Much research on Alternative Certification Programs (ACPs) has focused on comparing inputs (e.g., teacher diversity) and outputs (e.g., teacher retention) with those of traditional teacher education programs. However, the choice between a traditional program and an alternative route is not a choice between some professional preparation and no preparation. Instead the choice is about the timing and institutional context for teacher education and how to best help teachers develop the knowledge and skills to be “highly qualified.” What researchers have failed to do, for the most part, is study how teachers learn within the context of ACPs. In 2003, we initiated an alternative certification program for mathematics and science teachers at our university. Program evaluators examined students’ decisions to enter the program, satisfaction with the program, self-efficacy for teaching, and self-reported achievement of the state teaching standards. Project investigators conducted research about: effective recruitment strategies; the perceptions of various stakeholders concerning the design of the guided internship component; and the development of teacher identity within the program. However, many questions about teacher learning in ACPs remain unanswered. In this paper, we propose a specific research project situated within a larger agenda for studying teacher learning in the context of ACPs. We believe that such research will guide policy making about and the design of high quality ACPs. The ultimate goals if for teachers to leave these programs with the greatest likelihood of success.

Why Study Alternative Certification?

Numerous studies have shown that the classroom teacher is the most important factor in student achievement [1]. Indeed, the strongest predictor of how well a state’s students performed on a recent national assessment was the percentage of well-qualified teachers--those who were fully certified and had majored in the subjects they taught [2,3]. However, U.S. schools face a growing and critical shortage of qualified teachers, even in the wake of a federal mandate that requires a “highly qualified” teacher in every
classroom by the end of the 2005-2006 school year. The situation is especially desperate in mathematics and science, where the workforce is plagued with an insufficient supply of qualified teachers and retention difficulties. Fewer than half of all U.S. mathematics teachers have a major or minor in mathematics; national figures for those who lack state certification in their field range from 28-33% for mathematics teachers and 18-20% for science teachers [4,5]. Yet, over the past decade, the demand for secondary teachers, especially in mathematics and science, increased by 22%. In a report released by the National Commission on Teaching and America’s Future [6], low retention also was cited as a major contributing factor to the teacher shortage. However, the report found that stronger teacher preparation led to higher retention of beginning teachers. The report asserted that quality teacher preparation hinges on careful recruitment, strong academic preparation, extensive clinical practice, and supportive induction programs.

Many states have responded to the teacher shortage and the need for highly qualified teachers by authorizing alternative pathways to teacher certification. Moreover, NSF encouraged the design and implementation of alternative pathways for science and mathematics teacher certification through its STEM-TP program. These alternative paths, typically shorter in duration than traditional teacher preparation programs, often place teachers in full-time teaching positions after minimal preparation. By 2003, 46 states and DC had initiated alternative routes to teacher certification, and over 200,000 teachers had been prepared in such programs [7].

Although these alternative routes have been successful at recruiting a more diverse pool of teachers, they have a “mixed record in terms of the quality of teachers recruited and trained” [8, p. 198]. Some alternative certification programs have been more successful than others, suggesting that research is needed that goes beyond examining whether or not alternative certification is a viable model of teacher preparation; we need to investigate when, why, and how alternative models of teacher preparation can be most effective. Investigating these questions requires a careful examination of what alternative certification candidates learn and what facilitates and constrains their learning. Ultimately, a better understanding of the development of teacher knowledge within the alternative pathways context will facilitate the development and implementation of more effective teacher preparation and larger numbers of qualified mathematics and science teachers. To ensure that we are preparing the highest quality teachers, it is imperative that we study the development of teacher knowledge in alternative certification programs.

The purpose of this paper is to describe a need in the research literature on ACPs. Based on that need, we propose a specific study to take place within the context on one ACP. Finally we present a broader agenda for research on ACP learning. We believe that such research will inform both policy makers and program designers.

What Do We Know?

The literature relevant to the research proposed in this paper includes the research on alternative certification as well as that on teacher learning in field-based settings. We
reviewed recent research syntheses [9, 10, 8] as well as individual research studies [e.g., 11, 12] to ground the research questions and study design.

**Alternative Certification**

One concern in the research on alternative certification is the lack of a clear definition of what constitutes an alternative certification program (ACP) in contrast to a traditional teacher education program (TEP) [13]. This lack of definition is exacerbated by the lack of description of the structure of alternative certification programs [13] in specific research studies. Although we acknowledge this problem in the ACP research, below we describe some of the key research findings and identify areas for further study.

One of the demonstrated strengths of ACPs is the varied demographic backgrounds of ACP teachers. As a group, they are typically more ethnically diverse than traditionally certified teachers [14, 15]; in addition, ACPs attract a higher percentage of males into the teaching profession. ACP teachers are more likely to have lived in an urban setting, and perhaps as a result, are more willing to teach in urban or rural settings than TEP teachers [16]. Thus, ACPs have increased the number of mathematics and science teachers and placed a large proportion of these teachers in urban settings [15]. Approximately half of ACP teachers enter teacher education programs after beginning their careers in a non-teaching field [15], potentially bringing knowledge of practical job experiences into the classroom.

Mixed results have been found regarding the extent to which ACPs produce “highly qualified” teachers. For example, Darling-Hammond, Chung, and Frelow [11] found that teachers in TEPs felt more prepared to teach than teachers in ACPs. However, in the *Teach for America* program, ACP teachers relied on instruction that encouraged memorization and following rules more than did their traditionally certified counterparts [17]. In contrast, Gomez and Stoddart [18] found that ACP teachers held higher expectations for underprivileged students, leading to the potential for increased student achievement in the classrooms of these teachers.

Considerable variation exists in the design and purpose of alternative certification programs [19, 20]. For example, Scribner, Bickford, and Heinen [21] found differences in program goals, structure, support in teaching field placements, and mentoring available to interns among the various ACPs within the state of Missouri. Because of this variation in program design, the research results are difficult to interpret and inadequate for informing the design and implementation of ACPs. Thus it is important for ACP researchers to define the context of the ACPs in which their research takes place.

Much of the literature has focused on comparing outcomes for TEPs and ACPs. However, Stoddart and Floden [22] argued that the choice between a traditional program and an alternative route is not a choice between some professional preparation and no preparation. Instead the argument is about the timing and institutional context for teacher education and how to best help teachers develop the knowledge and skills to be “highly qualified.” Further research is needed to understand teacher learning within the context of
ACPs. Such research will guide the design of ACPs so that teachers leaving these programs will have the greatest likelihood of success.

Field-based Internships

One of the challenges in any mathematics or science teacher preparation program involves helping preservice teachers move away from mathematics and science instruction as characterized by the memorization of facts toward a standards-based view of teaching as a process of inquiry that requires student-led investigation, conjectures, evidence, and explanation. Both ACP and TEP teachers enter teacher development programs with experiences that they need to “unlearn” if they are to exemplify instruction described in the mathematics and science standards [25]. Most teacher educators agree that field-based experiences are an essential part of learning to teach [26]. These experiences must include opportunities to observe, study, and discuss inquiry/problem-based teaching and learning.

Because alternatively certified teachers often have little experience in the classroom other than their experiences as students, the relationship that they develop with a mentor in a field-based internship can be an important part of their transition into a teaching career [27, 28]. As such, field experiences can provide opportunities for ACP interns to experience teaching in a manner that differs considerably from their previous experiences as students. However, research shows that field experiences are often disconnected from the image of teaching that is portrayed in university methods courses [26, 29]. Teaching interns can have difficulty linking theory to practice in field settings [30] and mentor teachers often provide minimal instructional support in these areas [31]. Thus field experiences can lead to little change in teacher knowledge or instructional practices [32, 33, 34]. However, other studies demonstrate that mentor teacher knowledge of student learning and standards-based instruction can impact intern teachers’ instructional practices [35].

Despite the potential shortcomings of field-based experiences, evidence exists that carefully designed field placements have the potential to: 1) engage interns in exploring different instructional methods [36, 37], 2) increase intern self-efficacy [38], and 3) connect university coursework to classroom decision-making [39]. In addition, field placements offer opportunities to engage in professional discourse with practicing teachers [40], serving as a “transformative pathway” through which preservice teachers come to understand and experience what it means to be a teacher [41].

However, most of the aforementioned studies examined the impact of field experiences in TEPs and for only short periods of time (typically one semester). We have little understanding of what or how ACP interns learn in coursework and field experiences throughout teacher development programs and into the initial years of teaching [42]. According to [26], “There is not enough information on the long-term development of teaching practice” (p. 331). Thus, we need to better understand the development of teacher knowledge in field-based settings over time. This need is even
greater in ACPs where interns often become independent practitioners in their classrooms much sooner than students in TEPs.

A Proposal to Study Teacher Learning

Context of one Alternative Certification Program

In January, 2003, the Missouri Department of Elementary and Secondary Education approved the University of Missouri-Columbia (MU) alternative certification programs in Science and Mathematics Teacher Education. These streamlined programs prepare individuals who hold undergraduate degrees in mathematics or science for careers in teaching, grades 6-12. The design and initial implementation of these programs under the auspices of SMAR^2T: Science and Mathematics Academy for the Recruitment and Retention of Teachers (www.smar2t.missouri.edu), was funded by an NSF STEM-TP grant. Although the definitions of ACPs differ across studies, we applied Adelman’s [43] definition of alternative certification to our program: “those teacher education programs that enroll noncertified individuals with at least a bachelor’s degree offering shortcuts, special assistance, or unique curricula leading to eligibility for a standard teaching credential” (p. 2).

SMAR^2T ACP operates on a cohort system. In April, 2005, the program selected its third cohort of students. Within a cohort, students self-select one of two program tracks: the 24-month Independent Internship track for individuals who are currently teaching full time under the state’s temporary certification, or the 15-month Guided Internship track for full time students preparing to become teachers. Both tracks lead to full state certification and a Master’s degree. Formative feedback from the external evaluator [44] has improved all components of the program: campus-based coursework, field based internships and supervision, and exit projects, including an Action Research project and a state-required online certification portfolio.

A typical cohort is comprised of 30 students, 15 in science and 15 in mathematics, about 25-30% of whom participate in the Independent Internship track. All students begin their program with an 8-week, 11-credit intensive summer experience: an 8-credit block of Educational Foundations (learning theory, schools and society) with an accompanying field internship in a summer school setting, and a 3-credit subject specific pedagogy (science or math methods) course. During the fall semester, students in both tracks enter a year-long field internship in a middle or secondary science or mathematics classroom. The Independent Internship students serve their internship as full time teachers, paid by a school district, and supervised by a district-appointed mentor and a university supervisor. The Guided Internship students are placed in classrooms of mentor teachers for four hours per day, five days per week, where they receive intensive guidance from the classroom teacher and supervision from a university representative. The university supervision is similar across the two tracks, with the university supervisor providing feedback on teaching 2-3 times per semester.
During the school year, all students are enrolled simultaneously in their second (fall semester) and third (spring semester) subject specific pedagogy courses. Students from both tracks enroll in a second intensive summer session, after which the Guided Internship students graduate and assume full time teaching positions. The Independent Internship students stay in the program another year, completing the rest of the program’s requirements while they continue their teaching duties and receive internship credit. These two models of alternative certification are illustrated in Figure 1.

The key difference between these models is the point of transition into full-time teaching and the accompanying degree of guidance received. The Independent Internship students become full-time teachers after an 8-week summer session. They have complete responsibility for their classrooms while they take coursework at the university, and have limited guidance from an assigned mentor in their building. The Guided Internship students, on the other hand, participate in a year-long internship under the direct guidance of a veteran teacher, and take more university coursework concurrently with this field experience. When they enter their first year of full time teaching, they have spent one year as a “student teacher” under the direct guidance of a mentor. We are interested how the key element of these two models—the type of internship, whether guided or independent--influences the development of teacher knowledge.

Program evaluators for the SMAR²T ACP examined students’ decision to enter the program, experience in the program, self-efficacy for teaching, and self-reported achievement of the state teaching standards [44]. Project investigators conducted research about: effective recruitment strategies [45], the perceptions of various stakeholders concerning the design of the Guided Internship [46], and the development of teacher identity within the program [47, 28]. However, many questions about teacher learning in ACPs remain unanswered. The proposed research addresses important research questions that emerged from the design of the two different internship models in the SMAR²T ACP and from the gap in the literature regarding ACP teacher learning in field experience settings.

Research Framework and Questions

Our theoretical framework for teacher learning is based on the assumption that teacher knowledge influences classroom performance and student learning. Teacher learning in a teacher preparation program is a product of a number of interacting factors: prior knowledge, coursework, mentoring, and learning through experience. Attention to and reflection on teaching practice is an impetus for new knowledge to develop over time. This framework implies that studying teacher learning demands the use of authentic tasks of teaching that measure teacher knowledge growth over time.
In defining teacher knowledge, we include two components: 1) content knowledge for teaching (CKT) [49, 50], the ways teachers understand subject matter for instructional purposes; and 2) pedagogical content knowledge (PCK) [51, 52, 53], what teachers know about learners, curriculum, instruction, and assessment that helps them transform content knowledge into effective teaching and learning. Although CKT and PCK are relevant constructs for both mathematics and science teaching, for purposes of description we provide a CKT example for mathematics teachers and a PCK example for science teachers.

**CKT for mathematics teaching.** Ball, Lubienski, and Mewborn [54] asserted that many well-educated adults cannot comfortably answer basic questions about mathematics, such as

Why does it work to add a zero on the right when multiplying by 10, or two zeros when multiplying by 100? Why, when the number includes a decimal, do we move the decimal point over instead of adding zeros? Is zero a number? If it is a number, is it even or odd? What does it mean to divide by one-half? What is an irrational number? Is a square a rectangle? What is the probability that in a class of 25, two people will share a birthday? (p. 433)

Paradoxically, these questions involve concepts that teachers of mathematics need to be able to address with their students. Thus, the mathematical understandings necessary for teaching are qualitatively different from the mathematical understandings necessary for, say, engineering. The ACP teacher brings a strong background in content knowledge into the teacher preparation program; however, this content knowledge is not necessarily the CKT needed by middle or high school teachers. We are interested in how guided and independent ACP interns build their CKT in the field.

**PCK for science teaching.** Besides knowing the content in this manner, teachers also need extensive knowledge of students, curriculum, instruction, and assessment related to that content. For example, suppose a science teacher decides to engage students in learning about the moon. That teacher needs to know something about the misconceptions that students may bring to class --some students believe that the phases of the moon are caused by the earth’s shadow; other students believe that the phases of the moon are caused by differences in cloud cover [55]. That teacher also needs to know what curriculum materials and instructional strategies are particularly effective in engaging students in learning about the moon [e.g., 56]. Finally, the teacher needs to understand how to effectively assess student learning about the moon [57]. Although students come to ACPs with undergraduate degrees in mathematics or science, they likely lack the PCK to be able to transform that knowledge into effective instruction. We are interested in how PCK develops in both guided and independent ACP internships.

This proposed research is premised on the belief that, by studying the development of teacher CKT and PCK, we can inform the design of ACPs and influence the quality of beginning mathematics and science teachers. Thus, the purpose of the proposed research is to examine science and mathematics teacher learning in the context
of an ACP that employs two different internship models. We are NOT interested in
evaluating the effectiveness of the two internship models, but in understanding teacher
learning in these two different contexts. The research will be guided by an overarching
research question and several subquestions:

*How does science and mathematics teacher knowledge (CKT and PCK) develop during
either a guided or independent internship experience model of alternative certification,
and what facilitates and constrains teacher learning?*

- What CKT do teachers learn and what facilitates their learning?
- What do teachers learn about math/science learners and what facilitates their
  learning?
- What do teachers learn about math/science curriculum and what facilitates their
  learning?
- What do teachers learn about math/science instruction and what facilitates their
  learning?
- What do teachers learn about assessment and what facilitates their learning?
- What factors constrain the development of CKT and PCK for these teachers?

**Methods**

In order to examine teacher learning as defined by our theoretical framework and
guided by our research questions, we will collect data about teacher CKT and PCK via
multiple data sources. Our work plan (see Table 1) for the project involves longitudinal
data collection for three cohorts of SMAR²T ACP students in the Guided and
Independent Internship tracks, each over a 2-year period. We estimate the sample size at
72 teachers total, 24 in each cohort. Although the program enrolls about 30 students per
year, our sample size will depend on teacher and school agreement to participate, and
teaching location. We will collect data at various transition points in the program:

1. Upon entry into the program.
2. At the end of the first summer.
3. Two times during the first year of teaching for Independent Internship students
   and the year-long internship for Guided Internship students.
4. Two times during the second year of teaching for Independent Internship students
   and first year of teaching for Guided Internship graduates.
5. At the end of this 2-year period.

Multiple data sources collected for each cohort (see Table 2, below) will provide different
windows into teacher learning throughout the data collection period. These data sources,
based on authentic activities of teaching, are described in the following sections.
<table>
<thead>
<tr>
<th>Year</th>
<th>Season</th>
<th>Activity Details</th>
<th>Cohort(s)</th>
<th>Other Research Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>YEAR 1</strong></td>
<td>Summer 2006</td>
<td>Entry task; End-of-summer interviews</td>
<td>Cohort A (24)</td>
<td>Gain informed consent from participants in Cohort A; Finalize research protocols and train research team on research protocols; Design project website</td>
</tr>
<tr>
<td></td>
<td>Fall/Spring 2006-07</td>
<td>Observation data cycles 1 and 2; Mentor teacher interviews</td>
<td>Cohort A (24)</td>
<td>Advisory Board Meeting 1; Begin construction of Cohort A intern profiles; Attend NSF PI Conference</td>
</tr>
<tr>
<td></td>
<td>Summer 2007</td>
<td>None; Entry task; End-of-summer interviews</td>
<td>Cohort A (24)</td>
<td>Gain informed consent from participants in Cohort B; Begin data analysis by subquestion; Prepare conference proposals; Update website</td>
</tr>
<tr>
<td></td>
<td>Fall/Spring 2007-08</td>
<td>Observation data cycles 3 and 4; Exit task</td>
<td>Cohort A (24)</td>
<td>Advisory Board Meeting 2; Begin construction of Cohort B intern profiles; continue data analysis by subquestion; Prepare/present conference papers; Attend NSF PI Conference</td>
</tr>
<tr>
<td></td>
<td>Summer 2008</td>
<td>None; Entry task; End-of-summer interviews</td>
<td>Cohort B (24)</td>
<td>Gain informed consent from participants in Cohort C; Complete Cohort A intern profiles; Continue data analysis by subquestion; Submit manuscripts and prepare conference proposals; Update website</td>
</tr>
<tr>
<td></td>
<td>Fall/Spring 2008-09</td>
<td>Observation data cycles 3 and 4; Exit task</td>
<td>Cohort B (24)</td>
<td>Advisory Board Meeting 3; Begin construction of Cohort C intern profiles; continue data analysis by subquestion; Prepare/present conference papers; Attend NSF PI Conference</td>
</tr>
<tr>
<td></td>
<td>Summer 2009</td>
<td>None</td>
<td>Cohort C (24)</td>
<td>Complete Cohort B intern profiles; continue data analysis by subquestion; Begin cross-case analysis (Cohorts A and B); Submit manuscripts; prepare conference proposals/book prospectus; update website</td>
</tr>
<tr>
<td></td>
<td>Fall/Spring 2009-10</td>
<td>Observation data cycles 3 and 4; Exit task</td>
<td>Cohort C (24)</td>
<td>Advisory Board Meeting 4; Continue data analysis by subquestion; Prepare/present conference papers; Attend NSF PI Conference; State-wide Conference; press releases; letter to state officials</td>
</tr>
<tr>
<td><strong>YEAR 5</strong></td>
<td>Summer 2010</td>
<td>None</td>
<td></td>
<td>Complete Cohort C intern profiles; complete data analysis by subquestion; Complete cross-case analysis with all Cohorts; Submit manuscripts; prepare conference proposals; update website</td>
</tr>
<tr>
<td></td>
<td>Fall/Spring 2010-11</td>
<td>None</td>
<td></td>
<td>Prepare/present conference papers/Book manuscript; Attend NSF PI Conference; Statewide Conference; press releases; letter to state officials</td>
</tr>
</tbody>
</table>
Table 2.
Data Collection per Cohort

<table>
<thead>
<tr>
<th></th>
<th>First Year</th>
<th></th>
<th>Second Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Summer</td>
<td>Fall</td>
<td>Spring</td>
</tr>
<tr>
<td>• Entry task</td>
<td></td>
<td>Observation</td>
<td>Observation</td>
</tr>
<tr>
<td>• End of</td>
<td></td>
<td>data cycle 1</td>
<td>data cycle 2</td>
</tr>
<tr>
<td>summer interview</td>
<td></td>
<td>Interview with mentor teacher</td>
<td>Interview with mentor teacher</td>
</tr>
</tbody>
</table>

**Entry/Exit Task**

We have designed a comprehensive written task that participants will complete upon entry into the program, before they have taken any formal coursework, and again at the end of the 2-year data collection period. The task uses the “Lesson Preparation Method” [58, 59] in which participants design a series of lessons to introduce a particular mathematics or science topic at a particular grade level. To uncover CKT and PCK, the task is embedded with a series of questions that reveal a respondent’s knowledge of content, learners, curriculum, instruction, and assessment. The entry/exit lesson planning task will be tailored to the participants’ certification area: mathematics, life science, physical science, or earth science. A preliminary version of the task for life science students is included in Box 1. At the end of the first summer, we will conduct an individual interview with each participant to examine any changes the teacher would make to the lesson plans after participating in the 8-week summer intensive coursework, and to probe reasons for the lesson planning behavior. During the interview, we will also show the interviewee a video segment of a mathematics or science classroom and ask him/her to respond to written prompts. These entry and end-of-summer data will provide a baseline for future comparisons. The same lesson planning and video analysis task, administered at the end of the 2-year participation period, will provide summative data about teacher learning that is directly comparable to entry level knowledge.

**Observation-Based Data Collection Cycle**

We also have designed a data collection cycle that will be implemented during the field-based internship period/beginning years of teaching for each participant. We will follow each participant through this cycle. The cycle begins with a lesson planning task similar to the entry task, but individualized for each participant based on a topic he/she will actually be teaching. The written lesson planning task will be followed by a site visit from designated members of the research team. Prior to classroom observation, the researcher will interview the participant about the planned lessons, probing to uncover deeper understanding of teacher CKT and PCK. Next, the researcher will observe, videotape, and take field notes for two consecutive lessons. Following each lesson (after school hours), the researcher will administer a stimulated recall interview [60, 61] in which participant knowledge is probed via playback of critical parts of the lesson. Finally, at the end of the entire instructional unit, the participant will complete an online written analysis of the teaching and learning that occurred. The analysis task will include questions about what participants learned through teaching the lesson and how they will change their plans and instruction in future teaching.
Box 1

Entry/Exit Task (Life Science Example)

**Your Context:** A science teacher in the XYZ School District retired during the 5th week of the semester. The principal called you to see if you would be willing to take over the teacher’s required 9th grade general science class (25 students). When you visit, you notice that the classroom is set up so that students sit in groups at tables. At the front of the room, there is a teacher demonstration table and a whiteboard. There are computer stations in the classroom, as well as animal cages and various kinds of science equipment.

**Your Task:** When you look at the XYZ Curriculum Guide, you realize that the next unit you are to teach in the area of life science is supposed to address the following Missouri Grade Level Expectation (GLE): *As energy flows through the ecosystem, all organisms capture a portion of that energy and transform it to a form they can use.*

To begin your unit planning, design a sequence of two introductory lessons to address this GLE. As you develop your two lesson plans, provide as much detail as possible, and be sure to answer the following questions.

1. What important ideas will you try to teach? Which ideas will you teach first?
2. What do you think your students will already know? What will they have trouble learning?
3. What instructional materials will you use to help you plan?
4. What will you do first, second, third, etc. as you teach these two lessons?
5. What will you expect students to do during each lesson?
6. How will you know what students are learning?

**Mentor Teacher Interviews**

A final source of data about teacher learning in two field-based models of alternative certification will come from the mentor teachers. In the Guided Internship, the mentor is a full-time collaborator in helping to prepare the intern, through side-by-side planning, teaching, assessment, and reflection. In the Independent Internship, the mentor plays a reduced role outside of the classroom, and is seldom involved in intensive planning with or observing of the intern. During our first year site visits to the interns’ classrooms, we will schedule individual interviews with the mentor teachers. These interviews will focus on the mentor teacher’s perceptions related to the intern’s performance and learning, and how the mentor facilitated that learning.

**Data Analysis.**

Data analysis will begin as soon as data become available and continue through the end of the project. Since most of the data will be qualitative, we will use software tools (NVivo and
We will use an inductive process to code the data set and derive assertions related to each research question strand (CKT, learners, curriculum, instruction, assessment, constraining/facilitating factors). First, investigators will create beginning case profiles of each of their designated research participants. Second, each investigator will lead the analysis of one of the research strands across the entire data set. Using this analysis by strand, we will re-construct the case profiles. Each case will demonstrate a trajectory of teacher learning across a 2-year period, and will allow comparisons across cases. To inform this case-based data analysis, we will use the work of Dr. Julie Luft’s (Arizona State University) TPC-funded research, “Exploring the Development of Beginning Secondary Science Teachers in Various Induction Programs.” Luft’s team has created PCK analysis rubrics for two of our research strands--knowledge of student learning and knowledge of instructional strategies. She has agreed to share these research products with our team. We will adapt these rubrics for our science and mathematics education participants, and develop parallel analysis rubrics for the other research strands.

Third, after the individual cases are constructed, we will perform cross-case analysis, comparing the Guided and Independent Internship groups. This analysis will enable us to detect differences attributable to the two models of field-based alternative certification. We will also perform cross-case analyses by subject matter (mathematics/science) and recruitment type (homecomers/career changers, see Abell et al., 2005) to determine if differences in learning are attributable to other group factors.

Potential Implications of the Study for Various Stakeholder Groups

The findings of our work will have implications for several different audiences. Our dissemination strategies are designed to communicate with these audiences to produce broader impacts as follows:

1. **Science and mathematics education researchers.** The products of our research will be communicated to the audience of researchers in the form of dissertations, papers presented at professional conferences (e.g., AERA, NARST, PMNA), and publications in refereed journals. We will also take advantage of the opportunity to informally discuss our research findings with other TPC Principal Investigators at annual TPC PI meetings. Furthermore, we anticipate publishing an edited book that collects and connects these research products into one volume.

2. **Science and mathematics teacher educators.** The individuals who design and teach in science and mathematics teacher preparation programs come from a variety of backgrounds, including science and mathematics content, general curriculum and instruction, and science/mathematics education. They have varying degrees of knowledge about the teacher learning research. To disseminate our findings to the individuals in our state who prepare mathematics and science teachers in traditional and alternative programs, we will hold a 2-day statewide conference.
during Years 4 and 5 of our project. In addition, in an attempt to coordinate efforts within Missouri, we have created a website (www.teach-math-or-science.org) that includes information about all the alternative routes to certification within Missouri and other resources. Both the statewide conference and the website are structures that other states could use to coordinate and disseminate efforts related to teacher preparation and support. We also will communicate with teacher educators beyond our state through papers presented at the Association for Mathematics Teacher Educators (AMTE) and the Association for Science Teacher Education (ASTE) annual meetings, journals publications, and postings of findings on our websites.

3. **Policymakers.** State and federal governmental agencies have developed a number of policies that govern teacher quality and teacher certification. The findings of this research will inform current teacher education policy. We will provide press releases to the media and to science and mathematics supervisor organizations (Council of State Science Supervisors (CSSS), National Science Education Leadership Association (NSELA), and National Council of Supervisors of Mathematics (NCSM)) to communicate findings to policy makers. More specifically, we will send a letter to state officials in departments that certify teachers, informing them of the research findings and the implications for their work.

4. **School personnel.** Because school personnel mentor, support, and hire alternative certification teachers, we will communicate our findings to them through websites, press releases, and presentations/publications in venues for administrators and teachers such as National Council of Teachers of Mathematics (NCTM) and National Science Teachers Association (NSTA). We will also include past alternative certification candidates and school administrators as panelists on presentations and as co-authors on publications.

**Conclusion: A Research Agenda for Alternative Certification**

In a recent report from the American Educational Research Association, Zeichner [62] recommended a research agenda for teacher education guided by a set of methodological criteria. Methodologically he included criteria for strong theoretical frameworks, rigorous research designs, and better measures of teacher knowledge that would give “more attention to the impact of teacher education on teacher learning and teacher practices” (p. 740), especially in subject-specific teacher preparation settings.

We believe that these criteria can and should also be applied to teacher education research in the context of ACPs. The ACP research proposed in this paper fulfills a number of Zeichner’s methodological recommendations: 1) it is situated in a relevant theoretical framework, 2) it is focused on the teaching of particular subjects—mathematics and science, 3) it examines the connections between teacher education, teacher learning, and teacher practice, and 4) these connections are studied over time. Future ACP research must meet these and other methodological criteria.

In the same report [62], Zeichner also made several recommendations for the content of future teacher education research. He claimed:
We know very little from the existing research about how the context of instruction in teacher education programs influences what opportunities are made available to teacher education students, what they learn from these opportunities, and how this learning impacts teacher quality and student learning. (p. 747)

This criticism can be levied against research on both TEPs and ACPs. However, our evaluation of the ACP research is that it has focused even less than TEP research on the context of instruction and what teachers learn in teacher preparation. Instead, ACP researchers have concentrated on program inputs (types of students) and outputs (especially retention).

We challenge the science and mathematics teacher education research communities to take research on ACPs to the next level. First, we challenge researchers to document program components whenever an ACP is being studied so that opportunities to learn are made clear. We also challenge researchers to design research projects aimed at understanding teacher learning within ACPs. How do teachers learn in both coursework and field experiences? Does the length of the ACP affect teacher learning? Finally, we challenge researchers to conduct longitudinal studies that extend the examination of teacher learning from the ACP into the beginning years of teaching. What do teachers transform from the ACP to the classroom? How do students of ACP teachers learn?

This is a demanding research agenda for the science and mathematics teacher education research community. The study proposed in this paper is one step along the way. We believe that more studies of ACPs that fulfill Zeichner’s methodological and topical criteria are needed. Future ACP research that meets these criteria will have great potential to influence policy makers and program designers, and ultimately to improve teacher quality and student learning.

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References


