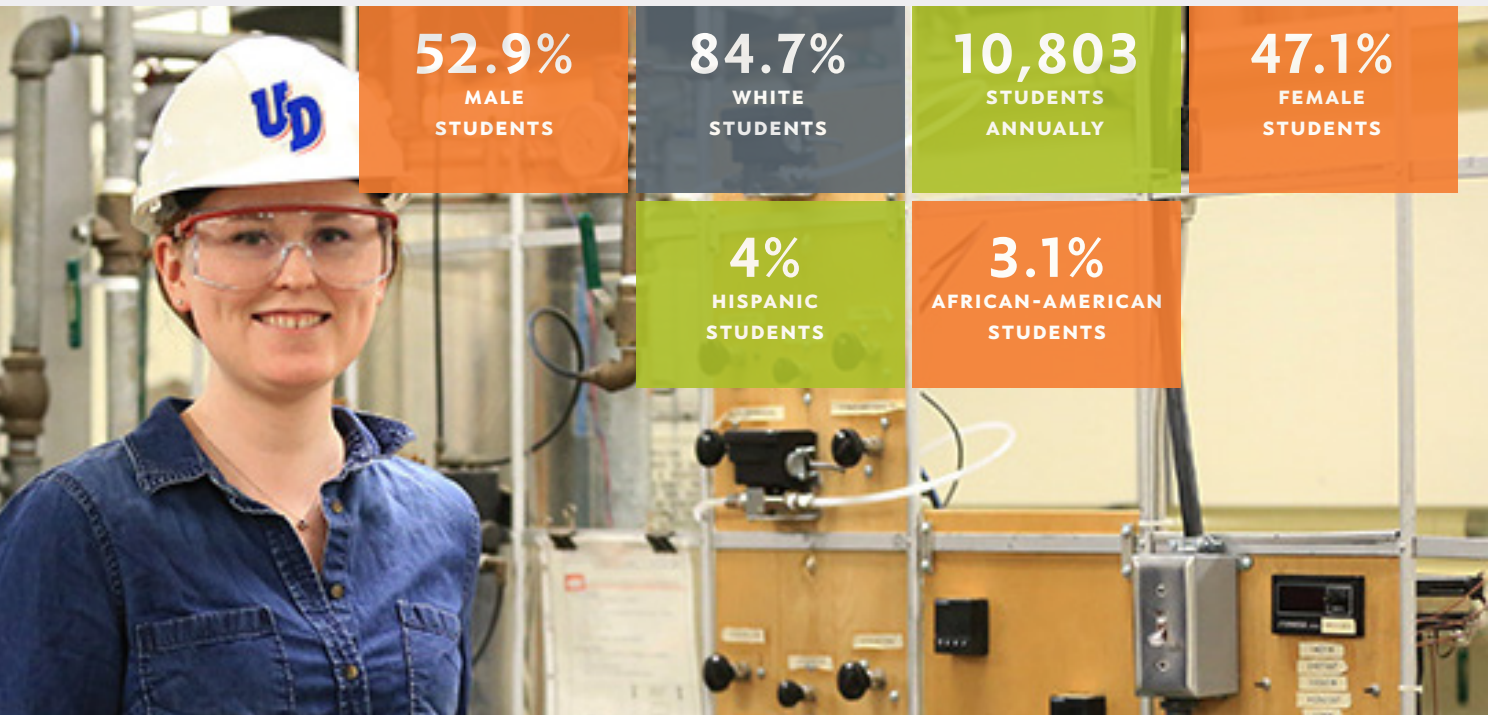
With high admission rates, Wright State University has educated a broad range of students in its 50 years of existence.² According to its faculty, the school is well known for serving non-traditional students, students with disabilities, and low-income students with a relatively affordable education. In 2012, WSU⁴ began the successful implementation of the Student Centered Active Learning Environment with Upside-down Pedagogies (SCALE-UP) model in a single computer engineering course. SCALE-UP is an inverted lecture style of instruction in which students view content at home and conduct group activities in class. The TIDES-supported expansion of the SCALE-UP model has helped catalyze three efforts to improve the outcomes of underrepresented students in STEM over the last three years:

- Redesigning all five courses in the shared core computer science and computer engineering curricula based on the SCALE-UP model (Computer Science I, Computer Science II, Digital Systems Design, Computer Organization, and Data Structures);
- Implementing in-class interventions and active learning strategies (such as less direct lecturing and more groupwork) that remove barriers to underrepresented student learning in the five core courses; and
- Measuring the impact of the SCALE-UP model and active learning strategies on underrepresented students in the five core courses.



About The Sites

UNIVERSITY OF DAYTON



UD Demographics⁵

The University of Dayton is a highly-selective Marianist Catholic research university that has served students for nearly 100 years.⁶ Presently serving more than 8,000 students, UD has implemented the Inquiry-Based Computer Science Curriculum for STEM Student Success program⁷ in several sections of a College of Arts & Sciences entry-level computer science course over the last three years. Emanating from the UD team's desire to transform computer science and related curricula on campus, and to inform pedagogies of other STEM-related disciplines at the university, this TIDES-supported inquiry-based program aimed to achieve three goals:

- Eliminate four significant barriers for underrepresented UD students in computer science fields:
 - » Major variations in pre-college computer experience and expectations
 - » Low self-confidence that negatively affects academic performance and interest
 - » The nature of computer-related curriculum and pedagogy that do not engage students
 - » Peer culture that is not conducive to long-term success in computer science
- Assess and disseminate outcomes from the program to provide lessons for other disciplines and colleges at UD
- Scale the program's initiatives to other UD natural science disciplines, such as Biology



About The Sites



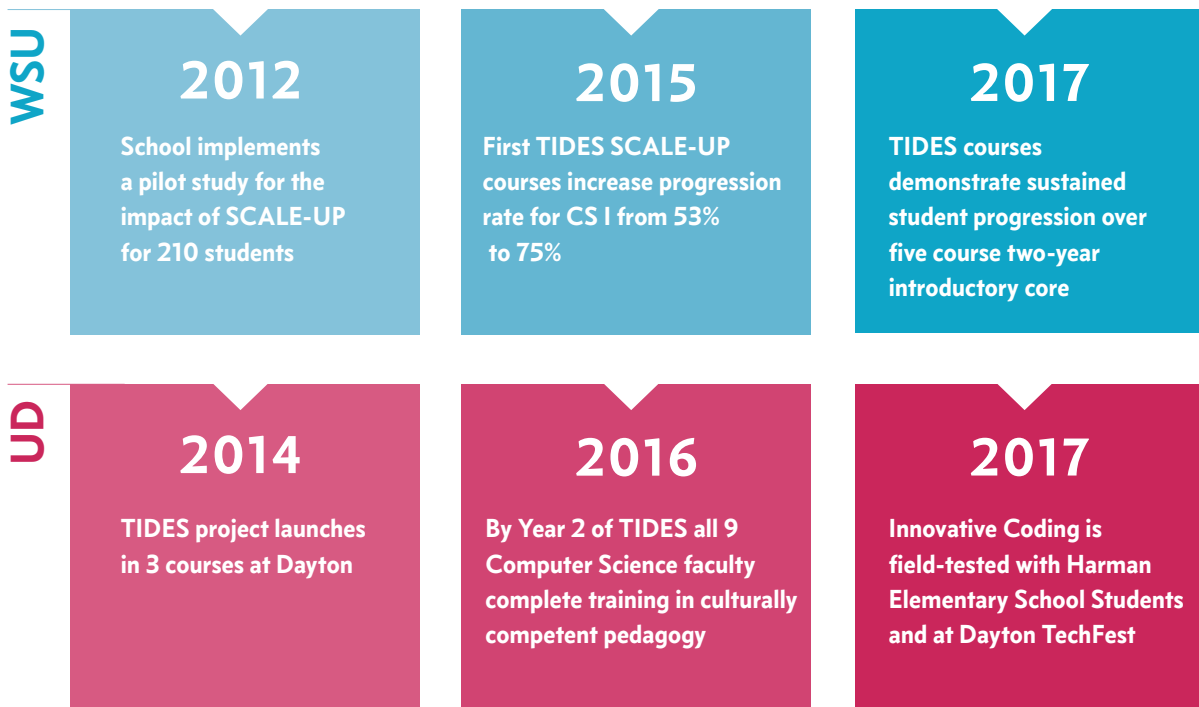
A transformed SCALE-UP Classroom at WSU

In the last three years, UD and WSU have made strides in achieving their shared goals of transforming teaching and removing barriers to learning for underrepresented students in STEM. One quality that emerged from both sites is the existence of a campus-wide culture of innovation that preceded the universities' entrance into the AAC&U-TIDES network—a culture that has been continually advanced even after joining the network. Each university's project had high-level champions in their administrations undertaking pedagogical reforms complementary to the AAC&U-TIDES active learning interventions.

Both universities' efforts were also supported by department chairs (Dr. Zargham at UD and Dr. Rizki at WSU), who created opportunities for their colleagues to try new approaches to instruction that would promote success among underrepresented students in computer science and computer engineering. Additionally, each project had principal investigator teams (led by Dr. Pair at UD and Dr. Doom at WSU), composed of educators and administrators who understood the unique challenges of implementing curricular reform. A final and crucial element behind the advancement of the two initiatives was having faculty in both schools who strongly supported the teaching and learning enhancements being implemented by the projects.



FIGURE 2:
TIMELINES Wright State University (WSU) University of Dayton (UD)



The active learning strategies implemented by Wright State University and the University of Dayton have had positive effects on faculty, students, and the broader campus and local communities.

IMPLEMENTATION PROGRESS

The WSU and UD teams worked with their STEM department colleagues to implement active learning strategies in their classrooms—positively affecting the experiences of women and other underrepresented minorities in their courses and on their campuses.

In the case of UD, this included the design and launch of the Introductory CS149 course, Creative Media. UD has seen students in its Computer Science program who pass this course earn better grades than their counterparts in future Programming I and II courses.

WSU has experienced promising early results in terms of the success of students enrolled in classrooms which had implemented their models around active learning strategies and reducing the effects of five barriers to student success—as compared to a hybrid lecture course that did not intentionally address those barriers (Academic Preparation, Motivation and Interest, Psycho-Social Skills, Opportunity, and Cognitive Skills).



These results hint at the model's promise for supporting the persistence of women and under-represented minorities in STEM. A key element in implementing this project was the on-campus pedagogical training provided to instructors by principal investigators, and the participation of professors in AAC&U-TIDES convenings, at which they could share lessons and insights with other STEM professors seeking to apply active learning strategies at their institutions. Professors interviewed at both UD and WSU reported that these changes in instruction and student mentoring practices have led to better relationships with their students and increased overall student satisfaction with these introductory courses. Pre- and post-course surveys and informal conversations also suggest that students at each university were pleased with their experiences in these modified courses.

WSU developed a Student Success Center through which to spread its model for active learning and inverted instruction to the broader campus. Beyond the changes made within specific courses, the WSU team has influenced the campus more broadly through supporting faculty in transitioning to active learning environments across the University. Members of the WSU team have led university-wide panels, round-tables, and helped to establish an annual teaching for student success symposium designed to lower barriers for faculty transition towards culturally relevant and student-centered active learning strategies. Faculty from across all disciplines of study at WSU have helped break down several large lecture courses in ways that enable a personalized classroom experience in line with the SCALE-UP active learning approach. Unlike the traditional lecture style of instruction, WSU faculty are encouraged to become more mobile and engage these students directly to assess their understanding of the material being taught.

UD has created a virtual reality software package with the potential to affect additional disciplines and future pipelines of students who enter computer science fields. Beyond changes in the CS149 core course, the UD team created a virtual reality software package called "Innovative Coding," which helps students without extensive math and science backgrounds better understand the basics of coding by creating virtual worlds. This game-oriented software can help less experienced college students, as well as students in the local K-12 system, gain exposure to computer science. The Innovative Coding software has been piloted with a local middle school to great effect, and has the potential to spread to schools that teach underrepresented youth in Dayton.

TIDES offers us a great opportunity to see a bigger picture of teaching and how to get students involved from the early stages of their studies...I learned quite a bit from other universities and it is my pleasure to see how they actually organize things together to do this for students.

-PROFESSOR, UNIVERSITY OF DAYTON



EMERGENT CROSS-CAMPUS THEMES

While UD and WSU have varied student bodies, missions, and cultures, several cross-cutting themes emerged from our site visits:

- **Connect curricular interventions to campus-wide reform efforts.**

In both cases, faculty highlighted how TIDES projects complemented larger strategies to increase retention and broader success for students. These interventions include an undergraduate educational initiative at Dayton aimed at retaining students; and campus-wide momentum at Wright State to implement more active learning strategies in classrooms.

- **Maintain a student focus.**

In both cases, faculty looked beyond the drop-failure-withdrawal rate to adopt new teaching methods that improve students' experience in courses. Through survey data and sharing classroom successes, the principal investigators at both campuses could see that the inverted-style coursework and transformed classroom environment resonated with the most underrepresented students. This included work conducted outside of the classroom and new methods of engaging students (such as coaching and placing students into learning cohorts).

- **Empower faculty to lead the change.**

One of the important features shared by both universities is the belief that faculty engagement with students had to change to achieve retention and success goals. Through informal and formal coaching with the TIDES network, and support from their department chairs, faculty were given opportunities to experiment with new methods in-class. These new methods included more group work with students and less direct lecturing from faculty. Faculty were also empowered to change their system of office hours and make contact with students on campus. This new relationship with students contributed to faculty themselves becoming transformed by these projects—as they gained a more holistic view of the students they are teaching through building relationships outside of the classroom.



The real question is, 'what's going on in a student's mind?' Are they able to see progress towards a degree every single term? And what is the next step? And do I have a chance at earning this degree? And the answer now in computer science is every kid has a chance.

-DEAN, WRIGHT STATE UNIVERSITY



- **Focus on institutional resources for sustainability.** Leaders of the WSU and UD initiatives noted that TIDES support provided opportunities to bring together colleagues who understand the need to undertake curricular reform in STEM education. Teams at both universities have created synergies between this small investment and the larger goals of the universities to create sustainable models for the schools that will enable them to continue to evolve their curricula after the investment wanes. To build these synergies, university staff were engaged in non-academic areas—such as advising and in their work with UD’s Learning Teaching Center—as well as in trainings and face-to-face meetings which helped colleagues think about how resources can be pooled to transform the way that underrepresented students engage learning in STEM fields.

At WSU, the university provost has committed institutional resources to continue the transformation of introductory courses through active learning/flipped-classroom approaches made possible in the Student Success Center. Members of the UD team will continue to inform the field as a leader in the Ohio region of AAC&U’s Project Kaleidoscope⁸ network that connects STEM faculty to the latest reforms and new concepts in STEM teaching and learning. UD will also continue its Innovation Coding program with college and pre-college students.



The TIDES initiatives of Wright State University and the University of Dayton in the computer science field have broader applications for schools wishing to implement curricular and pedagogical changes to engage more underrepresented students. We share several implications below:

- ▶ **Establishing a culture of trust can foster support for curricular and pedagogical experimentation.**

An environment of trust can open room for experimentation (and potential failure) with curricular reform or other campus-wide efforts. While campus and departmental cultures differ, enlisting champions who view the planned reform or intervention (such as active learning) as a strategy that supports multiple levels of institutional goals can spur progress.
- ▶ **Viewing students as partners in learning can create more opportunities for academic success.**

Active learning approaches at colleges and universities can do more to transform the instructor-student relationship than including more group work and fewer lectures. Barriers to student success must be considered in ways that lead to new thinking about what happens outside of the classroom environment. This approach may provide an opportunity to garner student feedback beyond end-of-semester surveys, and contribute to an environment of continuous quality improvement in classroom instruction.
- ▶ **A “bottom-up approach” to curricular reform can inspire faculty to take the lead on designing strategies and programs.**

Faculty and administrators across the STEM Active Learning investment agree that faculty are the primary agent of change in curricular reforms. Although support from department chairs and administrative staff is key, individual professors must be given the space to understand the impact of active learning strategies, and to experiment with new approaches to learning in and out of classrooms. Professors must also be provided with resources to shift the learning environment (including course releases and opportunities to participate in communities of practice).
- ▶ **Networks such as AAC&U-TIDES can play a critical role in providing opportunities for faculty to create changes in curriculum and teaching practices.**

Interviewees across campuses spoke about the “transformative” experiences in the network. Along with opportunities to talk with peers in a more informal setting than traditional conferences, networking with other faculty from other schools with different philosophies and student demographics created energy around improvements in teaching, course-design, student supports, and student interaction back on network members’ home campuses.



WRIGHT STATE UNIVERSITY TEAM



Dr. Travis Doom



Dr. Michael Raymer



Dr. John Gallagher

Principal investigator Dr. Doom worked with colleagues in the Computer Science & Engineering department to implement the SCALE-UP model with support from TIDES. The professors also have worked with colleagues from other departments to adapt active learning strategies across the Wright State campus.

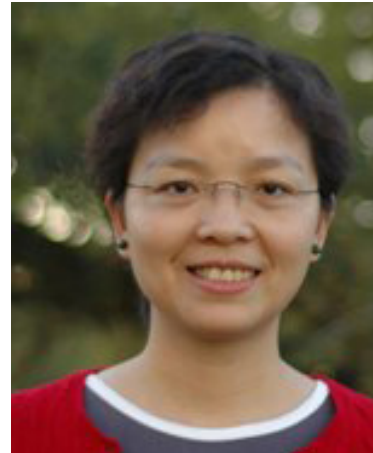
UNIVERSITY OF DAYTON TEAM



Dr. Medhi Zargham



Dr. Donald Pair



Dr. Zhongmei Yao

Department chair and principal investigator Dr. Zargham worked with his team to transform three introductory sections in Computer Science at the University of Dayton. They also supported colleagues in integrating culturally competent pedagogy into their instruction. Dr. Zargham led the development of “Innovative Coding,” a software package that has great potential to help young children of all backgrounds develop the familiarity with coding principles.

Equal Measure would like to thank the interviewees who participated in the site visits:

University of Dayton

Dr. Donald Pair
Associate Dean

Dr. Zhongmei Yao
Associate Professor of Computer Science

Dr. Mehdi Zargham
Chair of Computer Science

Dr. Jennifer Speed
Director of Extramural Funding

Dr. Suzanne Franco
External Evaluator

Dr. James Buckley
Associate Professor and
Director of Graduate Program
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Dr. Ju Shen
Assistant Professor and
Director of Interactive Visual Media Lab

Dr. Raghava Gowda
Associate Professor of Computer Science

Dr. Kim Trick
Assistant Dean

Dr. Deb Bickford
Associate Provost

Dr. David Wright
Director of Academic Technology
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Elizabeth Uptegrove
Teacher, Harlan Elementary School

Wright State University

Dr. Travis Doom
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Science and Engineering

Dr. Mateen Rizki
Chair of Computer Science and Engineering

Dr. Nathan Klingbiel
Dean of the College of Arts & Sciences

Dr. John Gallagher
Professor and Faculty Program Director
of Sensor Systems Research

Dr. Michael Raymer
Professor and Director of the Graduate Program
for Computer Science and Engineering

- 1 To learn more about AAC&U-TIDES, see <https://www.aacu.org/tides>
- 2 To learn more about Wright State’s history and mission, see: <https://www.wright.edu/about>
- 3 Wright State University Fact Sheet: <http://webapp2.wright.edu/web1/newsroom/for-the-media/factsheets/>
- 4 WSU objectives drawn from TIDES proposal: “Research and development of educational methods for use in inverted-lecture computer science classrooms based on a model of the barriers to student success in STEM”
- 5 University of Dayton College Profile: https://www.collegedata.com/cs/data/college/college_pg01_tmpl.jhtml?schoolId=347
- 6 To learn more about UD’s history and mission, see <https://udayton.edu/about/history/index.php>
- 7 UD objectives drawn from AAC&U-TIDES proposal: “Inquiry-Based Computer Science Curriculum for STEM Student Success Program”
- 8 For more information on AAC&U’s Project Kaleidoscope work, see: <https://www.aacu.org/pkal>

