The Uteach Model of STEM Teacher Preparation: Replication and Opportunities for Growth

Jill Marshall
University of Texas at Austin
Hugo Rossi Lecture Series

• “Designed to bridge the College of Science and the College of Education... to promote best practices and student success”
UTeach began as a bridge between the Colleges of Natural Sciences and Education.
K-12

CONS

UTeach

COE
What do you know about UTeach already?

• And what do you hope to find out today?
There are many UTeaches

UTeach
Liberal Arts

UTeach
Urban Teachers
UTeach Secondary STEM Teacher Preparation

- 1987- TEA Standards for Teacher Education require subject area degree or equivalent, limit education courses to 18 hours. (Abolishes secondary education degree)
- 1997- After several years of planning with master high school teachers and (sometimes heated) negotiation with the College of Education, Dean Mary Ann Rankin (CONS) launches UTeach.
- 2006- UTeach Institute established
- 2006- U Houston begins replication funded with Texas High School Project funds.
- 2007- RAGS; UTeach Institute/NMSI fund 13 replication sites with Exxon-Mobil donation.
- 2016- 44 replication sites across the US
UTeach Guiding Commitments

Equity
- Complex Flexible Degrees
- Student Support
- Generative Instruction

Inquiry
- Research based
- Assessment based
- Constructivist teaching

Situated Cognition
- Field Based
  - Project Based
- Interdisciplinary STEM Focus
- No isolated theory/methods courses
Collaborative Academic Program: Co-Directors from Education and Natural Sciences

<table>
<thead>
<tr>
<th>Natural Sciences</th>
<th>Research Methods</th>
<th>Domain Courses</th>
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<tbody>
<tr>
<td></td>
<td><em>Major in Science or Mathematics</em></td>
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<tr>
<td>Liberal Arts</td>
<td>Perspectives on Science &amp; Mathematics</td>
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<tr>
<td>Education (STEM Education)</td>
<td>Knowing &amp; Learning in Math &amp; Science</td>
<td>Classroom Interactions in Math &amp; Science</td>
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<td>Project-Based Instruction in Math &amp; Science</td>
<td>Domain Courses</td>
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<tr>
<td>UTeach Master Teachers</td>
<td>STEP 1, 2</td>
<td>Apprentice Teaching</td>
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<td>Domain Courses</td>
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UTeach Course Sequence

specially designed content courses

- Physics by Inquiry
- Functions & Modeling
- Research Methods
- Perspectives on Science & Math

recruitment courses

- Step 1
- Step 2

education sequence

- Knowing & Learning
- Classroom Interactions
- Project-Based Instruction
- Apprentice Teaching

Total Course Hours: 24 – 30
Professional Development Course Hours: 18
Field Experience Hours: approx 312, 32-40 before AT
Equity Commitment: Curriculum Allows Many Entry Points

<table>
<thead>
<tr>
<th>Semester 1</th>
<th>Semester 2</th>
<th>Semester 3</th>
<th>Semester 4</th>
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<th>Semester 6</th>
<th>Semester 7</th>
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<tbody>
<tr>
<td>Freshman Pathway</td>
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<tr>
<td>STEP 1 1</td>
<td>STEP 2 1</td>
<td>Knowing &amp; Learning 3</td>
<td>Classroom Interactions 3</td>
<td>Perspectives 3</td>
<td>Research Methods 3</td>
<td>Project-Based Instruction 3</td>
<td>Apprentice Teaching 7</td>
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Sophomore Pathway |
| STEP 1 | STEP 2 | Knowing & Learning | Classroom Interactions | Perspectives | Research Methods Project-Based | Apprentice Teaching |

Junior/Senior Pathway |
| STEP 1 | STEP 2 | Knowing & Learning | Classroom Interactions | Perspectives | Research Methods Project-Based | Apprentice Teaching |

Post-Baccalaureate Pathway |
| STEP 1 & 2 | Knowing & Learning | Content Perspectives | Research Methods Classroom Interactions | Project-Based | Apprentice Teaching |
**STEP I**

- Five field experiences in elementary school classrooms (2 observations, 3 teaches)
- Taught by master teachers
- Using research-based materials (FOSS, GEM, reverse engineering lesson and ‘Maker’ project)
- Written and oral feedback from classroom teacher
- UTeach pays tuition
**UTeach Curriculum Overview**

STEP II

- Five field experiences in Middle school classrooms (2 observations, 3 teaches)
- Taught by master teachers
- Use research-based materials and write 5-E lesson plans (bristle-bot lesson)
- Written and oral feedback from classroom teacher
- UTeach pays tuition
Knowing and Learning in Mathematics and Science

- Research (learning science) on STEM knowing & learning
- Cognitive science behind reading
- Misconceptions vs. knowledge in pieces
- Self-reflections on understanding
- Processes by which scientists and mathematicians develop new knowledge
- Field Experiences: Clinical interviews of novices and experts solving math and science problems
- *How People Learn* (NRC) and *Schools for Thought* (Bruer)
## UTeach Curriculum Overview

<table>
<thead>
<tr>
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### Classroom Interactions

- Instructor team includes research faculty + master teacher
- Frameworks for analyzing instructional sequences to promote learning, focusing on content, teacher-student, student-student, and group interactions
- Analysis of instruction regarding equity toward diverse students (e.g., English language learners, students with learning disabilities, identifying and accommodating reading difficulties, cultural and gender issues in instruction)
- Model engineering design lesson
- Field experiences: Students plan, implement, and analyze multiple-day lesson sequences in high school STEM classrooms
Collaborative Activity: Functions

- Activity designed by Jennifer Smith

- Objectives:
  - demonstrate that end of chapter problems can be made collaborative,
  - provide an artifact for Portfolio 2B (math) and 2C (all areas) AND
  - to illustrate Johnson et al.’s essential elements of group work.
(Students have read Johnson, Johnson & Holubec (1994) and will use their framework to analyze today’s class and later their own instruction.)
B1. Suppose the function $s(t)$ gives the average weight in pounds of a baby at age $t$ months. Explain what the function $s(t)$ means in your own words. What could a graph look like?

B2. The weight $V$ of a particular baby, Jonah, is given by the equation $V(t) = s(t) + 2$. Write a sentence comparing Jonah’s weight to other babies’ weight.

B3. The weight $W$ of another baby named Ben is given by the equation $W = s(t + 2)$. Make a chart comparing Ben’s weight to other babies’.

B4. If you graph $V(t)$ and $W(t)$, how will the graphs differ from the graph of $s(t)$?
At the end of the lesson

• We will have a gallery walk presenting each group’s solution. ONE representative will stay will the group’s representation and the rest of the group will circulate and give feedback.

• You will assess how well your group worked together to accomplish the task

• You will assess how well the lesson illustrated the 5 elements.
Mentor Teacher Role in Classroom Interactions

- Recruit mentor (high school) teachers and arrange classroom lessons
- Participate in course instruction
- Review lesson plans and provide formative assessment on practice teaching and other coursework
- Observe and provide feedback on model teaching in high school classrooms
- Have served as instructor of record for the course.
Project Based Instruction

- Project-based and case-based instructional approaches
- Instructional strategies to facilitate reading in STEM
- Experience, review and observe of complete units of project based instruction (including soap project, “radical rides” design projects)
- Students design an interdisciplinary project-based unit
- Field Experiences: Teach project unit to high school students
- Master Teachers arrange and support field experiences and have served as Instructor of Record for the course.
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## Apprentice Teaching

- Stipends for mentor teachers; great care in placement
- Master Teachers facilitate weekly seminar, serve as Instructor of Record, observe and support students in the classroom and in preparation of a portfolio.
- Half-days in school, full responsibility for teaching classes for 14 weeks
- Weekly observations and written evaluations by teams of university facilitators
- Loans of technology, supplies and equipment
Funding for UTeach at UT Austin

• Primary funding support comes from UT Austin
  – Approximately $1 million/year UT funds for Master Teacher salaries, advising, staff support
• Significant dedicated facilities
• Scholarships from various sources
• Sustainable private funding is used to support some of the special features critical to UTeach success
  – Endowment Goal of $15M = $750,000/year operating funds for internships, mentor teachers, tuition, induction support, master’s program
    – Tuition for the first two courses ($50,000/yr)
    – Mentor teachers in AISD classrooms ($200,000/yr; $125-$1000/teacher/semester)
    – Internships ($200,000/yr; ~$1,800/student/semester)
    – Induction support ($100,000/yr)
UTeach Outcomes
The University of Texas at Austin

- UTeach Science, technology, engineering, and math (STEM) teacher preparation program established Fall 1997
  
  http://uteach-institute.org/replicating-uteach

- Spring 2015 enrollment: 490 students
- 35% of students are from underrepresented Hispanic and African American populations
- Graduates per year: approximately 70
- 90% enter teaching
- Approximately 80% of graduates who begin teaching are still in schools 5 years later
- Over half teach in schools with a majority of economically disadvantaged students
- Cumulative graduates as of Fall 2015: 952
- 23% of graduates are from underrepresented Hispanic and African American populations
UTEACH AUSTIN GRADUATES: PERCENTAGE ENTERING TEACHING

<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>2000-2001</td>
<td>91%</td>
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<td>93%</td>
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<td>2007-2008</td>
<td>94%</td>
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<td>2008-2009</td>
<td>92%</td>
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<tr>
<td>2009-2010</td>
<td>90%</td>
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<tr>
<td>2010-2011</td>
<td>91%</td>
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<tr>
<td>2011-2012</td>
<td>88%</td>
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<td>2012-2013</td>
<td>89%</td>
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ENrollment

• Following growing national interest, the UTeach Institute was established in 2006 to support and evaluate replication of the UTeach model at universities nationwide: http://uteach-institute.org/about
• 44 universities in 21 states and the District of Columbia currently have UTeach programs: http://uteach-institute.org/community
  1, UTeach Austin, started in Fall 1997 (Year 18)
  13 started in 2008 (Year 7)
  8 started in 2010 (Year 5)*
    *As of Summer 2014, the University of Memphis discontinued its UTeach program, so there are 7 remaining programs that started in 2010.
  4 started in 2011 (Year 4)
  8 started in 2012 (Year 3)
  1 started in Fall 2013, and 5 started in Spring 2014 (Year 1)
  5 started in 2015
• National enrollment, Spring 2015: 6,892 students
• 24% from underrepresented Hispanic, African American, and American Indian populations

Graduates

• Cumulative graduates, Spring 2014: 2,144 (includes 878 from UTeach Austin)
• Projected UTeach graduates expected once current programs conclude their grant periods: approximately 1,000 per year
• Projected UTeach graduates nationwide by 2020: 8,000
• Projected secondary STEM students taught by UTeach graduates nationwide by 2020: more than 4 million
NATIONWIDE ENROLLMENT IN UTEACH PROGRAMS
FALL 2008 TO SPRING 2015
UTeach Graduates Nationwide
Through Spring 2014

Cumulative program graduates through Spring 2014: 2,144
  UTeach at UT Austin: 878
  UTeach partner programs: 1,266

Graduates identified as underrepresented minorities: 17%

Graduates entering teaching: 87%

Graduates retained in teaching: 76%

Graduates who teach in schools with a majority low-income population: 66%

Graduates teaching by subject area (n = 1,330):
  Mathematics: 758
  Science: 457
  Computer Science: 14
  Engineering: 16
  Unknown subject: 277
  Other: 148

Based on the 94% of graduates through Spring 2014 successfully tracked. Schools with a majority low-income population are defined as schools deemed eligible for Title I funding according to the National Center for Education Statistics, Elementary/Secondary Information System (EISi). EISi data were available for 81% of schools where UTeach graduates were employed. UT Austin data is reported separately because that program began producing graduates in 2000, nine years before the first partner program produced graduates. Graduates teaching multiple subjects are counted once per subject area.
ETHNICITY OF UTEACH GRADUATES THROUGH SPRING 2014

- White: 66%
- Hispanic: 12%
- Asian: 11%
- African American: 4%
- Not Reported: 4%
- 2% Other
- 0.4% American Indian

n = 2,144
MAJORS OF UTEACH GRADUATES THROUGH SPRING 2014

- Mathematics: 43%
- Biology: 21%
- Other Non-STEM: 9%
- Other: 10%
- Chemistry: 7%
- Other STEM: 5%
- Physics: 3%
- Geosciences: 1%
- Engineering: 1%
- Computer Science: 1%

n = 2,144
UTEACH PROGRAM GRADUATES
(CUMULATIVE COUNT)

Actual graduates

2011: 781
2012: 1149
2013: 1623
2014: 2144

Projected graduates

2016: 3800
2018: 5800
2020: 8000
PROJECTED NUMBER OF SECONDARY STEM STUDENTS TAUGHT BY UTEACH GRADUATES

- 1 MILLION
- 2 MILLION
- 3 MILLION
- 4 MILLION
- 5 MILLION

Years:
- 2012
- 2014
- 2016
- 2018
- 2020
UTeach Outcomes: Retention in Teaching

Percentage teachers left in classroom, SASS* vs UTeach

45% of UTeach grads teach in schools with more than 40% low-income students.

*Schools and Staffing Survey
UTEACH AUSTIN TEACHER RETENTION: PERCENTAGE EMPLOYED IN K–12 SCHOOLS

YEAR ENTERED TEACHING

- 2000-2001: 67%
- 2001-2002: 59%
- 2002-2003: 42%
- 2003-2004: 55%
- 2004-2005: 60%
- 2005-2006: 70%
- 2006-2007: 58%
- 2007-2008: 62%
- 2008-2009: 69%
- 2009-2010: 84%
- 2010-2011: 80%
- 2011-2012: 94%
- 2012-2013: 97%
UTeach Outcomes: Retention

Texas Teacher Retention for teachers entering from 2004 until 2013
Teacher Years in Classroom

Fraction Remaining

Number of Teachers Entering
- 184
- 14,666

Population
- STEM, Standard Program
- STEM, Alternative Program
- UTeach
UTeach & non-UTeach teacher performance vs years of teaching experience

Composite UTOP Score vs Years of Experience

- UTeach
- Non-UTeach
UTeach vs non-UTeach teacher effectiveness in affluent vs non-affluent student populations

<table>
<thead>
<tr>
<th>Composite UTOP Score</th>
<th>UTeach</th>
<th>Non-UTeach</th>
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<tbody>
<tr>
<td>5</td>
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% Students Eligible Reduced Lunch

- 0-33%
- 33%-66%
- 66%-100%
Find all classrooms with ninth-graders taking Algebra I in 2012.

For each classroom, find these students’ average 8th grade mathematics score the previous year.

The “Expectation” for each classroom is a quadratic model using prior year score and poverty concentration.
Subtracting “Expectation” Yields Residual

Figure 3.2: Construction of math and science residual scores proceeds by fitting ninth grade Algebra I and Biology end of course exam class averages with a quadratic model in prior year math score and classroom poverty concentration. The top panel shows the regression line as a function of pretest score. I call this regression line the “Expectation”. The bottom panel shows classroom performance minus Expectation for all ninth grade Algebra I test takers and all ninth grade Biology test takers.
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3.3 Hierarchical Linear Model Quadratic in Prescore

The most complete current results use a hierarchical linear model where teachers are nested in campuses. The campuses are characterized by a single constant term.
UTeach vs. Alternative Cert. Novice Teacher Outcomes vs. Pre-Test

Algebra Classes broken down by Certification Type
Standard Teachers from Texas UTeach
Years of Experience < 4
U: 101  A: 100 , 1497 Classes , 22706 Students

Math Pretest Score

Certification Type
- Standard or PostBacc
- Alternative

Biology Classes broken down by Certification Type
Standard Teachers from Texas UTeach
Years of Experience < 4
U: 69  A: 62 , 1167 Classes , 19411 Students

Science Pretest Score

Certification Type
- Standard or PostBacc
- Alternative

Figure 4.3: Expectations from 3.2. Novice Texas UTeach graduates versus alternatively certified novice teachers in the same schools. Six stratified views of student gains in math and science with teacher preparation route as a factor, using the three main continuous variables – average pretest score, school poverty concentration, and classroom poverty concentration – as independent variable. The width of each ribbon indicates one standard uncertainty. Overall, Texas UTeach graduates appear to obtain equal or superior performance.
UTeach vs. Alternative Cert. Novice Teacher Outcomes vs. Poverty Concentration

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Standard Teachers from Texas UTeach
Years of Experience < 4
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Texas UTeach grads have gains equal to or higher than alternatively certified teachers in every case except 1:
Particularly in high poverty urban settings
UTeach: Opportunities for Growth

- Replication- Changing vs. expanding?
- TEA audit: Increased training in reading strategies, mental and emotional health.
- Identifying additional field teaching opportunities
- Expanded computer science teacher preparation
- “Making Teachers” (Noyce grant).
- Leadership development
What do you still want to know?

• More information at uteach.utexas.edu
• Feel free to email: marshall@austin.utexas.edu