Volume 16 (2025), pp. 59-75
American Journal of STEM Education: Issues and Perspectives
Star Scholars Press
https://doi.org/10.32674/fvsgr909

UTeach a Quarter of Century in Review: Impact, Challenges, and New Directions in STEM Teacher Preparation

Patrick McGuire
University of Colorado Colorado Springs, USA

Mary Urquhart
University of Texas at Dallas, USA

Mary Enderson
Old Dominion University, USA

Kimberly Hughes
University of Texas at Austin, USA

Michael Marder
University of Texas at Austin, USA

Elizabeth Goldberg
University of Texas Rio Grande Valley, USA

ABSTRACT

This article provides a summary of the first quarter century of the UTeach secondary STEM teacher preparation program (from 1997–2022). In addition to UTeach program expansion and impact statistics, we highlight current challenges faced by secondary STEM teacher preparation programs, including overall declines in university-based enrollments. To conclude, we discuss new directions for UTeach and offer recommendations for ways in which university-based stakeholders can

work together with K-12 district partners to positively affect teacher preparation and STEM education for the next 25 years.

Keywords: UTeach, STEM Teacher Preparation, University-based Models

Editors:
Uchenna Emenaha Miles, Assistant Professor, University of Texas at San Antonio, USA
Grant Clayton, Associate Professor, University of Colorado Springs, USA

INTRODUCTION

UTeach is a STEM teacher preparation program that originated at The University of Texas at Austin (UT Austin) in 1997 and has since expanded to 54 other universities in the United States. The fact that it has survived so long and spread thus far indicates that this program meets an organic need. At the same time, it is natural to wonder how a program from a single university managed to grow in this way. The explanation requires a brief explanation of the Texas education landscape in the period in which UTeach was founded.

An underappreciated feature of education reform is that when policy changes are put in place, it can take ten years or more for their consequences to play out in full. Thus, it was with Texas Senate Bill 994 of 1987. The bill was very controversial, and the inner workings of the debate that led to its passage are described in delightful detail by Barron (1994). Holmes discussions (Holmes Group, 1986) led a group of education deans to recommend the abolition of undergraduate degrees in education. They intended this to be accompanied by the requirement of a master's degree in education for certification, following the lead of the medical professions. Instead, Texas policymakers abolished undergraduate education degrees without requiring a master's degree for certification and put an 18-hour cap on undergraduate coursework in education. This was intended to improve the teaching profession by having future teachers major in the discipline they would teach. The immediate consequence was a steady drop in the number of students pursuing teaching certification, since the elimination of education degrees did not by itself create viable pathways into teaching.

UTeach was created in 1997, when the need for careful replacement for education degrees became too urgent to ignore, and in response to a growing awareness that universities need to do more to

produce highly qualified STEM teachers (Marder, 2020). UTeach was predicated upon the idea that effective STEM teachers must possess deep subject knowledge in the discipline(s) they would be teaching and the requisite pedagogical skills and strategies needed to convey that knowledge effectively to students. Thus, the UTeach program is designed to attract talented and passionate individuals in STEM disciplines by providing them with an innovative, research-based curriculum that combines teacher training with undergraduate STEM degree plans in math, science, engineering, or computer science. The UTeach program is known for its innovative approach to STEM teacher preparation and program elements, which make it both research-based and practitioner-focused. The program model is built on several well-defined "elements of success" (see Figure 1 and Hughes, Welch, & Moreland, 2020 for additional details).

Figure 1: UTeach Elements of Success

For example, the model focuses on inquiry and project-based STEM instruction, early field experiences, and dedicated support from experienced K-12 practitioners and university STEM and education faculty. Operationally, the success of UTeach relies heavily on strategic cross-college collaboration among faculty and staff across colleges of education and colleges of sciences (or their STEM College equivalents).

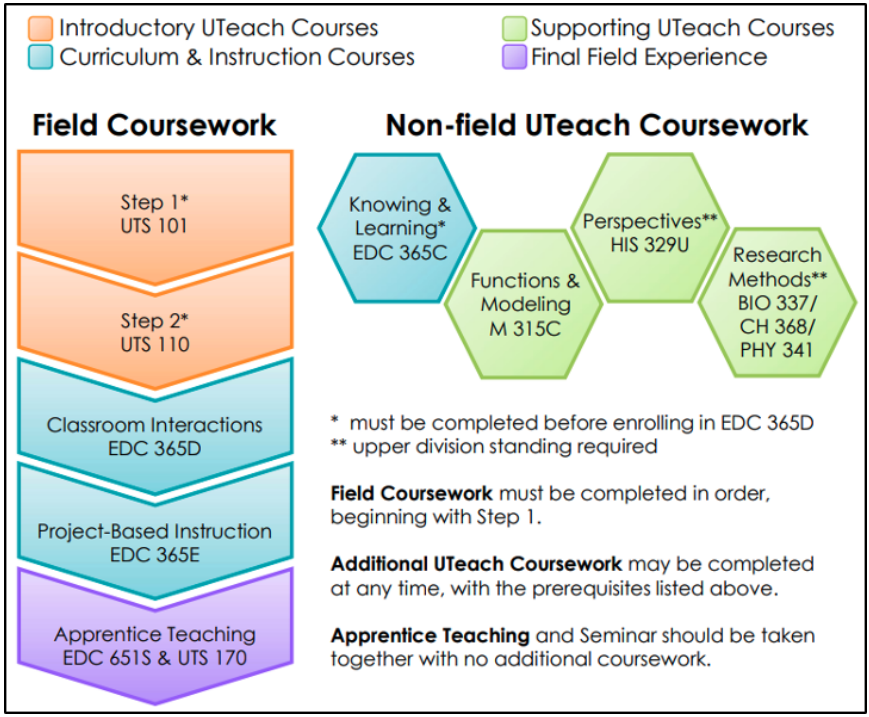
The UTeach theory of change is predicated upon the idea that increasing the number of highly qualified STEM teachers produced by university-based teacher preparation programs will lead to improved K-12 student learning outcomes, increased interest in STEM careers, and a stronger STEM workforce throughout the United States. The UTeach program model provides teacher preparation programs in a different direction than traditional programs provide. Historically, content coursework has been taught by content experts, whereas education coursework has been taught by educational generalists across all disciplines. The constraints created by the Texas policy context under

which UTeach grew meant that Colleges of Science had to play a much more active role than was traditional, and content and pedagogical instruction had to merge. The UTeach model focuses on STEM education, as it involves instruction focused on inquiry; exposure to field-based experiences for preservice teachers; and the use of learning theories, technological tools, and models pertinent to the sciences. These experiences, taught and overseen by scientists, mathematicians, computer scientists, and STEM educators, support the UTeach theory of change. These practices encourage STEM majors to consider teaching as a viable career option while being prepared to carry out inquiry-based instruction in their classrooms and support the future growth of STEM majors.

UTEACH INSTRUCTIONAL PROGRAM

The UTeach instructional program (see Figure 2) is research-based, clinically intensive, specialized for middle and high school STEM teaching and learning, and it is designed to encourage early exploration of teaching by a wide range of STEM disciplinary majors.

Figure 2: UTeach Course Sequence



UTeach begins with two one-semester-credit-hour courses that provide STEM majors with opportunities to explore teaching as early as their freshman year. In these early outreach courses—Step 1: Inquiry Approaches to Teaching and Step 2: Inquiry-Based Lesson Design—UTeach students co-teach lessons first in elementary schools and then in middle schools under the guidance of experienced K–12 practitioners.

These introductory recruitment courses are followed by three three-semester-credit-hour courses. Knowing and Learning in Mathematics and Science replaces a traditional educational psychology course and focuses on applying learning theories to secondary mathematics and science. Classroom Interactions provides high school teaching experience and emphasizes organizing instruction across multiple days and translating theory to practice. Project-Based Instruction offers additional high school teaching experience and centers on designing and implementing problem- and project-based units of instruction over extended periods of time.

A capstone experience, Apprentice Teaching, provides a semester-long teaching placement in local schools. In addition, three specialized content courses round out the UTeach instructional sequence. Research Methods emphasizes experimental design, data analysis with statistics, mathematical modeling, and scientific writing and presentation. Perspectives on Science and Mathematics examines significant episodes in the history of these disciplines and their societal impact. Functions and Modeling, taken by mathematics majors, addresses secondary mathematics topics through applied, problem-based approaches.

Rather than offering additional stand-alone courses, UTeach integrates key themes in teacher development. Key themes include creating equitable and inclusive classrooms, supporting special populations of students, integrating technology, and managing classrooms effectively—throughout the curriculum. Each course also makes explicit the underlying connections between science and mathematics, encouraging cross-disciplinary lesson design and emphasizing integrated STEM approaches. While courses have evolved over time at UT Austin and each UTeach expansion site adapts the sequence, the overall instructional model has remained a faithful reflection of the original design. This consistency ensures that new teachers graduate with core proficiencies in STEM teaching practices and the ability to create learning environments that engage all students.

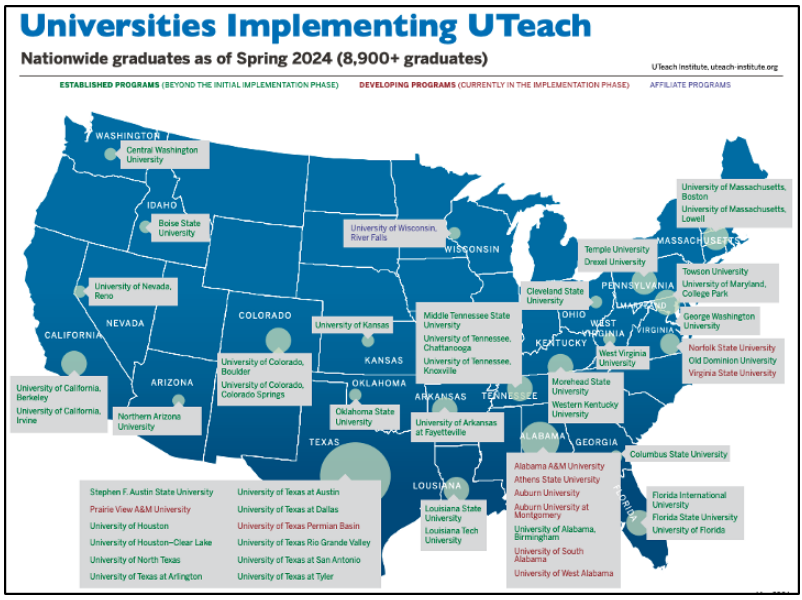
EXPANSION AND IMPACT

From 1997–2006, the UTeach program demonstrated proof of concept at UT Austin, producing 334 graduates in its first decade—

consistently more than 60 per year after 2003. Encouraged by a task force that included business leaders, program leaders began sketching expansion plans in 2005. The *Gathering Storm* report (Augustine, 2007), which highlighted UTeach as a model for increasing the number and quality of STEM teachers, further boosted these efforts. Subsequent foundation gifts, most notably from ExxonMobil, led to the creation of the UTeach Institute in 2006 to support national expansion of the model.

The Institute provides research-based implementation and operational support that is designed to help universities establish successful and sustainable UTeach programs. The Institute maintains a well-established approach to developing and scaling evidence-based education programs (Beth et al., 2011; Hughes et al., 2020; Romero & Hughes, 2020) aligned with recommendations from the research literature on the fidelity of implementation, program expansion and evaluation, and networked improvement (Century et al., 2010; Bryk et al., 2011). Significant effort has been invested in establishing and supporting a networked improvement community of more than 700 university faculty at 55 universities, as well as their program alumni, which provides a framework for collaborative development, testing, and improvement of STEM teacher development approaches (see Figure 3 below). This significant national expansion effort reflects both the interest and willingness of university leaders to support STEM teacher preparation.

Figure 3: UTeach expansion snapshots



Increased Number and Percentage of UTeach-Produced Teachers

UTeach continues to be one of the largest producers of STEM teachers in the United States, accounting for approximately 4–6% of new STEM teachers produced annually over the past five years (see Table 1 for additional data for production dating back to 2011–12).

Table 1. Total Overall U.S. STEM Teacher Production and Percentage of UTeach Graduates

Year	Overall US STEM Teacher Production[1]	Overall # of UTeach program completers[2]	Percentage of Overall US STEM Teachers from UTeach
2011-12	21,578	367	1.70%
2012-13	20,287	478	2.36%
2013-14	19,107	514	2.69%
2014-15	17,551	522	2.97%
2015-16	16,501	611	3.70%
2016-17	16,321	620	3.80%
2017-18	15,313	655	4.28%
2018-19	14,440	719	4.98%
2019-20	13,019	763	5.86%
2020-21	14,392	863	6.00%
2021-22	data unavailable	782	n/a

Sources: Title II data (US Department of Education), UTeach Institute (2022)

Since 2011, with the exception of a small dip in production from 2021–2022, likely attributed to the COVID-19 pandemic, the number of UTeach graduates has grown steadily. This increase in production by UTeach programs is particularly noteworthy given the overall decline in US STEM teacher production. Sixty-seven percent of UTeach graduates teach in high-needs K-12 schools, and 81% are retained at the five-year mark (UTeach Institute, 2024). Compared with non-UTeach teachers, UTeach teachers have been shown to produce significantly better learning outcomes for their students (Backes et al., 2018).

CHALLENGES AND LESSONS LEARNED

The UTeach model, while adopted across diverse U.S. institutions of higher education, has not been embraced in all arenas. Some teacher preparation programs promote traditional coursework that is practiced or taught at the end of one's preparation program. The idea is that the theory is important, and one can try to implement it when the student teaching experience is in place. Although educational theory is important, the UTeach model prioritizes the continual application of theory to practice through the pairing of Master Teachers with STEM education research faculty and early, intensive, and well-supported clinical field teaching throughout the program (Ronfeldt, 2021). This requires field placements that are crucial to preservice teacher learning. As noted in various fields of research, "hands-on" learning has great benefits for the learner themselves as well as for future students or individuals with whom they may interact (Goodman et al., 2016; Handur et al., 2016; Sivan et al., 2000).

The UTeach model presents some challenges related to school placements, early field experiences, and supporting teachers who mentor UTeach preservice teacher candidates. For example, UTeach students begin their first Step 1 course as early as their freshman year, which requires careful planning. This planning includes ensuring that background checks are completed, understanding school entry procedures, and identifying mentor teachers who align with the UTeach philosophy and are willing to support early teaching experience. Teachers who agree to work with UTeach preservice teachers must invest time in discussing teaching practices, sharing ideas, and providing feedback, which demands significant effort and commitment. Consequently, universities must find ways to acknowledge and "reward" these teachers for their support. This might involve offering professional development points, providing monetary stipends, or hosting appreciation events.

In addition to school challenges, challenges exist at universities. Many faculty do not have time or space in their workload to travel to schools and observe as part of their coursework. Thus, the UTeach model requires a great deal of support from Master Teachers, typically employed as clinical faculty or lecturers, whose role is distinct from that of research or tenure-track faculty. Carrying out observations of UTeach student teaching is very time consuming because it involves reviewing and providing feedback on lesson plans, lesson observations, and debriefing with UTeach students on lesson feedback, reflections, and take-aways. This process is very labor intensive and often does not fit well for workload in the academic arena.

While UTeach has learned countless lessons throughout its 25+ year existence, this article addresses only a few critical lessons. First, the number of teachers who enter and remain teaching in the profession is highly important to our future generation. National data on UTeach indicate that 85% of program completers enter the classroom and that 81% teach for at least five years (UTeach Institute, 2024). This is impressive and not always the case with traditional or other teacher preparation programs. UTeach alumni often indicated that they felt more than prepared for their first year of teaching because of the field experiences they had throughout their program of study. They not only had opportunities to interact with and teach students in STEM fields but also had opportunities to form relationships with teachers who supported them professionally in the work they do, including tasks unrelated to teaching content.

A second lesson learned is that schools look different and are more diverse in the populations that they serve—both from rural and urban perspectives. As a result, universities need to make a more concerted effort in recruiting from underrepresented groups so that students have teachers who look like them and possess greater insight into the challenges that learners face. Thus, UTeach is making a more concerted effort to reach these populations and fill the pipeline with teachers of color and diverse backgrounds. Notably, UTeach invites all students to consider and "try out teaching" through early exploratory courses, thereby creating low-stakes opportunities for students who might not necessarily see themselves as teachers to explore the option. This simple invitation can appeal to a more diverse student population. Increasingly, UTeach recruitment efforts and messaging are designed to address the priorities and concerns of diverse student populations specifically. Students are also recruited into a program that allows them to add a teaching credential without adding time or cost to their degree, a critical consideration for structurally disadvantaged students and one that promotes greater diversity in UTeach programs. Finally, sufficient attention to financial and other student support is critical to retaining these students once they are enrolled in the program. Currently, 34% of UTeach teachers identify as belonging to historically underrepresented ethnic/racial groups. Additionally, as UTeach program leadership becomes more diverse, it provides a growing platform for these types of conversations to occur and to identify additional strategies to address the diversity needed in STEM teaching fields.

Finally, having a UTeach network of programs provides support for program staff to continue to look for ways to improve their own programs, address program challenges, and support many programs in making changes. Changes across many programs add power and strength to the way teachers are prepared, and the UTeach nation supports this practice from a university and national perspective.

NEW DIRECTIONS FOR THE NEXT 25 YEARS OF UTEACH

Over the past 17 years, since the expansion of the UTeach model began, a vibrant network improvement community serving UTeach programs and their faculty, staff, students, and alumni has developed. Components of the UTeach model support the development of teacher educator and teacher learning communities and facilitate interactions between programs. Each teacher educator includes education and STEM faculty with rich pedagogical and content knowledge (respectively) and practitioner-based Master Teachers with experiential expertise from years of experience as K-12 classroom teachers. Through field experience observations of preservice teachers and interactions with hosting K-12 mentor teachers, each master teacher maintains engagement with today's classrooms. The UTeach model's dedication to new-teacher induction and ongoing alumni services includes extensive professional development opportunities. As the UTeach network has moved forward, it has embraced collaborative innovation and support opportunities generated by and for members of the UTeach community.

The COVID-19 pandemic represented a major challenge for UTeach programs, as it did for education at all levels around the world. The UTeach community responded with the initiation of UTeach STEM Educators Association (USEA) virtual workgroups that brought program leaders, faculty, staff, and alumni from around the nation to collaborate on issues such as the rapid pivot to online teaching in universities and partner schools, recruitment, professional development, and induction. In response to the killing of George Floyd, the UTeach community built on this model, initiating virtual committees to address issues of equity and racial justice (ERJ) within the context of UTeach teacher preparation. Working groups and committees leveraged the power of online, grassroots collaboration and developed organically into networked improvement communities and communities of practice. Recent research suggests that educators who participate in networked improvement communities experience benefits such as stronger collaboration, deeper professional learning, and greater use of effective instructional practices. These benefits are associated with positive impacts on student outcomes over time (Perlman, Bryk, & Russell, 2025), reinforcing why UTeach continues to prioritize these working groups as part of its long-term strategy for STEM teacher development and support.

Individual programs share approaches and innovations with one another, providing opportunities to learn from successes and failures. Course-specific working groups focused on immediate responses to the pandemic and best practices for rich virtual instruction. The recruitment working group discussed successful pre-pandemic messaging approaches

as well as brainstorming new approaches needed in a remote, pandemic world. The professional development and induction working group leveraged the power of remote learning and collaborative efforts with K-12 partners to adapt to the evolving needs of alumni, teacher educators, and students. Early network-wide opportunities included virtual mental health training for alumni and faculty made possible by one university's external partnership (Goldberg et al., 2023).

The recruitment and professional development and induction working groups remain active to the present day. The recruitment working group has held workshops and summits to cull best practices across UTeach programs to address the ever-growing problem of recruiting and retaining STEM teachers within the profession (Feber, 2022). The professional development and induction working group is active in elevating the voices of its members and fostering leadership opportunities, particularly among alumni. For example, the professional development and induction working group developed the monthly virtual Master Teacher Professional Development (MTPD) series to showcase the innovative practices of Master Teachers across the UTeach network. Additionally, professional development sessions, workshops, and conferences such as the UTeach STEM Educator K-12 Virtual Summit, Career Day, and Presentation Interest Group have afforded alumni opportunities to present to a national audience of peers and former professors on the outstanding work they are doing within and beyond the walls of their classrooms. Providing opportunities for alumni to present in these forums not only allows them to share best practices but also builds confidence and advances their careers.

Building off this work, UTeach looks to continue innovating and excel in the following areas. First, we seek to move forward by returning to our roots of promoting cross-fertilization between STEM faculty and STEM education faculty. While the UTeach model calls for collaboration between these groups, implementation can be difficult and requires intentionality and buy-in from all stakeholders toward building real and lasting culture shifts. In this way, teacher preparation is no longer siloed but is viewed as a priority of the entire community.

Second, we also look to strengthen our collaborative efforts with our K-12 partners to adapt to the evolving needs of teachers, schools, and districts in areas such as equity and racial justice, artificial intelligence, mental health, and blended and personalized learning instructional models. Many UTeach programs have already begun creating and implementing high-quality instructional materials and support in these areas.

Third, UTeach continues to explore ways to diversify the STEM teacher pipeline. This includes creating more inclusive pathways that honor the experience and commitment of military and career changer

teacher candidates through accelerated or intensive programs for post-baccalaureate candidates, crediting prior learning and industrial work, and developing more flexible coursework and training options through hybrid, online, part-time, or evening programs. This is coupled with exploring ways to make teacher preparation and professional development more affordable through grants, tuition reimbursements, paid residencies for preservice teachers, and salary supplements for in-service teachers.

Fourth, we continue to prioritize our induction efforts by building robust support systems for new teachers. These include collaborating with alumni to understand their current needs and future career goals to create targeted, high-quality professional development and interest groups customized to their needs.

Fifth, after 25+ years, UTeach programs realized that the complex and ever-changing work of teacher preparation cannot be done in isolation. Therefore, we look to continue to grow and strengthen our national networks by supporting and enhancing the efforts of the USEA and various UTeach working groups by systematically sharing this work through avenues such as the annual UTeach Conference.

HOW THE UTEACH NETWORK CAN RESPOND TO DECLINING TEACHER PREPARATION ENROLLMENT TRENDS

Although this article is not specifically focused on the enrollment declines in university-based teacher preparation programs (see Fuller, 2023; Partelow, 2019; and Sutcher et al., 2019 for one of the many examples documenting a steep enrollment decline over the past decade), we would be remiss not to address this reality and discuss the role that the UTeach network can play in combating this decline. Recent national data confirm this trend, showing a continued decrease in the number of new STEM teachers entering the profession, even as overall preparation quality and diversity have modestly improved (Nguyen, 2025).

In light of these challenges, it is important to highlight how UTeach is uniquely positioned to address the STEM teacher shortage through a proven, university-based teacher preparation model. First and foremost, the UTeach network remains among the few dedicated entities actively working to reverse this increasingly concerning trend while maintaining a balance between quantity and quality. Unlike nonuniversity-based pathways, which often emphasize rapid certification at the expense of thorough preparation, UTeach programs equip future teachers with pedagogical content knowledge needed for effective, inquiry-based STEM instruction. This dual emphasis on STEM subject mastery and pedagogical practice will continue to produce highly qualified graduates who enter the

STEM teacher workforce not only to meet but also to increase K-12 student learning outcomes (Marder & Hamrock, 2020; Rhodes & Marder, 2024).

Second, UTeach must continue to leverage its strong national reputation and position to fiercely advocate for the continued and expanded role of university-based teacher preparation. These advocacy efforts should include strategic awareness campaigns targeting upper-level university leadership and policymakers that highlight the long-term benefits of university-based teacher preparation models. Data-driven comparisons, such as the studies referenced above, demonstrate that university-trained teachers tend to have superior retention rates, preparedness, and teaching effectiveness. Additionally, university-prepared teachers serve as ambassadors for their institutions and the knowledge produced there. However, what will happen to public support for universities if they continue to supply fewer STEM teachers to public schools? As highlighted in a recent national consensus report by education experts, sustaining public trust and investment in university-based preparation will require coordinated advocacy that clearly communicates these long-term benefits to institutional leaders and policymakers (National Academy of Education, 2025).

Third, the UTeach network must take a proactive approach to policies that impact traditional teacher preparation models, especially in response to the enrollment declines in traditional pathways. This includes identifying and addressing barriers such as time and cost while maintaining the high-quality elements of success that have been hallmarks of the UTeach model for the past 25 years. Removing barriers (proposed or enacted, perceived or real) is critical for UTeach to remain competitive with faster and cheaper alternative models, which have grown significantly in recent years despite persistent concerns about their quality and effectiveness (Noble & Ellis, 2025).

Finally, UTeach programs have the capacity to prepare many more teachers than they currently do, both within existing programs and from the possibility of further expansion. UTeach programs cannot accomplish this without assistance from allied organizations and the broader educational community. This includes collaborative research initiatives, joint professional development efforts, and support from universities, school districts, and political leadership to sustain and scale up successful practices.

CONCLUSION

As many universities across the United States continue to systematically shift away from preparing STEM teachers via traditional

models, this trend exacerbates inequities that are easier to condemn than combat. Despite the challenges outlined in this article and those that are yet to be encountered, the future of UTeach looks promising. UTeach has demonstrated its ability to remain nimble and responsive to the needs of various stakeholders and will continue to adapt its operational strategies to meet the evolving needs of STEM education. Moreover, UTeach remains the only national effort that deliberately and specifically creates STEM teacher programs rather than individual STEM teachers. Finally, UTeach exemplifies how our nation's colleges and universities can work together, often across professional party lines, to address STEM teacher development challenges effectively. In the future, UTeach's commitment to continuous improvement, adherence to the elements of success, and focus on strategic expansion will have a positive effect on secondary STEM teacher preparation and STEM education for the next 25 years and beyond.

REFERENCES

Augustine, N. (2007). *Rising above the gathering storm: Energizing and employing America for a brighter economic future*. Committee, National Academy of Sciences, National Academy of Engineering, and Institute of Medicine of the National Academies.

Backes, B., Goldhaber, D., Cade, W., Sullivan, K., & Dodson, M. (2018). Can UTeach? Assessing the relative effectiveness of STEM teachers. *Economics of Education Review, 64*, 184–198. https://doi.org/10.1016/j.econedurev.2018.05.002

Barron, G. O. (1994). *An analysis of Senate Bill 994: Policy making in teacher education in Texas* [Doctoral dissertation, The University of Texas at Austin]. *ProQuest Dissertations and Theses Global*. https://www.proquest.com/docview/304114099/abstract/C5375421E1DC4FD8PQ/1

Beth, A. D., Hughes, K. K., Romero, P., Walker, M. H., & Dodson, M. M. (2011). Replication as a strategy for expanding educational programs that work: The UTeach Institute approach to program replication [Conference presentation]. Annual Meeting of the American Association of Colleges for Teacher Education, San Diego, CA.

Bryk, A. S., Gomez, L. M., & Grunow, A. (2011). Getting ideas into action: Building networked improvement communities in education. In *Frontiers in sociology of education* (pp. 127–162). Springer Netherlands.

Century, J., Rudnick, M., & Freeman, C. (2010). A framework for measuring fidelity of implementation: A foundation for shared language and accumulation of knowledge. *American Journal of Evaluation, 31*(2), 199–218.

Darling-Hammond, L. (2005). The case for university-based teacher education. In R. Roth (Ed.), *The role of the university in the preparation of teachers* (1st ed., pp. 19–36). Routledge.

Feber, T. (2022). The US is in dire need of STEM teachers. *Physics Today, 75*(3), 25–27.

Fuller, E. J. (2023). *Trends in enrollment in US teacher preparation programs: 2009–2021* (Research Brief No. 6). Penn State University, Center for Evaluation and Education Policy Analysis.

Goldberg, E. R., Kirkland, P., & Urquhart, M. L. (2023). UTeach Nation: How teacher educators create communities of practice and professional development within the UTeach Network. In B. M. Butler, A. Cuenca, & J. K. Ritter (Eds.), *Pathways into teacher education: Profiles in emerging teacher educator development* (pp. 205–215). Information Age Publishing.

Goodman, S. G., Seymour, T. L., & Anderson, B. R. (2016). Achieving the performance benefits of hands-on experience when using digital devices: A representational approach. *Computers in Human Behavior, 59*, 58–66.

Handur, V., Kalwad, P. D., Patil, M. S., Garagad, V. G., Yeligar, N., Pattar, P., & Joshi, G. H. (2016, December). Integrating class and laboratory with hands-on programming: Its benefits and challenges. In *2016 IEEE 4th International Conference on MOOCs, Innovation and Technology in Education (MITE)* (pp. 163–168). IEEE.

Holmes Group. (1986). *Tomorrow's teachers: A report of the Holmes Group*. East Lansing, MI: Author.

Hughes, K. K., Welch, A. R., & Moreland, A. L. (2020). The UTeach instructional program elements and courses. In J. Goodell & S. Koc (Eds.), *Preparing STEM teachers: The UTeach replication model* (pp. 166–174). Information Age Publishing.

Marder, M. (2020). The development of the UTeach model. In J. Goodell & S. Koc (Eds.), *Preparing STEM teachers: The UTeach replication model* (pp. 3–16). Information Age Publishing.

Marder, M., David, B., & Hamrock, C. (2020). Math and science outcomes for students of teachers from standard and alternative pathways in Texas. *Education Policy Analysis Archives, 28*(27). https://doi.org/10.14507/epaa.28.4863

National Academy of Education. (2025). *Evaluating and improving teacher preparation programs: Executive summary* (K. M. Zeichner, L. Darling-Hammond, A. I. Berman, D. Dong, & G. Sykes, Eds.). https://naeducation.org/wp-content/uploads/2025/02/Evaluating-and-Improving-Teacher-Preparation-Programs-Executive-Summary-FINAL.pdf

Noble, A., & Ellis, A. (2025). *What's the alternative? How some alternative certification programs are shortchanging teachers and students*. National Council on Teacher Quality. https://www.nctq.org/research-insights/whats-the-alternative-how-some-alternative-certification-programs-are-shortchanging-teachers-and-students/

Nguyen, T. D. (2025). The supply and quality of STEM teachers. *Humanities and Social Sciences Communications, 12*(1), 1–12. https://doi.org/10.1057/s41599-025-04648-8

Partelow, L. (2019). What to make of declining enrollment in teacher preparation programs. *Center for American Progress*. https://www.americanprogress.org/issues/education-k-12/reports/2019/12/03/477311/make-declining-enrollment-teacherpreparation-programs/

Perlman, H., Bryk, A. S., & Russell, J. L. (2025). Measuring educators' perceived benefits of participation in educational improvement networks. *Peabody Journal of Education, 100*(1), 82–99. https://doi.org/10.1080/0161956X.2025.2444844

Rhodes, A., & Marder, M. (2024). Measuring the value of teachers from traditional certification pathways in Texas: A comprehensive study. *Education Policy Analysis Archives, 32*(51). https://doi.org/10.14507/epaa.32.8556

Romero, P., & Hughes, K. (2020). Implementing and sustaining UTeach programs: Lessons learned from national expansion. In J. Goodell & S. Koc (Eds.), *Preparing STEM teachers: The UTeach replication model* (pp. 17–30). Information Age Publishing.

Ronfeldt, M. (2021). Links among teacher preparation, retention, and teaching effectiveness. *National Academy of Education*. https://doi.org/10.31094/2021/3/1

Sivan, S., Leung, R., Woon, C., & Kember, D. (2000). An implementation of active learning and its effect on the quality of student learning. *Innovations in Education & Training International, 37*(4), 381–389. https://doi.org/10.1080/135580000750052991

Sutcher, L., Darling-Hammond, L., & Carver-Thomas, D. (2019). Understanding teacher shortages: An analysis of teacher supply

and demand in the United States. *Education Policy Analysis Archives, 27*(35). http://dx.doi.org/10.14507/epaa.27.3696

UTeach Institute. (2022). *UTeach national expansion: Spring 2022*. https://institute.uteach.utexas.edu/sites/default/files/UTeach-National-Snapshot-Spring2022.pdf

UTeach Institute. (2024). *UTeach national expansion: Spring 2024*. https://institute.uteach.utexas.edu/sites/default/files/documents/UTeach-National-Snapshot-Spring-2024.pdf

Bios

PATRICK MCGUIRE, PhD, is a professor in the Department of Teaching & Learning at the University of Colorado Colorado Springs. His major research interests include STEM teacher preparation, mathematics education, and instructional technology. Email: pmcguire@uccs.edu

MARY URQUHART, PhD, is an associate professor and department head of Science/Mathematics Education at the University of Texas at Dallas and director of UTeach Dallas. Her major research interests include STEM teacher preparation and retention, conceptual change in STEM, and p-20 astronomy and physics education. Email: urquhart@utdallas.edu

MARY ENDERSON, PhD, is a retired educator. Prior to her retirement, she served as an associate professor of mathematics education at Old Dominion University and codirector of MonarchTeach. Her major research interests include mathematics education, STEM literacy, and university-based teacher preparation. Email: menderso@odu.edu

KIMBERLY HUGHES, EdD, is the director of the UTeach Institute at the University of Texas at Austin. Since 2007, she has led national expansion and improvement efforts for the UTeach secondary STEM teacher preparation model. Her major research interests include STEM teacher preparation, program scale and sustainability, and fidelity of implementation in higher education change initiatives.
Email: hughes@uteach.utexas.edu

MICHAEL MARDER, **PhD**, is a professor of physics at the University of Texas at Austin and cofounder of the UTeach program. In addition to his research in condensed matter physics, he has written extensively on STEM education and public education policy. His recent work focuses on the design and evaluation of teacher preparation pathways and their impact on student learning outcomes. Email: marder@physics.utexas.edu

ELIZABETH R. GOLDBERG is a clinical professor of practice and master teacher for the UTeach program at the University of Texas Rio Grande Valley. Her major research interests include STEM teacher preparation, induction, and teacher mindsets.
Email: elizabeth.goldberg@utrgv.edu

Note: The authors would like to acknowledge the use of OpenAI's ChatGPT in assisting with the editing of this manuscript to ensure clarity and coherence throughout the article. The contributions of ChatGPT helped enhance the overall quality of this work.