Kindling, Spark, Oxygen: The Wave of Change for Students at Public Research Universities

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A suggestion I received from our retreat organizers was to consider providing, as a university president, a "view from the top." As a prologue to the view I see, I want to share a story of an undergraduate student whose path crossed mine several times during his years at Iowa State. This past spring, Jackson Orr earned his B.S. at Iowa State in biological systems engineering. In the fall of 2018, his freshman year, I first met Jack as I greeted new students moving into our residence halls.

We continued to cross paths randomly over the next few years. Before he graduated this past spring, Jack contacted me because he wanted to share how meaningful his undergraduate research experience had been for him. It truly changed his path to the future.

Jack conducted research for faculty in our agricultural and biosystems engineering department and in our chemistry department. As an engineering major, he conducted an honors chemistry project. After taking the "organic chemistry for engineers" course, he immediately enrolled, as a sophomore, in an organic chemistry course designed for chemistry majors, emphasizing a more in-depth treatment of the subject. His insightful questions caught the attention of the faculty instructor who invited him to join a lab group, where he contributed to a peptide chemistry project looking at folded biomolecules. He also conducted biological systems engineering research with faculty in his home department.

Jack told me his undergraduate research experience made him appreciate the application of fundamental knowledge. Without his involvement in research, he did not think he would have truly appreciated the full value of his coursework. For Jack, bringing research into the equation of lecture and class lab work brought everything into focus — it tied it all together into a cohesive picture. For him, research exposed how the principles of science and engineering could be used to constantly transform the way we view the world. He told me that, with each new experiment and each new published paper, the world as we know it takes on a different light.

Jack came to the realization that the researcher's job is to share with a larger community the value of these ideas, these new steps of progress, and their potential to contribute to the betterment of humanity.

He also came to realize that, in research, there were no answers at the back of the book, and that a research problem may not have just one "correct" answer. The process almost always is accompanied by failures along the way, but Jack found motivation in his underlying passion for the science — and that potential for making a contribution to society.

I marveled at Jack's sense of understatement: He told me that "there was something to be said about contributing to novel problems." This fall, Jack Orr will begin a graduate program in chemistry at the University of Minnesota. I am certain we will be hearing more about him and his work in the coming years.

Today's Students, University Landscape

I wanted to put Jack Orr's experience in the foreground, against the backdrop of the challenges that beset our broader

student population.

Students are struggling to regain a sense of continuity and connection as we continue to emerge from the high-anxiety years of COVID-19. While we are hopeful that we may be past the worst of the COVID-19 years, uncertainty lingers. "Student disengagement" is a phrase we hear more often. During the pandemic, faculty have shared, anecdotally, that fewer students are showing up to class and turning work in on time. The wave of pandemic-induced change resulted in many students feeling overwhelmed and facing financial and technological difficulties.

The number of college dropouts increased in 2020, the highest levels seen in the past decade. Twenty-six percent of students who started college in 2019 did not return the next year during the pandemic. A significant number cited mental health concerns for the reason why; also, mental health was a contributing factor for a third of the students who didn't finish degrees.

The most frequently mentioned reason for leaving college was change in motivation or focus, or a life change. These students struggled to see how their college education connected to a meaningful career or a successful life in the future.

My view — my lens — is one of a president of a land-grant university, a university of science and technology. For 165 years, our mission has been one of access, opportunity, research, extension and outreach, and practical, purposeful education. Our hallmark — our number-one job — is helping students make that leap into their futures; to equip them so that when the waves of change come rolling in, they are able to surf.

We do so in countless ways. Faculty in every discipline mentor students toward the opportunities and resources that might best serve them and move them forward from wherever they are. They believe deeply in helping all students excel — a land-grant university idea and ideal.

But we have a special opportunity to invite and welcome undergraduate students into the world of research.

Kindling, Spark, Oxygen

The title of my presentation comes from something one of our faculty said in front of more than 200 donors to our university. He was part of a faculty research panel explaining how our research teams were using innovation and partnerships to advance benefits to society. He made the point that students were an important part of the research team. He said that to make a fire, you need a fuel source — kindling —, a spark, and oxygen. He said students bring the kindling and the spark, and it's our faculty who provide the oxygen — the environment — to set a blaze of innovation going.

For his audience, this faculty member was speaking in context of the resources made possible by donor-funded, endowed faculty positions. A faculty with an endowed position sees the spark in a student and know it's ready to take off, and it's those flexible philanthropic dollars that help supply the oxygen. It's an investment in the future, helping to align talented students who have the energy and excitement to make their impact on the world — who are ready to start a fire.

Science has been described as humankind's most cooperative endeavor. The barriers that separate us in other parts of our world can be lowered in a lab. Research on the benefits of undergraduate research demonstrates, most compellingly, its efficacy for students of diverse identities and demographics. Students of color, indigenous students, low-income students and first-generation students experience the greatest gains from participating in research, including persistency to graduation, the pursuit of advanced degrees, and self-efficacy. Not

surprisingly, these students particularly respond to supportive relationships with mentors and peers.

Over a decade ago, the prediction was that a wave of change would expand the opportunity for undergraduate research beyond the "boutique experience" of a small percentage of science majors. More efforts are incorporating undergraduate research into the curriculum — course-based undergraduate research experiences, or CUREs.

The Freshman Research Initiative concept, developed at the University of Texas at Austin, has been one way to engage students right away with scientific research. At Iowa State, we used funding from the Howard Hughes Medical Institute to establish a Freshman Research Initiative, to promote student interest and retention in science through 13 faculty-designed introductory courses. The implementation of first-year research experiences in association with learning communities was found to provide instructional support and build on ongoing retention efforts in the communities. In examining affective and behavioral gains of first-year students, it was found that after a single semester, students involved in research reported positive gains relating to research, and to thinking and working like scientists. Students expressed comfort working collaboratively and communicating science — outcomes that scored highly among personal gains. Experimental design and problem solving were some of the highest reported gains in the category of "Thinking and Working like a Scientist." Under "Attitudes and Behaviors of a Researcher," project ownership was a major gain.

When offered to list additional gains not included in other categories, the most common theme from students related to working with others. CURE had a positive impact on students' belonging as they worked collaboratively with others. It was noted that a one-semester experience probably was too short to achieve greater gains in a sense of belonging. That sense of belonging develops significantly over time as the number of collaborations increase and external validation by the broader scientific community becomes a possibility.

Drawing Students into Research

The value of undergraduate research as a high-impact practice should be made more available and within reach of more students. Clearly, the role of faculty mentors is the number-one factor. In interviews with 33 international scientists honored for their achievements in undergraduate research mentoring, a defining characteristic was their ability to balance structure and personal consideration for their students. Faculty mentors provided the environment — the oxygen — that allowed students to simultaneously experience both a sense of freedom and a sense of control within the research process. The "inculcation of enthusiasm" was the key element, and the earlier the better.

In May our graduating senior Jack Orr credited four faculty members for being influential mentors to him. He said they were nothing but supportive throughout his journey, always taking the time to make sure he felt valued as a person and as a student — while at the same time pushing him to be his best. What stood out for him, he said, was how inspired he felt when he interacted with each of these mentors. The excitement and passion they infuse into their work were contagious; Jack reported he could not help but feel uplifted and energized.

So I asked Jack's faculty mentors what it was they did or said when a student like Jack appeared at their doors — or any student who expressed an interest in research. Here's what they told me:

- Look for how a research program overlaps with interests they already have; find that spark.
- Listen to a student's plans on where

he or she honestly wants to go, and work on the transferrable skills that will help them get where they want to go.

- Help them not to get lost. Research is challenging because there's so much you can get lost in. It's easy to try to do too much, so focus on one step or one aspect of the problem. Talk regularly about each step, and what the next step will be. Find out what's going well and what's not, but always talk about next steps. What's the next incremental step in the series of small steps that keep adding up.
- Provide assurance, and reassurance, that what they are producing is meaningful. Students often struggle with "Am I good enough? Is this the right step?" Work to build up their confidence.
- Reach out to the students who are inquisitive. Sometimes it's planting the seed of an idea: Have you ever thought about working in a research lab?
- Try your best to get students to understand that if they put in the work, there will be a return on investment — you arm yourself with useful knowledge when you realize it's time well-spent. It helps to solidify the notion of "I can succeed."
- Our teaching programs give students the tools; innovation is taking those tools and putting them to use to build something. Tell students that, with these tools, they can create something new, solve a previously unsolvable problem — a problem that doesn't have an answer in the back of the textbook.
- In our research projects, we give them real responsibilities. It's a true way to create experiential learning for students and build their portfolio.

Each of us, myself included, could tell our own story of how research, science, and technology molded our young lives — how we began to feel like we belonged, that we were part of something incremental yet significant. How the long hours in the lab or out in the field instilled an unspoken but hard-wired definition of teamwork. How the faculty, staff, and graduate students and post-docs we worked with became a community we wanted to live on in some way, extending beyond our diplomas. As many of us also know, former students often stay in contact with a faculty mentor years later. They felt a personal connection. They formed personal relationships and friendships in the lab despite the fact that many students did not actually take classes together. There was a cross-pollination of ideas and skills, a sense of community, and a common interest in the work at hand.

Earlier this summer, we instituted a new nine-year strategic plan for Iowa State University, with a set of strategic goals expressed as "to be" statements — What do we want Iowa State to be? Our number-one "to be" statement is to be the most student-centric leading research university. Our institution's full and formal name is Iowa State University of Science and Technology. We are owning that full title, in all its implications for our students' futures. Reaching that goal means ramping up our students' participation in high-impact practices, such as undergraduate research, that prepare them through hands-on, experiential, and real-world opportunities.

Private Funding Opportunities

To be able to extend to more students the brand of community and engagement that research offers, we should take a closer look at philanthropy. Private giving should not be a missed opportunity, or one that remains mostly untapped.

We know extremely well that donors love to support students, primarily through scholarships. Other than scholarships, lifting up private funding for

more undergraduate research experience is a missed opportunity. At Iowa State University, our portfolio of donor-funded undergraduate research opportunities is a fairly modest one. Some are expendable, others have been endowed.

One privately funded undergraduate research internship program in our College of Engineering annually funds 10 students studying chemical and biological engineering. The program also funds seminars in which students learn about intellectual property, patents and trademarks, and copyright law — strengthening a commitment to transfer innovations to help society. The donors were an alumni couple, with the husband a former student who did undergraduate research that was instrumental in a successful career as a patent attorney.

The Science With Practice program in our College of Agriculture and Life Sciences takes its name from Iowa State University's official motto. For nearly 20 years, the experiential learning and work program has provided undergraduate students from across the college the opportunity to work closely with faculty and staff on research projects, earn academic credit, and get paid for hands-on work on a research project. Hundreds of students have participated, with more than 200 mentors across the college. The program was made possible by an investment of private funds from the ISU Agricultural Endowment, a nonprofit organization stewarding private gifts that date back 85 years. Another couple established a separate endowment with their own private giving to support Science With Practice students who work on projects directly related to sustainability in production agriculture. These endowments match funds a mentor pays the students and provide central support overall for administering the program.

Surveys conducted of students who completed the Science With Practice coursework and research experience found that they were able to communicate more effectively and professionally with mentors, clients, and co-workers. A high percentage aspired to attain more advanced degrees.

We are entering our second year of programming with the Student Innovation Center, a new building made possible by both private funds and state support. It's a "playing field" — another way we add oxygen to the kindling and spark. The Student Innovation Center is meant to be a hub in which we invite students from every major to explore their creativity in labs and other creative spaces and experiment with entrepreneurship. In its first full year, the center offered more than 80 elective innovation programs, including competitions with company sponsors, for students or student teams to pitch problem-solving new products or services.

In June 2022, to jump-start our new strategic plan, we announced an investment of $10.5 million in private gift funds for nine initial projects. Six of the projects totaling $3.8 million are pegged to our aspiration to be the most student-centric leading research university.

Embedded in our strategic plan is an annual process to request proposals for possible investment that bring us closer to our aspirational goals. I have already received one idea from a trio of distinguished professors who propose that the university create 100 paid undergraduate research positions to work on new-frontier research with the Ames National Laboratory, our U.S. Department of Energy lab on campus. It is an exciting idea, and it is one that I could foresee generating significant donor interest.

As large public universities struggle to maintain or increase state support — to demonstrate the value of the social contract established at our earliest founding — private funds from donors and industry partnerships play an even larger role. Donor funding of scholarships,

completion grants, and emergency funds are critically important in helping to keep the cost of a college education accessible to first-generation and Pell Grant-eligible students.

We do have an opportunity, through philanthropy, to connect more undergraduates to research. In 2016, the College of Natural Sciences at University of Texas-Austin launched an effort to grow an endowment for its Freshman Research Initiative program. We need more of those kinds of efforts. I picture again that faculty member, in front of a roomful of donors, talking about research, the potential for students, the connections to industry and progress. He may not have known at the time — but perhaps he did — that he was making a pitch.

Sallie Mae's How America Completes College 2022 report states that COVID-19 brought a renewed focus on why some students complete a college degree while others do not. Students need help connecting the dots between their curriculum and their future career. I believe that for many, undergraduate research can help make that connection. The report says that colleges and corporations — and, I would add, other kinds of donors — can step in to provide professional mentorship opportunities, internships, and other options to help students explore and visualize careers and professional success.

Summary

One of the waves of change for students is the voices today whispering to them that they don't need a college degree to succeed. For some students, the choice not to attend college will be the appropriate one. However, I think that in a subtle or indirect way, intentional or not, the voices that downplay the value of a university education feed into the persistent anti-science sentiment that has become more pronounced during the pandemic. From my view as a university president, it denies the oxygen needed for an idea, a creative angle, an innovative product to catch fire. There are students with intrinsic motivation to work harder, persist longer, and maintain a pursuit toward a goal. High-impact practices such as undergraduate research can create intrinsic interest or coax it to forward.

Back to my prologue about our recent graduate, Jack Orr. He had intrinsic motivation to succeed and the mindset to explore beyond the borders of his chosen curriculum. He brought home to me the message that what happens at a public research university doesn't happen at every university. It takes faculty willing, able, and eager to supply the oxygen needed for this tremendous supply of kindling and spark to catch fire.

Jack Orr's story is more than just about believing in yourself. It's one about believing in others and contributing to a greater cause to achieve something beyond what any one individual can do. I believe we can expand that opportunity through more intentional initiatives with private donors who love to see our students succeed, who think outside the box of scholarships, and who envision making possible a more research-directed pathway for more students.

Our task as leaders is to add oxygen to what's already there — the kindling of desire to make a better life and a better future, and the spark of intellect, curiosity, and creativity. With all the global challenges facing us today, the worst that can happen is to have fewer flames of innovation, or to see a flame flicker or die for lack of oxygen. The best we can strive for is to fan the flames of our students' hopes and goals and help them burn steady.

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