Title
Exploring the Influences of a Partner-Based Teacher Credential Program on Candidates' Performance Outcomes

Journal
Peabody Journal of Education, 89(4)

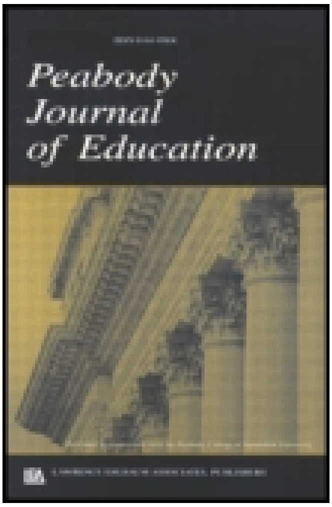
ISSN
0161-956X

Authors
van Es, Elizabeth A
Sandholtz, Judith Haymore
Shea, Lauren M

Publication Date
2014-08-08

DOI
10.1080/0161956x.2014.938996

Peer reviewed



Peabody Journal of Education
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/hpje20

Exploring the Influences of a Partner-Based Teacher Credential Program on Candidates' Performance Outcomes

Elizabeth A. van Es[a], Judith Haymore Sandholtz[a] & Lauren M. Shea[a]
[a] University of California, Irvine
Published online: 05 Sep 2014.

PEABODY JOURNAL OF EDUCATION, 89: 482–499, 2014

ISSN: 0161-956X print / 1532-7930 online
DOI: 10.1080/0161956X.2014.938996

Routledge
Taylor & Francis Group

Exploring the Influences of a Partner-Based Teacher Credential Program on Candidates' Performance Outcomes

Elizabeth A. van Es, Judith Haymore Sandholtz, and Lauren M. Shea
University of California, Irvine

The study compared candidates in a 4-year undergraduate program for secondary mathematics and science teaching, based on the UTeach model, with candidates in a 1-year postbaccalaureate program at the same institution. Candidates in the undergraduate program participated in a partnership of university mathematics, science, and education departments and intensive field-based experiences in high-needs schools. We conjectured that this approach would better prepare prospective teachers to develop beginning teacher competencies. Analysis of the Performance Assessment for California Teachers Teaching Event identified few differences between candidates in both groups. Surveys revealed significant differences between candidates' perceptions of their preparation for teaching. These findings suggest that different program models can offer differential support to prospective teachers but how the program features are enacted influences the impact that these programs have on teacher preparation.

Schools of education have faced increased criticism for not preparing teachers for the demands of the profession (Darling-Hammond, 2010; Grossman & McDonald, 2008). Key issues at the core of this criticism include (a) teacher preparation focuses too much on theory about teaching and learning and too little on developing prospective teachers' practice-based knowledge; (b) preservice teachers have little preparation in contexts that will help them learn to support a range of learners and provide equitable learning opportunities to all students; (c) preservice teachers are placed in classrooms with ineffective teachers, in schools that are often failing students; and (d) the programs do not adopt innovative practices or develop institutional capacity that prepare future teachers to teach in the 21st century (Darling-Hammond, 2006, 2010). In response, reform efforts that seek to improve teacher education have called for a fundamental shift in teacher preparation, with greater attention to learning how to teach through increased participation in the field observing and teaching in real classrooms (Ball & Forzani, 2009; Grossman & McDonald, 2008). Simply spending more time in the field, however, will not in itself change the quality of teacher preparation (Valencia, Martin, Place, & Grossman, 2009). Rather, how this time is structured and the kinds of opportunities that preservice teachers have to learn to teach during these experiences will influence the extent to which they are well prepared to enter the profession.

The purpose of this study is to explore the influence of one effort to reform teacher education that involves greater participation in classroom settings and a shift in the instructional focus in

Correspondence should be sent to Elizabeth A. van Es, School of Education, University of California, Irvine, 3455 Education, Irvine, CA 92697. E-mail: evanes@uci.edu

university coursework. This program, housed at a large public university in California, is one of 35 scale-up sites for the UTeach teacher education initiative (The UTeach Institute, 2013). The UTeach teacher preparation program originated at the University of Texas at Austin to recruit undergraduate science, mathematics, and computer science majors and prepare them to become exemplary science, technology, engineering, and mathematics (STEM) teachers. Based on its initial success in increasing the number of certified STEM teacher graduates, the program received support from several agencies to scale up its approach across the country. A key characteristic of this program is that it brings together partners at the university and school district sites to provide field-based learning experiences that are coordinated with pedagogically rich university coursework focused on the intersection of teaching, learning, and content. We view two core components of this program as central to the design to promote successful teacher preparation. One is the intensive field-based component that extends over the course of the program in carefully selected classrooms with mentor teachers whose teaching intends to align with program goals. The second is the role of the university-based master teacher who identifies mentor teachers for field placements, coteaches the university courses, and supervises students in the field as they enact what they learn in their coursework. We speculate that these programmatic features play an important role in preparing teacher candidates in a 4-year undergraduate program to develop beginning teacher competence. Moreover, we conjecture that the partnerships within the university (i.e. Colleges of Education, Liberal Arts, and the Sciences), as well as between the university and school-based sites that are unique to the UTeach program, afford a carefully designed course of study and mentorship that may better equip prospective teachers to enact ambitious teaching practices (Lampert, Beasley, Ghousseini, Kazemi, & Franke, 2010; Windschitl, Thompson, & Braaten, 2011).

To explore this program's influence on candidates' preparation for secondary mathematics and science teaching, we compare candidates in the 4-year undergraduate program with candidates in a 1-year postbaccalaureate (postbac) program at the same institution. We specifically address three research questions: (a) Do teacher candidates' scores on a summative teaching performance assessment vary across the two programs? (b) To what extent do teacher candidates in each program implement ambitious mathematics and science teaching practices? (c) To what extent do candidates' perceptions about the effectiveness of their preparation for classroom teaching vary across the two programs?

THEORETICAL FRAMEWORK

We draw on two lines of research to frame this study. The first relates to the goals of ambitious mathematics and science teaching, and the second relates to the role of partnerships in teacher education.

Ambitious Mathematics and Science Teaching

In the last 20 years, mathematics and science education research has made progress in documenting the knowledge and practices that teachers need to support learners in developing deep and rich understandings in these content areas (National Research Council [NRC], 2001, 2007). In mathematics, for example, this vision of instruction, referenced recently in the literature as *ambitious teaching*, calls on teachers to design high-quality, cognitively demanding tasks and to orchestrate meaningful discussions where students engage in mathematical reasoning to develop procedural fluency and conceptual understanding (Lampert et al., 2010; Smith & Stein, 2011). In addition, this vision of teaching seeks to support students in developing productive dispositions in mathematics, where students see mathematics as useful and worthwhile and develop identities as mathematics learners and doers (NRC, 2001). Similarly, calls for improving science education emphasize students learning to collect, interpret, and evaluate evidence to formulate scientific explanations of observed phenomena (American Association for the Advancement of Science, 2009; Duschl, 2008; NRC, 2007, 2012; Windschitl, Thompson, & Bratten, 2008). This approach to science instruction focuses on the processes for doing science such that the discourse of a science classroom is on making the case for "how we know what we know and why we believe it" (Duschl, 2008, p. 269). Thus, science is less about experimentation and more about explanation and model building in which individuals ask critical questions and develop appropriate skepticism about proposed explanations of scientific phenomena (Duschl, 2008). Engaging in this kind of scientific work requires that students learn to construct and evaluate arguments and participate knowledgeably in public discussions about science and technology (NRC, 2012; Ryu & Sandoval, 2012), as well as become critical consumers of scientific data by attending to and reasoning about scientific ideas, evaluating evidence for scientific claims, generating and testing models of scientific phenomena, and becoming effective problem solvers (American Association for the Advancement of Science, 2009; Duschl, 2008; NRC, 2007, 2012).

This instructional vision places many new demands on teachers. Teachers need to learn to design and enact tasks that make student thinking visible, as well as enact practices for orchestrating meaningful discussions around student work. To engage students in such conversations, in which they conjecture, explain, reason about, and construct arguments about mathematics and scientific phenomena, students and teachers need to create new forms of participation. In mathematics, this might involve a teacher posing a problem and then allowing students time to struggle with the problem, inviting several students to share their solution strategies, and comparing and contrasting their strategies to develop a deep understanding of mathematical concepts (Hiebert & Grouws, 2007; Smith & Stein, 2011). For science, this approach includes asking students to model scientific phenomenon, to seek evidence to support or refute the model, and then to construct an argument in which evidence confirms or refutes the model and alternative models are explored (Duschl, 2008; Windschitl et al., 2008). The idea is that through such activities students learn relevant content while developing both the language and practices for participating in the discipline.

An important dimension of this approach is gaining insight into the range of student thinking that emerges during instruction and using student ideas to inform future instructional decisions both in the moment of a lesson and in subsequent lessons (Lampert et al., 2010). Although it is not common practice for teachers to design instruction to gain insight into student thinking or to attend to student thinking while teaching (Jacobs, Lamb, & Philipp, 2010), both student and teacher learning benefit from such practice (Franke, Carpenter, Levi, & Fennema, 2001; Saunders, Goldenberg, & Gallimore, 2009). Moreover, learning to attend to the particulars of student thinking can support teachers in adopting a more student-centered approach to teaching and developing a student-centered frame for instruction (Levin, Hammer, & Coffey, 2009). Research suggests that it can be particularly challenging for preservice teachers to enact this vision of instruction (Lienhardt & Steele, 2005; Stein, Engle, Smith, & Hughes, 2008). However, recent reform efforts offer models for preparing prospective teachers to meet these demands, as we describe in the following section.

The Role of Partnerships in Preservice Teacher Education

Calls for the improvement of teacher preparation propose that teacher education be grounded in practice (AACTE, 2010; Grossman & McDonald, 2008). Research finds that preparation programs directly focused on teaching practice benefit teachers in their 1st year of teaching (Boyd, Grossman, Lankford, Loeb, & Wyckoff, 2009), and several approaches have been advocated for a practice-based pedagogy for teacher education (Darling-Hammond, 2006; Lampert et al., 2010). In both mathematics and science education, researchers have defined a set of research-based practices and accompanying tools for beginning teachers that are limited in number but provide an instructional core that guide beginning teachers in achieving this vision of teaching (Franke & Chan, 2007; Lampert et al., 2010; Windchitl et al., 2011). Others advocate for developing preservice teachers' abilities to learn in and from their teaching—with less emphasis on the core instructional practices and more on skills for learning to learn from one's practice in systematic ways (Hiebert, Morris, Berk, & Jansen, 2007). A third approach focuses on developing organizational capacity by cultivating school–university partnerships that situate the work of teacher education in carefully selected schools and providing preservice teachers with opportunities to learn from content experts, teacher educators, exceptional mathematics and science teachers, and school leaders (Darling-Hammond, 2006). Darling-Hammond (2006) identified several essential features for building effective partnerships: *coherence and integration* among courses and between courses and clinical experiences in schools; *extensive, well-supervised clinical experiences linked to coursework using pedagogies that link theory and practice* in schools with diverse student populations; and *new relationships with schools*. In this model, teacher education is treated as a coordinated system that draws on the expertise of many to provide prospective teachers with a coherent program grounded in the work of teaching (Thompson, Windschitl, & Braaten, 2013). Few studies examine the influence that such models of teacher education have on preservice teachers, particularly as they attempt to enact ambitious teaching practices in mathematics and science (see Thompson et al., 2013, for an exception). In this study, we explore this question by examining the influence that a partner-based undergraduate teacher preparation program has on prospective STEM teachers.

The UTeach model for teacher education that we investigate in this study is designed to provide a coherent, integrated teacher education program with extensive, intensive field-based experiences carefully mentored by university and school-based faculty. Faculty members from Schools of Education and the Arts and Sciences at the university provide instructional experiences to develop content knowledge for teaching. In addition, exceptional teachers from local K-12 schools become university instructors who coordinate and supervise field-based experiences in selected local schools with teachers who intend to adopt ambitious mathematics and science pedagogy. We seek to investigate how a program that consists of these features prepares future teachers for this challenging work.

METHODS

Study Context

This study takes place at a large public university in California that houses two distinct teacher credential programs. One is a postbac credential program that consists of three quarters of coursework and field-based experiences. Candidates take courses each quarter in the following strands: Learning from Teaching; Human Development and Theory; Pedagogy and Content Knowledge; Language, Literacy, and Technology; and Professional Conduct and Policy. Across all strands is a focus on learning relevant theory and content knowledge, as well as a field-based component for bridging theory and practice in school settings. In the first quarter, candidates are assigned a school-based field placement, where they observe one class and then take on increased responsibility over the 3-month period. In the second quarter, they continue taking courses at the university and begin their student teaching experience, teaching two sections of the same course (e.g., Algebra I or Earth Science) while also being placed in a third class in which they experience working with diverse student populations, such as a special education course or a class specifically focused on supporting English Language Learners. In the third quarter, with coursework mostly completed, they focus primarily on student teaching.

The second program is a 4-year undergraduate credential program modeled after the UTeach teacher preparation program. Central features of this program include (a) extensive collaboration between Colleges of Education and those responsible for administering science and mathematics degrees; (b) master teachers who have exemplary secondary teaching experience in the roles of clinical faculty; (c) research-based instruction to develop deep content knowledge and build strong connections between theory, practice, and content; and (d) continuous field experiences that are carefully structured to promote learning effective teaching practices in STEM education (The UTeach Institute, 2013). During the 4-year program, undergraduate students have multiple opportunities to participate in classrooms, with each course providing increased opportunities for students to learn about and employ research-based teaching strategies in K-12 contexts. They begin their field experiences in elementary classrooms, then move to middle school contexts, and ultimately observe and teach in high school settings. This approach provides candidates with opportunities to understand the progression and development of mathematics and science concepts from the early elementary years through high school. Students also complete a sequence of courses in their 3rd and 4th years, based on the UTeach model, in the following strands: theories of knowing and learning in mathematics and science; approaches to analyzing, enacting, and assessing classroom interactions in mathematics and science classrooms; methods for designing instruction for English Language Learners in the content areas; and methods for designing complex instruction in mathematics and science to promote equitable opportunities in secondary classrooms. Students apply research-based theories and frameworks to observation and analysis of mentor teachers' practice (Boaler & Humphreys, 2005; Smith & Stein, 2011; Windschitl et al., 2008), and with support from both university-employed master teachers and school-based

TABLE 1
Focus of Guiding Questions in Performance Assessment for California Teachers Rubrics

Focus of Guiding Questions	Category
Q1: Establishing a balanced instructional focus	Planning
Q2: Making content accessible	
Q3: Designing assessments	
Q4: Engaging students in learning	Instruction
Q5: Monitoring student learning during instruction	
Q6: Analyzing student work from an assessment	Assessment
Q7: Using assessment to inform teaching	
Q8: Using feedback to promote student learning	
Q9: Monitoring student progress	Reflection
Q10: Reflecting on learning	
Q11: Understanding language demands and resources	Academic language
Q12: Expanding students' academic language repertoire	

mentor teachers, they participate more centrally in classrooms, designing and teaching lessons and reflecting on their teaching effectiveness.

Participants

Participants in the study were candidates who were preparing to teach mathematics or science at the secondary level and who completed their credential program and the summative performance assessment during the 2011–12 and 2012–13 academic years. Over this 2-year period, the pool included 23 candidates in the 4-year undergraduate program and 83 candidates in the 1-year postbac program. The candidates in the undergraduate program were the first two cohorts to complete the program in its entirety at this university.

Data Sources

Data for the study come from two main sources: (a) the Performance Assessment for California Teachers (PACT) Teaching Event, and (b) an exit survey of candidates. The PACT Teaching Event is a portfolio assessment for California teachers that measures preservice teachers' ability to plan, teach, assess, and reflect on a lesson sequence (Pecheone & Chung, 2006). Candidates submit (a) a description of the school context to situate the lesson plan and analysis of teaching, (b) lesson plans for a 3- to 5-day teaching sequence with accompanying assessments and student work, (c) two edited video clips for a combined total of 15 to 20 min along with commentary and analysis of instruction, (d) example assessments and samples of student work, and (e) reflections for the entire lesson segment. The Teaching Event involves subject-specific assessments of candidates' competency in five categories: planning, instruction, assessment, reflection, and academic language. The content-specific scoring rubrics are organized around two or three guiding questions for each category. Table 1 identifies the focus of the questions within each of the five categories at the time of data collection.

For each question, the scoring rubric includes descriptions of performance for each of four levels or scores. Level 1, the lowest level, is defined as not meeting performance standards, and candidates need additional student teaching experience before they will be considered ready to lead a classroom. Level 2 is considered an acceptable level of performance. These candidates are judged to have adequate knowledge and skills with the expectation that they will improve with more support and experience. Level 3 is defined as an advanced level of performance on the standards relative to most beginners. Candidates at this level are judged to have a solid foundation of knowledge and skills. Level 4 is reserved for stellar candidates who demonstrate an outstanding and rare level of performance for a beginning teacher. Trained scorers of the PACT Teaching Event participate in training and meet a calibration standard each year. Candidates earn a score of 1 to 4 for each of the 12 questions, resulting in total possible scores that range from 12 to 48.

Candidates in both programs completed the PACT Teaching Event as part of the state licensing requirements. To compare candidates' performance on the summative assessment as well as their classroom teaching practices, we collected four sources of evidence from their PACT Teaching Events: (a) total scores, (b) scores on each of the 12 questions, (c) pass/fail determinations, and (d) video clips of classroom instruction.

The exit survey, developed by the School of Education program evaluation team, is administered to all candidates at the conclusion of their specific program. The survey asks candidates to rate how prepared they feel to perform a series of identified tasks as a beginning teacher on a 4-point Likert scale that ranges from *poorly prepared* to *very well prepared*. The main portion of the survey consists of 33 questions grouped into six domains that correspond with the teaching performance expectations: (a) making subject matter comprehensible to students, (b) assessing student learning, (c) engaging and supporting students in learning, (d) planning instruction and designing learning experiences for students, (e) creating and maintaining effective environments for students learning, and (f) developing as a professional educator. An additional question focuses on an overall evaluation of the candidates' preparation. Another section includes 12 statements focused on candidates' personal views about the professional environment of the credential program. These survey items include a 5-point Likert scale that ranges from *strongly disagree* to *strongly agree*. A final, open-ended question asks candidates to add comments about their experience in the teacher credential program.

Data Analysis

Data analysis took place in three phases, each related to one of the three research questions. In the first phase, we compared candidates' performance on the PACT by examining total scores, scores on individual questions, and pass/fail determinations for all 106 candidates: 23 in the undergraduate program and 83 in the postbac program. For each program, we calculated means and standard deviations for the individual questions, the total score, and the number of failing students. Based on the mean and standard deviation of all candidates from both cohorts (M = 29.67, SD = 5.67), we grouped candidates in four ranges. Thus, we determined the number of students per cohort whose score fell 1 *SD* above and below the average and 2 *SD* above and below the average. To examine the extent to which student performance on the PACT Teaching Event varied by program, we compared the percentage of students scoring in each of the total score ranges. In addition, for each program, we determined the minimum and maximum score per question. Then, to determine statistical differences between students' scores from each program, we performed *t* tests for independent samples. We conducted tests to determine the mean differences between the groups on individual questions, total scores, and percentage of students failing. Confidence intervals were also produced by this analysis.

In the second phase, we compared the teaching practices of a subset of candidates in each program. We conducted a randomized sample from each of the four total scores ranges (16–22, 23–29, 30–36, 37–48) and from each of the content disciplines. With the exception of the 16-to-22 range, this randomized selection resulted in identifying one candidate with a math concentration and one with a science concentration in each range and program. Data for this analysis consisted of the videos of teaching submitted as part of the PACT Teaching Event. The mathematics candidates were required to submit one or two video segments that lasted no longer than 20 min total and that demonstrated how candidates engaged students in understanding mathematical concepts, procedures, and reasoning. The science candidates submitted two segments no longer than 20 min total. The first clip captured how the candidates facilitated students' engagement in meaningful scientific thinking during a scientific inquiry that involved collecting data or selecting data collected by others. The second clip depicted how the candidates actively engaged students in analyzing, interpreting, and synthesizing the results of that inquiry. The PACT Teaching Event prompted candidates to include clips that illustrate interactions between and among the candidate and the students, as well as candidate responses to student comments, questions, and needs.

We coded the videos using an adapted framework that characterized teaching practices for noticing student thinking during instruction (van Es & Sherin, 2010). We analyzed the videos for three areas of teaching practice related to attending to and responding to student ideas, Making Student Thinking Visible, Pursuing Student Thinking, and Responding to Student Thinking During Instruction (see Table 2). We focused on exchanges related to eliciting and exploring student thinking for two reasons. First, attention to student thinking as it unfolds in a lesson is a core component of ambitious mathematics and science instruction. Second, both credential programs included courses that emphasized candidates learning to attend to student thinking and to use student thinking to make judgments about the effectiveness of instruction (Santagata & van Es, 2010). The first dimension, Making Student Thinking Visible, concerned candidates noticing that students had noteworthy ideas and making them public, as well as eliciting ideas from multiple students in small group and whole class discussions. The second dimension, Pursuing Student Thinking, reflected candidates' efforts to pursue student ideas and engage in extended discourse around these ideas by pressing on student thinking and asking students to elaborate on their explanations. The third dimension, Responding to Student Thinking During Instruction, captured adaptations that a candidate made to a lesson based on a student idea that emerged during instruction. Each dimension consisted of several subcategories, resulting in nine categories for analysis.

We divided the videos into 2 min segments, and the first author and another researcher coded the videos for confirming evidence of the nine teaching practices within each segment (Borko, Jacobs, Eiteljorg, & Pittman, 2008; van Es & Sherin, 2010). Initial interrater reliability across the nine practices was 75%. The two coders discussed differences in coding until consensus was reached. We calculated a percentage of overall enactment for each candidate for each of the nine categories, and then we compared the mean percentages of the two groups by using an independent samples *t* test to determine any statistically significant differences.

TABLE 2
Teaching Strategies for Attending to Student Thinking

Making Space for Student Thinking	Recognize a student has an idea	"Maria has an idea to share."
	Associate idea with particular students	"Jason thinks that as temperature increases, volume increases as well."
	Give students time to think	"Let's take a minute to think about this."
	Reiterate a student idea for discussion	"What do people think about Gavin's idea - to multiply all the cubes in the figure and then subtract them from the total number?"
	Elicit ideas from multiple students	"What are some other explanations for what's going on here?"
Pursuing Student Thinking	Probe student thinking	"Why do you think increasing the temperature causes an increase in the volume?"
	Ask students to explain reasoning	"Would that strategy always work?"
Responding to Student Thinking	Attend to student confusion and posing an alternative idea	"Could it be that another gas is being produced? What would that mean about the volume that the gas takes up?"
	Adapt the lesson for the whole class based on an individual student idea	"I saw that some students thought the answer was 6 and others thought it was 2/3. Let's think about these two ideas."

In the third phase, we examined candidates' perceptions about the effectiveness of their preparation for classroom teaching by analyzing their responses on the exit survey. To make comparisons across programs, we calculated and compared mean ratings for each group on each question. Upon noticing a trend in the "developing as a professional educator" domain, we conducted an independent *t* test for each question in that domain to determine any statistical significance of the differences.

RESULTS

In the following sections, we present the results for each research question. We first present data about candidates' scores on the performance assessment and report comparisons across the program groups. We then report the extent to which candidates implemented teaching practices that were responsive to student ideas. Finally, we present comparisons about candidates' perceptions about the effectiveness of their preparation for classroom teaching.

TABLE 3
Performance Assessment for California Teachers Score Results and Ranges (in Points) for Undergraduate and Post-Baccalaureate Candidates

		Undergraduate[a]		Postbaccalaureate[b]			95% CI	
Variable		M	SD	M	SD	*p*	LL	UL
Planning	Q1	2.87	.76	2.81	.59	.72	−.29	.41
	Q2	2.52	.66	2.58	.70	.72	−.38	.26
	Q3	2.70	.56	2.75	.54	.70	−.32	.21
Instruction	Q4	2.13	.76	2.43	.72	.10	−.66	.06
	Q5	2.39	.84	2.59	.77	.31	−.59	.20
Assessment	Q6	2.39	.84	2.42	.63	.87	−.42	.35
	Q7	2.04	.37	2.24	.67	.07	−.41	.02
	Q8	2.22	.80	2.52	.70	.08	−.64	.04
Reflection	Q9	2.52	.79	2.51	.69	.93	−.35	.38
	Q10	2.48	.79	2.46	.70	.91	−.35	.39
Academic language	Q11	2.17	.49	2.31	.62	.26	−.39	.11
	Q12	2.26	.54	2.31	.62	.69	−.32	.21
Total score		28.70	5.8	29.93	5.64	.37	−3.99	1.53
% failed		13.04	34.4	9.64	29.7	.67	−.13	.19

[a]$n = 23$. [b]$n = 83$.

Performance on PACT

Our findings show few differences between the groups in terms of performance on the PACT. As displayed in Table 3, there were no statistically significant differences for total score means between the two groups. The total score mean was 28.70 for the undergraduate group and 29.93 for the postbac group. There also were no statistically significant differences between the two groups for mean scores on any individual question. Although a slightly higher percentage of candidates in the undergraduate group than the post-bac group failed the performance assessment, the difference was not statistically significant.

As displayed in Table 4, the ranges in total scores and scores on individual questions were similar for both groups of candidates. Total scores for candidates in the undergraduate program ranged from 16 to 40, out of a possible 48, and from 18 to 45 for post-bac candidates. For the postbac group, scores ranged from a failing score of 1 to the highest score of 4 on each of the 12 individual questions. In the undergraduate group, scores similarly ranged from 1 to 4 on the majority of the individual questions. However, none of the undergraduate candidates received a

TABLE 4
Range of Scores (in Points)

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Total
Undergraduate[a]	1–4	2–4	2–4	1–4	1–4	1–4	1–3	1–4	1–4	1–4	1–3	1–3	16–40
Postbaccalaureate[b]	1–4	1–4	1–4	1–4	1–4	1–4	1–4	1–4	1–4	1–4	1–4	1–4	18–45

[a]$n = 23$. [b]$n = 83$.

failing score of 1 on two of the planning questions (Making Content Accessible; Designing Assessments), and none received a score of 4 on one instruction question (Using Assessment to Inform Teaching) and the two academic language questions (Understanding Language Demands; Expanding Students' Academic Language Repertoire).

We also examined the candidates' total scores in each of four score ranges and found that the percentage in the lowest and highest total score ranges is similar for both groups. In the undergraduate group, 8.7% of candidates received total scores between 16 and 22 compared to 9.6% in the postbac group, and 12.5% of undergraduate candidates scored in the highest range compared to 13.3% of postbac candidates. For the postbac group, the same percentage of candidates (38.6%) scored between 23 and 29 points as between 30 and 36 points. However, for the undergraduate group, a higher percentage of candidates (60.7%) scored between 23 and 29 than between 30 and 36 (17.4%). These findings suggest that the two groups of candidates were accomplishing the same levels of competence through participation in their respective programs. Given the intensive field-based component of the undergraduate program, we wondered if differences would arise in the particulars of their teaching practice. We present these findings in the following section.

Teaching Practices

The second research question concerned the extent to which teacher candidates in each group implemented ambitious mathematics and science teaching practices, with a particular focus on attending to and taking up student ideas during instruction. Similar to the analysis of the PACT scores, the analysis of teaching practices revealed no significant differences in eight of the nine categories (see Table 5).

Table 5 shows that, for all categories, candidates in both cohorts adopted these practices in less than 25% of the 2 min intervals. Although the practices did not occur in most of the 2 min intervals, when taken together in an instructional interaction, there is evidence that candidates in both cohorts sought to elicit student ideas from multiple students, probe student thinking, and attend to student confusion and pose alternative ideas to clarify student thinking. However, a comparison of the two groups shows a trend of the postbac candidates enacting more of these practices, with a greater percentage of segments in which they recognized particular student ideas, probed student thinking, asked students to explain their reasoning, and responded by posing an alternative idea. Moreover, we observed a statistically significant difference ($p < .05$) between the two groups for one practice, *asking students to explain their reasoning*. This suggests then that although neither group took up these practices extensively, when the postbac candidates did provide opportunities for student thinking to emerge, they were more likely to pursue those ideas to understand student thinking during instruction.

Perceptions of Preparedness

The third research question examined candidates' perceptions about the effectiveness of their preparation for classroom teaching. Our analysis of the exit surveys showed significant differences in candidates' overall evaluation of their preparation and in candidates' ratings of the

TABLE 5
Comparison of Percentages of Observed Ambitious Teaching Practices

	Make Space for Student Thinking					Pursue Student Thinking		Respond to Student Thinking	
	Recognize Student Has an Idea	Associate Ideas With Particular Students	Give Students Time to Think	Rephrase Student Idea for Discussion	Elicit Ideas From Multiple Students	Probe Student Thinking	Ask Students to Explain Reasoning	Attend to Student Confusion and Pose an Alternative Idea	Adapt the Lesson for Whole Class Based on Individual Student Idea
Undergraduate	.06	.06	.06	.02	.14	.12	.04	.10	.00
Postbaccalaureate	.12	.05	.03	.04	.14	.24	.16	.15	.00
Difference	.06	.01	.03	.02	0	.12	.12*	.05	0

Note. The average number of 2 min segments for the undergraduate cohorts was 10.6 and the average number for the postbaccalaureate cohorts was 10. Percentages were calculated by the number of 2 min intervals where the practice was observed divided by total 2 min intervals in the submitted video.

$^{*}p < .05$.

TABLE 6
Exit Survey Results for Professional Environment for Undergraduate and Postbaccalaureate Candidates

	Undergraduate[a]		Postbaccalaureate[b]		
Variable	M	SD	M	SD	*p*
Coordinators' sense of mission & purpose	4.85	.37	4.65	.58	.07
Directors' sense of mission & purpose	4.85	.37	4.67	.62	.10
Program leaders & faculty's professionalism & service to candidates, school, & society	4.90	.31	4.55	.71	.00**
High quality of classroom discourse, contributions, & presentations by candidates	4.95	.24	4.32	.78	.00**
Sense of mutual respect & support among candidates	5.00	.00	4.60	.73	.00**
Seriousness of purpose regarding course evaluations	4.70	.66	4.06	.92	.01*
Offers candidates intellectual safety to take risks	4.80	.52	4.31	.87	.00**
Challenges candidates to do best work	4.65	.67	4.35	.98	.19
Course teaching reflects pedagogical principles espoused by program	4.85	.37	4.06	1.12	.00**
Courses present clear & consistent vision of what constitutes good teaching	4.85	.37	4.17	.93	.00**
Analyst provides information as needed regarding credential requirements	4.85	.37	4.05	.97	.00**
Assistant(s) provide help in using information system & uploading PACT	4.80	.52	4.47	.75	.03*

Note. Each survey item included a 5-point Likert scale response ranging from *strongly disagree* to *strongly agree*.
[a]$n = 20$. [b]$n = 78$.
*$p < .05$. **$p < .01$.

professional environment of their credential program. However, there were few differences on questions in the survey related to candidates' preparation for the teaching performance expectations. On the 33 items that correspond with the teaching performance expectations, the mean ratings for the undergraduate program candidates tended to be slightly higher than for the postbac candidates, but the differences were not statistically significant. However, on the one question that asked about candidates' overall evaluation of their preparation for teaching, the 4-year undergraduate candidates' mean rating was 3.74 on a 4-point scale and was significantly higher ($p < .05$) than the postbac candidates' mean rating of 3.44. On the section of the survey about the professional environment, the mean ratings for the undergraduate program candidates were higher on all items, and the difference was significantly higher on nine of the 12 items (see Table 6). Several of these questions reflect goals of the undergraduate program, including providing candidates with a supportive environment, modeling pedagogical approaches being espoused in the program, and offering a consistent and coherent vision of high-quality instruction.

These findings suggest that candidates in both programs held similar perceptions about their preparedness to teach according to the teaching performance expectations. However, candidates in the undergraduate program felt better prepared in terms of their overall evaluation of the program and had higher ratings of the professional environment of their program.

DISCUSSION

Given the programmatic features of the 4-year undergraduate program, we expected to find differences between the two groups of candidates in the three focal areas in this study: performance on the PACT, enactment of ambitious teaching practices, and perceptions of preparedness for full-time teaching. We anticipated that the carefully supported supervision would help the undergraduate candidates perform at more advanced levels on the teaching elements that are measured in the PACT assessment. We also expected that the extensive field placements and the structured mentorship by exemplary teachers would provide them with opportunities to observe and implement student-centered teaching practices. Finally, we thought they would perceive being better prepared for the demands of the profession because of the extensive support provided through the 4-year program design.

In contrast to our expectations, we did not find key differences in all three areas. In both groups, the majority of candidates received passing scores on the performance assessment and an equivalent percentage scored in the highest and lowest ranges. In terms of ambitious teaching practices, though there was a trend for the postbac candidates to enact more student-centered practices in their lessons, few candidates appeared to be implementing ambitious teaching practices related to making student thinking visible. As for perceptions of preparedness to teach, candidates in both groups felt similarly prepared in terms of teaching performance expectations. Differences between the groups emerged in the overall evaluation of their preparedness and in their perceptions about the professional environment of their credential programs, with higher ratings for the undergraduate program group than the postbac program group.

We propose three possible reasons for the lack of differences. First, although the two programs have distinct design characteristics, candidates in both programs complete their field placements in the same school districts. We speculate that contextual factors in these districts may be particularly influential and may be constraining opportunities for candidates to enact ambitious teaching practice. More specifically, the standards climate in California plays a particularly strong role in determining what teachers will teach and how they will interact with students (Wilson, 2003). This issue is consistent with other research that demonstrates that teachers' district and policy climates influence the extent to which they perceive being able to enact teaching practices that are responsive to students (Spillane, 1999). Thus, although the undergraduate program design advocates for instructional approaches that reflect the goals of ambitious mathematics and science pedagogy, the candidates may be unable to put them into practice without the institutional support of the partner school districts.

Second, the enactment of the undergraduate program at this particular site may differ from the UTeach model as originally conceived. The program includes features specifically designed to prepare exemplary STEM teachers, but more important than the program design is the way in which key features are implemented. Researchers who studied professional development school partnerships, for example, discovered many programs that adopted the professional development school designation but functioned primarily as clustered sites for student teacher placements, with few, if any collaborative or shared governance features (Teitel, 1997). The character and quality of program components may be more important than the particular structural model of teacher education programs (Zeichner & Schulte, 2001). We speculate that the central components of the undergraduate program have yet to become institutionalized among all parts of the teacher education system in keeping with the program design. For example, the university and school-based mentors may have different images of effective teaching and may provide conflicting feedback to candidates during the student teaching experience. Without strong coordination and coherence between the university and school sites, the teacher candidates may be challenged to implement methods advocated in the teacher education program in their own practice (Valencia et al., 2009). An important area of future inquiry concerns how the university and school-based participants develop a shared vision of ambitious pedagogy and create coherence between the experiences in these two distinct settings.

Third, establishing teacher education programs based on partnerships is a complex process that takes time. Creating school–university partnerships is complicated because it involves combining institutions with distinctive and possibly conflicting missions, organizational structures, and cultures (Sandholtz, 1997). These types of teacher education programs need time to develop and mature. Moreover, change in partnership programs tends to be incremental (Sandholtz, 1999). After 2 years of implementation, it may be premature to compare candidate outcomes from a partnership program to those from an established program. Our findings may be different if we examined the program's impact over an extended period. The differences in candidates' perceptions of the professional environment suggest initial programmatic differences in areas such as mutual respect and support, intellectual safety to take risks, and a clear and consistent vision of effective teaching. As the partnerships become more established, these types of programmatic characteristics may lead to differences not only in perceptions but also in teaching practices.

CONCLUSION

Although the candidates do not yet exhibit ambitious teaching practices, we propose that candidates in both programs are making progress. When we examine their overall performance on the PACT, we find that candidates in both groups are developing the knowledge, skills, and disposition to teach in ways that are valued by their disciplinary focus. However, when we take a closer look at their specific teaching practices in the context of classroom interactions, we find that more work is to be done. The video segments suggest that the candidates have not yet established rich discourse communities where the students and teachers question ideas, explain their thinking, and take responsibility for one another's learning (Hufferd-Ackles, Fuson & Sherin, 2004). Learning to orchestrate these types of discussions can be challenging for novice teachers (Kazemi & Stipek, 2001). However, with structured guidance of particular practices grounded in the actual work of teaching, preservice teachers can adopt such approaches to teaching (Boyd et al., 2009). Thus, an important area of future inquiry concerns how the preparation programs intend to achieve this goal and how revisions in the candidates' experiences can better equip them to enact ambitious teaching practices early in their careers. Future research that follows candidates into their first years of teaching may also examine how their perceptions about the professional environment of the credential programs and the structure of support subsequently influence their experiences in their induction years.

We propose that the analysis we have undertaken is a useful first step for studying how teacher education programs influence future teachers. Teacher education programs continue to be criticized for not preparing preservice teachers. Few studies take both a broad and up-close look to assess the extent to which preservice teachers are well prepared for the profession. Our analysis suggests that multiple sources of evidence reveal different information about prospective teachers' preparation. Our analysis of the PACT scores offers a broad perspective about what the candidates in these programs know and are able to do and suggests that the majority of candidates in both programs meet initial requirements to become full-time teachers. By attending to other sources of evidence, in this case the videos of teaching and surveys, we begin to identify aspects of practice where future teachers need additional support and target aspects of the teacher education system to refine and to further cultivate. Such a systematic approach is being advocated for the improvement of teaching (Hiebert, Gallimore, & Stigler, 2002) and is a model that teacher education programs might adopt to learn in and from their practice to improve teacher preparation.

AUTHOR BIOS

Elizabeth A. van Es, Ph.D., is an Associate Professor in the Department of Education at the University of California, Irvine. Her research interests include Teacher Cognition; Pre-service Teacher Education; In-service Teacher Professional Development; Teacher Learning Communities; Uses of Video in Teacher Learning.

Judith Haymore Sandholtz, Ph.D., is a Professor in the School of Education at the University of California, Irvine. Her research interests focus on teacher professional development, teacher education, and school-university partnerships.

Lauren M. Shea, Ph.D., is the Director of the California Science Project at the University of California, Irvine. Her research interests include professional development in the integration of language and content, language acquisition strategies, and how technology can increase teacher and student outcomes in PD programs.

REFERENCES

American Association for the Advancement of Science. (2009). *Vision and change*. Washington, DC: Author.

American Association of Colleges for Teacher Education. (2010). *Reforming teacher preparation: The critical clinical component*. Washington, DC: Author.

Ball, D. L., & Forzani, F. M. (2009). The work of teaching and the challenge for teacher education. *Journal of Teacher Education*, *60*, 497–511.

Boaler, J., & Humphreys, C. (2005). *Connecting mathematical ideas: Middle school video cases to support teaching and learning*. Portsmouth, NH: Heinemann.

Borko, H., Jacobs, J., Eiteljorg, E., & Pittman, M. E. (2008). Video as a tool for fostering productive discussions in mathematics professional development. *Teaching and Teacher Education*, *24*, 417–436.

Boyd, D. J., Grossman, P. L., Lankford, H., Loeb, S., & Wyckoff, J. (2009). Teacher preparation and student achievement. *Educational Evaluation and Policy Analysis*, *31*, 416–440.

Darling-Hammond, L. (2006). Constructing 21st-century teacher education. *Journal of Teacher Education*, *57*, 300–314.

Darling-Hammond, L. (2010). Teacher education and the American future. *Journal of Teacher Education*, *61*, 35–47.

Duschl, R. (2008). Science education in three-part harmony: Balancing conceptual, epistemic, and social learning goals. *Review of Research in Education*, *32*, 268–291.

Franke, M. L, Carpenter, T. P., Levi, L., & Fennema, E. (2001). Capturing teachers' generative change: A follow-up study of professional development in mathematics. *American Educational Research Journal*, *38*, 653–689.

Franke, M. L., & Chan, A. (2007, April). Learning about and from focusing on routines of practice. Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL.

Grossman, P., & McDonald, M. (2008). Back to the future: Directions for research in teaching and teacher education. *American Educational Research Journal*, *45*, 184–205.

Hiebert, J., Gallimore, R., & Stigler, J. (2002). A knowledge base for the teaching profession: What should it look like and how can we get one. *Educational Researcher*, *31*(5), 3–15.

Hiebert, J., & Grouws, D. A. (2007). The effects of classroom mathematics teaching on students' learning. In F. K. Lester, Jr. (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 371–404). Charlotte, NC: Information Age.

Hiebert, J., Morris, A. K., Berk, D., & Jansen, A. (2007). Preparing teachers to learn from teaching. *Journal of Teacher Education*, *58*, 47–61.

Hufferd-Ackles, K., Fuson, K. C. & Sherin, M. G. (2004). Describing levels and components of math-talk learning community. *Journal of Research in Mathematics Education*, *35*, 81–116.

Jacobs, V., Lamb, L., & Philipp, R. (2010). Professional noticing of children's mathematical thinking. *Journal for Research in Mathematics Education*, *41*, 169–202.

Kazemi, E., & Stipek, D. (2001). Promoting conceptual thinking in four upper-elementary mathematics classrooms. *Elementary School Journal*, *102*, 59–80.

Lampert, M. (2010). Learning teaching in, from, and for practice: What do we mean? *Journal of Teacher Education*, *61*, 21–34.

Lampert, M., Beasley, H., Ghousseini, H., Kazemi, E., & Franke, M. (2010). Using designed instructional activities to enable novices to manage ambitious mathematics teaching. In M. K. Stein & L. Kucan (Eds.), *Instructional explanations in the disciplines* (pp. 129–141). New York, NY: Springer.

Levin, D., Hammer, D., & Coffey, J. (2009). Novice teachers' attention to student thinking. *Journal of Teacher Education*, *60*, 142–154.

Lienhardt, G., & Steele, M. D. (2005). Seeing the complexity of standing to the side: Instructional dialogues. *Cognition & Instruction*, *23*, 87–163.

National Research Council. (2001). *Adding it up: Helping children learn mathematics*. Washington, DC: National Academy Press.

National Research Council. (2007). *Taking science to school: Learning and teaching science in grades K–8*. Washington, DC: National Academy Press.

National Research Council. (2012). *A framework for K–12 science education: Practices, crosscutting concepts, and core ideas*. Washington, DC: National Academy Press.

Pecheone, R. L., & Chung, R. R. (2006). Evidence in teacher education: The performance assessment of California teachers. *Journal of Teacher Education*, *57*, 22–36.

Ryu, S., & Sandoval, W. A. (2012). Improvements to elementary children's epistemic understanding from sustained argumentation. *Science Education*, *96*, 488–526.

Sandholtz, J. H. (1997). A model not a mold: A comparison of four school/university partnerships. In D. Byrd & D. J. McIntyre (Eds.), *Research on the education of our nation's teachers: Teacher education yearbook V* (pp. 258–276). Newbury Park, CA: Corwin Press.

Sandholtz, J. H. (1999). Internal change—The challenge in school–university partnerships. In C. Major & R. Pines (Eds.), *Teaching to teach. New partnerships in teacher education* (pp. 127–142). Washington, DC: National Education Association.

Santagata, R., & van Es, E. A. (2010). Disciplined analysis of mathematics teaching as a routine of practice. In J. Luebeck & J. W. Lott (Eds.), *Mathematics teaching: Putting research into practice at all levels* (Vol. 7, pp. 109–123). San Diego, CA: Association of Mathematics Teacher Educators.

Saunders, W., Goldenberg, C., & Gallimore, R. (2009) Increasing achievement by focusing grade level teams on improving classroom learning: A prospective, quasi-experimental study of Title 1 schools. *American Educational Research Journal*, *46*, 1006–1033.

Smith, M. S., & Stein, M. K. (2011). *Five practices for orchestrating productive mathematics Discussions*. Reston, VA: National Council of Teachers of Mathematics.

Spillane, J. P. (1999). External reform initiatives and teachers' efforts to reconstruct their practice: The mediating role of teachers' zones of enactment. *Journal of Curriculum Studies*, *31*, 143–175.

Stein, M. K., Engle, R. A., Smith, M. S., & Hughes, E. K. (2008). Orchestrating productive mathematical discussions: Helping teachers move beyond show and tell. *Mathematical Thinking and Learning*, *10*, 313–340.

Teitel, L. (1997). Professional development schools and the transformation of teacher leadership. *Teacher Education Quarterly*, *24*, 9–22.

Thompson, J., Windschitl, M., & Braaten M. (2013). Developing a theory of early-career teacher practice. *American Educational Research Journal*, *50*, 574–615.

The UTeach Institute. (2013). *UTeach operations manual*. Retrieved from http://www.uteach-institute.org/files/uploads/uteach-operations-ch05-instructional-program.pdf

Valencia, S., Martin, S. D., Place, N., & Grossman, P. (2009). Opportunities lost and found: The student teaching experience. *Journal of Teacher Education*, *60*, 304–322.

van Es, E. A., & Sherin, M. G. (2010). The influence of video clubs on teachers' thinking and practice. *Journal of Mathematics Teacher Education*, *13*, 155–176.

Wilson, S. (2003). *California dreaming: Reforming mathematics education*. New Haven, CT: Yale University Press.

Windschitl, M., Thompson, J., & Braaten, M. (2008). Beyond the scientific method: Model-based inquiry as a new paradigm of preference for school science investigations. *Science Education*, *92*, 941–967.

Windschitl, M., Thompson, J., & Braaten, M. (2011). Ambitious pedagogy by novice teachers? Who benefits from tool-supported collaborative inquiry into practice and why. *Teachers College Record*, *113*, 1311–1360.

Zeichner, K. M. & Schulte, A. K. (2001). What we know and don't know from peer-reviewed research about alternative teacher certification programs. *Journal of Teacher Education*, *52*, 266–282.