The Teacher Immersion Course Model: A Reform-Oriented Early Teaching Experience that Capitalizes on Collaborations Between High Schools and Universities

Mel S. Sabella
Department of Chemistry and Physics, Chicago State University, Chicago, IL, 60628

Amy D. Robertson
Department of Physics, Seattle Pacific University, Seattle, WA, 98119

Andrea Gay Van Duzor
Department of Chemistry and Physics, Chicago State University, Chicago, IL, 60628

We describe a Teacher Immersion (TI) Course Model in which university physics departments and in-service K-12 teachers collaborate in the recruitment and preparation of future physics teachers. The immersion model creates opportunities for early teaching experiences by engaging prospective teachers in the planning, implementation, and assessment of a high school science lesson. Students in the immersion course define objectives; consult literature; assess learning needs; develop, practice, and implement lessons; and then reflect on the experience. The course supplements the existing science methods courses and student teaching experiences that are typical in many secondary education programs. The TI course can be implemented at colleges and universities for a relatively small cost.

I. INTRODUCTION

Despite the best intentions of teacher preparation programs, novice teachers (and teachers, in general) rarely adopt reform-oriented teaching practices once they enter their classrooms [1, 2]. This is often connected to specific systemic challenges: few pre-service candidates teach in K-12 classrooms until their internship year, and many do so in contexts in which authentic reform-oriented teaching is counter-cultural and in some cases discouraged [3]. Not only this, the traditional teaching that is often the cultural norm in K-12 schools aligns with novice teachers' own accumulated experience of teaching (as learners), reinforcing a vision of teaching as information delivery [4, 5].

If our nation wants competent, confident reform-oriented novice teachers, pre-service teacher education programs need to offer [6, 7, 8]:

- *Early opportunities for pre-service teachers to practice reform-oriented teaching.* When such opportunities are embedded in courses on educational theory, they provide authentic integration of theory and practice, situating learning in the practice of teaching [9, 10, 11, 12, 13].
- *Relevant, discipline-specific pedagogical instruction.* Not only do novice teachers need to situate their teaching in general, reform-oriented pedagogical instruction; they also need to develop pedagogical content knowledge via discipline-specific pedagogical instruction [14, 15, 16]. Ideally, such instruction would integrate knowledge about existing research-based instructional materials, research on children's ideas, epistemological resources, and accumulated wisdom of experience from teachers who have taught science for many years.
- *Mentorship from teachers who have intimate knowledge of the local context and who have successfully reformed their teaching.* Research increasingly acknowledges the importance of context on one's learning and actions [17, 18]. Thus, learning to teach involves *learning to teach a specific topic to a specific population.* Because a majority of teachers accept their first position within a fifty-mile radius of their teacher preparation program, learning from local teachers is a critical part of a novice teacher's professional preparation [19]. It is *especially* important that pre-service teachers are mentored by in-service teachers who have successfully reformed their teaching within the local context.

Chicago State University (CSU) and Seattle Pacific University (SPU) have implemented courses for pre-service teachers that respond to this call using

a Teaching Immersion (TI) course model. These courses, the Teacher Immersion Institute (TII) at CSU and the Science Teaching Immersion Experience (STIE) at SPU, provide scaffolded, reform-oriented teaching experiences for pre-service teacher candidates. This is accomplished through collaboration and joint leadership between high school and university faculty [20]. The TI model does not require extensive resources and is designed to utilize local teaching resources and contexts. Committed and prospective pre-service secondary teachers who enroll in the course benefit from connections to experienced in-service teachers, subject-specific pedagogical knowledge that blends the expertise of scientists and practitioners, and access to high school students prior to their student teaching experience.

In this chapter, we will describe the TI course model by introducing the shared content and structure of the TII and STIE courses, discussing how different players – including university faculty, mentor K-12 teachers, and university students – play key roles in the course, and by describing the affordances and challenges of implementing a TI course. Throughout the paper we will use TI to refer to the immersion course at both institutions, while the TII and STIE refer to the specific courses at CSU and SPU, respectively. The chapter is aimed at teacher educators who wish to implement a similar course in their local context.

Although there are a number of differences between CSU and SPU, with CSU being a public, majority black institution and SPU being a private, majority white institution, both institutions share a number of common goals and objectives. Students at both institutions share a commitment to service and often come from communities near the schools, and both SPU and CSU have science faculty that are committed to high quality teaching and recognize the importance of effectively preparing physics majors to teach in area high schools. Both institutions have multiple routes to certification: at CSU, students can enter the teaching profession through three tracks – an undergraduate degree in physics with certification in science, a certification-only program for students with an undergraduate degree, and a Masters of Arts in Teaching with initial certification. The state of Illinois certifies, or licenses students, broadly in science with designations in the disciplines. At SPU, students can become certified as undergraduates or via post-graduate programs including a Masters in Art of Teaching, Master of Teaching Math and Science, or alternative route to certification program.

II. TEACHER IMMERSION COURSE CONTENT AND STRUCTURE

In both the TII and STIE, our undergraduate STEM majors – whom we will refer to as interns (to distinguish them from the K-12 students with whom they are working – plan, implement, and assess a lesson in a high school science course. The goal of the TI courses is to immerse our interns in the experience of planning and assessing a single science lesson under the mentorship of experienced high school teachers, rather than to immerse them in the day-to-day experiences of a high school physics course. TI courses are designed to be taken by students with no background in educational theory as a means of introducing them to the field, as well as by students who have already chosen teaching as a career and are enrolled in a certification program.

Teaching a topic in an effective way that builds content understanding, incorporates inquiry, and establishes positive attitudes and expectations toward science is incredibly challenging. Because of this, we spend the entire semester focusing on a single topic that is taught in a single class period at a local high school at the end of the semester. While this may seem limited as we complete in a semester what an in-service teacher completes in a day, focus on a single topic allows novices to engage in deep reasoning and reflection.

In this section, we offer the reader an overview of the content of the TI courses at CSU and SPU, as well as some of the structural logistics. We emphasize the similarities between the courses in order to illustrate the model generally, and in some cases we provide context-specific details to demonstrate ways in which

one might adapt the model to meet local needs. First we briefly describe the recruitment and roles of the mentor K-12 teachers in the course, as a way of framing the remainder of the section.

A. Participation of University Faculty, Mentor Teachers, and University Students

The TI course is designed to capitalize on the expertise of both university faculty and K-12 teachers. Both teachers and university faculty often bring to bear relevant content knowledge and familiarity with research on student ideas and reform-oriented pedagogies. However, K-12 teachers have intimate knowledge of local contexts and experience planning and implementing lessons in ways that meet local and national standards. At both CSU and SPU, university faculty recognize this specialized professional knowledge that the mentor teachers bring. Teachers play important leadership roles in the courses at both institutions, although the specific roles taken on by faculty and K-12 teachers differ at each institution.

At CSU, two high school teachers, Passehl and Weisenburger, mentor TI interns. Passehl and Weisenburger were participants in professional development at CSU and were originally selected as mentor teachers based on their commitment to reform-oriented teaching. Sabella (Physics faculty), Van Duzor (Chemistry faculty), Passehl, and Weisenburger initially met and discussed the syllabus and the activities. During the first year, Sabella led the course by introducing assignments and choosing readings; consequently, students directed questions to him. In the second and third years of the TII, Passehl and Weisenburger assumed greater leadership roles and were the contact point for the interns, drawing on classroom experiences and issues relevant to Chicago physics teaching.

At SPU, Robertson (Physics faculty) planned assignments and structured the course, and mentor teachers Anderson and Christensen, as well as PhysTEC Resident Master Teacher Lippitt, worked with small groups of university interns during course meetings to plan and assess their lesson. Anderson and Christensen shepherded the implementation of TI interns' lessons in their high school classrooms.

B. Course Content

Interns in the TI courses at CSU and SPU spend several weeks planning a lesson on a single topic, implementing the lesson in a high school science course, and assessing the lesson. During this process they engage in the following pedagogical processes: forming groups and choosing topics, defining objectives, consulting literature, assessing learning needs, developing lessons, practicing lessons, implementing lessons, and reflection on lesson implementation.

1. Planning the lesson

Interns begin by *forming collaborative groups* and *choosing a lesson topic*. The lesson topic is negotiated between the mentor teacher and the TI interns. TI interns are encouraged to choose topics with which they have had extensive experience in their own university science courses (*e.g.,* electric circuits, energy, forces and motion). Often the final choice is influenced by timing (*i.e.,* when the TI interns are available and ready to implement the lesson within the mentor teacher's curriculum structure). In some cases, TI interns choose to adapt an existing lesson or curriculum rather than construct their own, and hence their choice of topic is also influenced by the existing K-12 course materials.

After they have chosen a topic, TI interns and mentor teachers work together to *articulate lesson objectives* while *consulting the literature* and *assessing learning needs.* Lesson objectives are what the TI students hope that the K-12 students will learn by participating in the lesson. TI interns are encouraged to connect their lesson objectives to:

- **Relevant state and national standards.** Mentor teachers support TI interns in understanding how to navigate existing standards documents (*e.g.,* Washington State standards, *Benchmarks for Science Literacy,* and *Next Generation Science Standards*) [21, 22, 23]. Interns are asked to earmark those standards and benchmarks that are related to their topic of choice, and they are held

accountable for articulating the connection between the earmarked standards and their lesson objectives.

- **Research on children's ideas about related science topics.** Interns are assigned one or more published articles or book chapters that describe research on children's ideas about their chosen topic. (Two useful sources of relevant articles are *Children's Ideas in Science* and *Making Sense of Secondary Science* [24, 25].) They write a short literature review, and they revise their lesson objectives on the basis of this review. They are required to articulate the connection between their lesson objectives and the existing literature.
- **Existing K-12 classroom norms.** Interns observe their mentor teacher's classroom at least once prior to implementing their lesson, preferably toward the beginning of the quarter/semester that they are enrolled in the TI course. Interns reflect on the existing classroom structure and norms immediately following their visit, and they describe how their lesson objectives are appropriate for the mentor teacher's classroom.

Interns at SPU are also asked to connect their lesson objectives to their teaching values. In particular, they are asked to reflect on what they value instructionally and why. For example, several STIE interns articulated that they value K-12 students being engaged and having fun, and they value K-12 teachers who clearly demonstrate that they care about their students. After these values are articulated, STIE interns reflect on the alignment of their lesson objectives with their values. SPU interns are asked to be transparent about these values for several reasons. For one, these values undoubtedly affect their choice of lesson objectives and their delivery of the lesson; however, these effects are often invisible to TI interns [26]. Making these effects visible offers TI students an opportunity to assess their values and the effect of these values on their teaching practice. In addition, consciously choosing to align one's teaching with one's values grounds teaching practice in passion and identity.

Although it is rare for practicing K-12 teachers to incorporate all three or four of these elements into a single set of lesson objectives, our goal is to introduce TI interns to a variety of sources that might inform their lesson objective development.

After articulating lesson objectives, TI interns *plan and develop their lesson* or *adapt existing materials.* At CSU, interns collectively pick a topic, such as energy or electric circuits, and each intern develops his or her own lesson; at SPU, groups of two or three students work together to plan and collaboratively teach a lesson. In each case, shared lesson topics have fostered collaboration among the interns.

Because the TI courses are staffed by reform-oriented mentor teachers and faculty, lesson plans primarily focus on opportunities for K-12 students to actively participate, with minimal delivery of information.[1] When TI interns construct their own materials, they tend to center on lab stations or experiments. For example, TI interns in the SPU course planned a lesson on electricity that involved four lab stations: (1) a hand-crank generator, (2) a potato-powered electric circuit, (3) a Stirling engine, and (4) current induced by magnetic fields. TI interns developed worksheets to go with each station that asked K-12 students to record their observations and make sense of the phenomena they observed, as well as to brainstorm possible real-world applications. At CSU, lessons tend to be class activities that incorporate interactive lecture and small group lab experiments.

Aligning lesson content with lesson objectives requires multiple levels of coordination: one must consider the order of questions/activities (is it logical?), the coherence of questions/activities (what is the big picture message, and does this group of activities communicate that message?), the alignment between specific objectives, which coordinate standards, classroom norms, research on children's

[1] To supplement the mentorship from the teachers, interns also read papers that focus on inquiry instruction. (An example of an overview paper on inquiry: *Inquiry Learning: What is it? How do you do it?* by Trout *et. al.* [1].)

ideas, and instructional values (does this set of activities support learners in accomplishing the lesson objectives, does it attend to possible pitfalls and/or capitalize on existing learner resources, and is it appropriate for this classroom?), and so on. This coordination is one of the most challenging tasks of the course for TI interns, not only in terms of execution, but also in terms of understanding what it means to coordinate objectives and lesson plans.

Prior to implementing their lesson in the K-12 classroom, TI interns *practice their lesson with their peers in the TI course*. Each intern or group of interns is given the opportunity for a 'dress rehearsal,' treating their peers as though they were the K-12 students for whom the lesson was designed. Their peers are instructed to ask questions as though they were K-12 students experiencing the lesson for the first time. After each intern (or team) has taught their lesson or a portion of the lesson, their peers, mentor teacher, and faculty instructor offer feedback both on the content and structure of the lesson as well as the delivery. At CSU, the practice lesson happens early in the semester to receive initial feedback. Interns implement the first ten minutes of their lesson to the others in the course. This helps set a tone for the lesson that focuses on inquiry and active student engagement and aids our interns in breaking up the challenging task of lesson development.

The final step in lesson planning is to submit a summary of the lesson topic and objectives (including a discussion of how the objectives integrate standards, classroom norms, research on children's ideas, and instructional values); a copy of the lesson that includes sufficient detail that someone who was not a part of our class could replicate it; a copy of the assessments (described below); and a detailed description about how the lesson addresses the lesson objectives. At SPU this is called a lesson portfolio.

2. Implementing the lesson

Interns then *implement their lesson in their mentor teacher's high school science course.* Typically, the lesson spans a single class period (rather than multiple days), and interns may teach the lesson to more than one class of the mentor teacher's students. Because the interns have observed their mentor teacher's classroom before lesson implementation, the K-12 students know whom they are, and introductions have already taken place. As the interns facilitate the lesson, the mentor teacher observes and assists as needed. For example, during small group activities, the mentor teacher may act as an additional instructor, supporting group work and answering questions as needed. During larger class activities, the mentor teacher will mostly observe and offer support (*e.g.,* classroom management or clarification) as requested by the TI intern(s). Mentor teachers offer feedback to interns immediately following lesson implementation. At CSU, mentor teachers often use portions of a popular observation protocol called the RTOP to organize and structure feedback [27].

3. Assessing the lesson

Interns assess their lesson implementation via three mechanisms: (1) more traditional pre- and post-assessments completed by K-12 students, (2) written reflections on their implementation of the lesson, and/or (3) video records of implementation.

CSU requires the interns to do two of the above; SPU requires all three and asks the interns to synthesize the results in an assessment portfolio. Each assessment is described in detail below. As with the formulation of lesson objectives, we expect that a typical (single) K-12 science lesson would rarely call for all three modes of assessment; our goal is to introduce the interns to different forms of assessment.

TI interns' lesson planning includes the *design of pre- and post-assessments* that match lesson objectives. As with the coordination of lesson objectives and lesson content, the design of assessments that are (a) intended to measure a shift in student understanding and (b) aligned with lesson objectives requires multiple levels of coordination. Assessments must not only include well-crafted questions, but the questions on the pre- and post-assessments must also provide similar enough

information that one can determine whether student performance has improved (but different enough questions that improvement cannot be attributed solely to a re-testing effect). In addition, the information that these questions provide must be relevant to the lesson objectives, so that the TI interns can assess whether or not the objectives have been met.

TI interns are offered a variety of options for pre- and post-assessment design, including written quiz questions, whiteboard questions, and targeted whole-class discussion. The first of these is usually the most popular choice; pre-assessment quizzes are typically given by mentor teachers in advance of lesson implementation, and post-assessment quizzes are given immediately following implementation.

Immediately following lesson implementation, TI interns *write personal reflections.* They are prompted to answer questions about their impressions of lesson success, what they learned about student understanding of their lesson topic, how well they think their lesson accomplished their objectives, the alignment of their teaching with their instructional values, and any modifications they would make to their lesson based on their impressions. At CSU, interns also describe the process by which they chose their objectives, explain the challenges they faced in developing these objectives, and articulate how the experience shaped their view of the high school teaching profession.

At SPU, as TI interns implement their lesson, *interactions between themselves and K-12 students are video recorded.* There are two cameras in the room, one that captures a wide-angle view of the entire class, and one that is pointed at a single group of K-12 students. TI interns are trained in video equipment use prior to implementation and do the recording themselves. Permission from students, parents, and school administration is acquired early in the quarter.

TI interns at both institutions then *analyze (and synthesize/coordinate) the assessment data they collected.* SPU interns must submit an assessment portfolio at the end of the quarter that contains:

- A copy of each group member's personal reflections.
- An analysis of pre- and post-assessments. The analysis includes a copy of the assessments, a discussion of the learning objectives the assessments are designed to assess, a discussion of student responses to the pre- and post-assessments, a comparison of pre- and post-assessment results, and an analysis of what this comparison implies about student learning and assessment design.
- A transcribed video clip (one per group member) and analysis. TI interns reflect on what they noticed while watching the clip that they did not notice while in the classroom, specific instructional choices they made, and student ideas about the science topic they chose. They offer an assessment of their teaching and/or their lesson in light of their lesson objectives.
- A synthesis of these three analyses. Interns are asked to identify any consistent themes or conflicting messages and to make recommendations for lesson modification that are grounded in their data.

At SPU, TI interns present their assessment results in the undergraduate research symposium at the end of the quarter. CSU interns submit post-test analysis and personal reflections at the end of the semester and engage in an informal group discussion with their peers, their high school mentors, and the university faculty about the experience.

C. Course Structure and Specifics

1. Length of course and timing of course elements.

At both CSU and SPU, the course meets in the evening to accommodate mentor teachers' schedules. The TI course structures at CSU and SPU differ somewhat due to local environments and available resources. The TII course at CSU is 2 credits and spans one semester (Spring), and the STIE course at SPU is split across two quarters (1 credit in Winter, 2 credits in Spring). Approximate timings for the different course elements are summarized in the table below:

Course Element	CSU (15 weeks)	SPU (19 weeks)
Lesson Planning	***11 weeks***	*10 weeks*
Discussion about literature and effective teaching	**2 weeks**	
Choose topic	**1 week**	1 week
Develop lesson objectives	**2 weeks**	3 weeks
Plan or adapt lesson	**3 weeks**	3 weeks
Develop assessment	**2 weeks**	1 week
Participate in lesson as learners	**1 week**	2 weeks
Lesson Implementation	***2 weeks***	*1 week*
Lesson Assessment	***2 weeks***	*8 weeks*

2. Grading and assignments.

At CSU, grades are based on participation and attendance as well as a series of papers reflecting on the lesson planning and implementation process. These assignments include a literature review of student understanding of a specific physics topic, development of pre-assessment and post-assessment instruments, observation notes and reflection on their high school visit, development of their activity for the mock lesson, development of the full activity for use in the high school classroom, implementation of the activity, written analysis of pre/post-assessment results, and a written reflection about implementation.

At SPU, grades are based on participation in course activities, weekly written assignments, and lesson (Winter) and assessment (Spring) portfolios (the latter discussed above). Weekly readings introduce TI interns to contemporary science education reform efforts (*e.g., Project 2061* and *National Science Education Standards*), research on children's ideas, and best practices in lesson design and assessment [28, 29].

III. AFFORDANCES OF PARTICIPATION IN TEACHING IMMERSION COURSE

The Immersion Model provides early exposure to the teaching profession, immerses interns in lesson planning and assessment practices, promotes reform-oriented teaching, illustrates the complexity of teaching, supplements course offerings in the School of Education, and empowers in-service K-12 teachers to participate in the preparation of future teachers. While some of these positive outcomes, or affordances, overlap with a standard Methods Course, some are specific to the Immersion Model. In fact, the immersion course supports a Methods Course by providing early, small-scale focused activities that may make interns' transition to a Methods Course easier.

A. Provides Early Exposure to the Teaching Profession.

Early teaching experiences have been shown to be an important component of teacher preparation programs [30]. These experiences allow pre-service teacher candidates an opportunity to decide whether they can see themselves in this challenging role *early* in their undergraduate careers, rather than waiting until their internship experience. In addition, the course provides a scaffolded experience of reform-oriented teaching to students who have not yet committed to teaching and thus serves as a recruitment tool.

B. Promotes Reform-Oriented Teaching.

Research has consistently demonstrated the importance of situating *learning to teach* in the *experience of teaching* [31]. Interns in the TI courses at CSU and SPU are not only exposed to educational theory and research-based pedagogical techniques; they are encouraged to try on these theories and techniques in K-12 classrooms, under the support and guidance of reform-oriented mentor teachers.

One interesting illustration of implementing educational theory in the classroom comes from the TI course at CSU. An intern – who is planning to be a high school science teacher, and who has completed the majority of her education courses – was challenged by her mentor teacher to engage students in exploring a phenomenon first, rather than explaining the phenomenon directly.[2] The mentor

[2] Pseudonyms are used in the dialogue.

teacher notices that the intern has provided significant background and explanation on the topic in her lesson:

TI Teacher: *So I'm wondering…what was your thought process for why you did this picture and reading before the lab?*

Lisa: *… Just to refer to the text so they will have a place to go back to and look at the relationship…*

TI Teacher: *What do you think is some feedback I gave to [Becky] that I could also give you?*

Lisa: *To reverse the order of what I did … the hands-on part first.*

Pablo: *Yeah.*

Lisa: *So basically we are giving the answer away … Ok.*

Pablo: *I think the both of you guys did like a reverse order type of thing. …*

Lisa: *I guess we're just so used to where … I just thought about it just now I just did a cookbook lab. I gave them the point first and then we did the lab to confirm what I said …*

TI Teacher: *Returning to the 5 e's methodology –*

Lisa: *Yeah so we just explained before we engaged or explored …*

Support from reform-minded teachers is especially important given the "apprenticeship of observation" that interns acquire over their lifetime of experience with traditional instruction [32]. Despite extensive exposure to reform-oriented teaching at the college level,[3] ongoing support and repeated experiences with inquiry-based instruction is often required to break away from the traditional lecture. The limited content focus of the TI Model, paired with observations of high school classrooms and participation in peer TI interns' lessons as learners, offers multiple opportunities for discussion and reflection on effective pedagogies for science instruction and fosters TI interns' understanding of the function of inquiry in student learning.

C. Illustrates the Complexity of Teaching.

Effective science teaching requires the successful coordination of content knowledge, pedagogical knowledge, pedagogical content knowledge, curricular knowledge, interpersonal skills, etc [33]. Faculty at CSU and SPU recognize, appreciate, and emphasize the challenging, professional nature of teaching, elevating the status of the profession and encouraging students to pursue certification. This recognition is especially important in light of research findings that suggest that one reason that the United States experience a shortage of high-quality physics teachers is the relative status of secondary education programs versus positions in industry or graduate school in physics [34].

As interns participate in the TI course, read papers about student learning, observe mentor teachers' classrooms, develop assessments and lesson activities, implement their lesson, and finally assess their lesson's success, they increasingly understand the complex sequence of activities and careful reflection that leads to effective instruction. One SPU intern acknowledged this understanding explicitly in her final course reflection: *"I used to believe that teaching was a relatively 'easy' profession. I thought that you showed up, taught a lesson, and graded some papers. However, I am realizing that it is a highly adaptive occupation. You can never 'master' it the way you can other jobs. Teaching becomes about learning to use formative assessment in-the-moment to help those around you. Lesson planning is a delicate process which involves a lot of preparation. This class has made me really appreciate the teachers I have had in my life because they undoubtedly put a lot of work into the lessons that they taught and the methods that they used to implement it."*

D. Supplements Course Offerings in School of Education

1. Immerses university students in lesson planning and assessment practices.

[3] Both SPU and CSU use research-based curricula in our introductory physics courses such as SMART Physics (www.smartphysics.com), Newtonian Tasks Inspired by Physics Education Research: nTIPERs (Addison-Wesley Series in Educational Innovation, 2001) C J Hieggelke, D P Maloney, Steve Kanim, *Tutorials in Introductory Physics (*McDermott, L. C., & Shaffer, P. S. (2001). *Tutorials in introductory physics and homework package*. Prentice Hall.)

By design, university students in the TI courses at CSU and SPU spend between fifteen and twenty weeks planning, implementing, and assessing a single science lesson. Throughout those weeks, these interns are exposed to multiple lenses through which to view lesson planning, to research-based teaching practices, and to various means of assessing student learning. Because there is only one topic in the class, there are many opportunities for iterative refinement of lesson plans and for exploring different aspects of developing a lesson: observing experienced teachers, teaching a topic, and reflecting on learning. The goal is for interns to leave the course with a 'toolbox' of best practices for planning, implementation, and assessment.

One intern at SPU reflected on the expansion of her repertoire of assessment tools via the TI course, writing: *"Prior to taking this class, I was a strong believer in end of the unit assessments or homework as the means to gauge student success. I now see that this is not the only way of doing this. In developing our lesson, we decided to [use] proximal formative assessment, ...assessing students['] understanding by their work on their whiteboards during their lab. I believe that this type of in the moment assessment is valuable because you can see how students develop their ideas and see the actual learning process. I think that this may be just as valuable of an indicator of student understanding as requiring students to recall information during a test and crunch numbers using equations. One benefit ... is that teachers ... assess students['] understanding right in that moment and alter or change the curriculum if he or she sees necessary. The teacher does not have to wait for a number of students to fail a test to see if the material was taught well. I think that utilizing a number of assessments is more successful than the typical assessment we are used to."* Likewise, one CSU education student observer-researcher commented on the affordances of the in-depth focus on a single lesson, comparing it to courses in which many lessons must be planned and implemented: *"... [In my other courses,] at the conclusion of the lesson the students' peers comment on the lesson via written remarks, but the student does not have the opportunity to redo the lesson in class or in an actual classroom. In addition, often times the teacher will administer a grade for the lesson the same day it is taught and there is no room for improvements."* Thus, the TI course provides an experience that complements – rather than replaces – important School of Education courses in which students develop integrated lessons across a unit.

We note that although there is a significant amount of pressure on the interns for their lesson to go well, instructors in the TI courses emphasize that this process is extremely challenging. All lessons are viewed as learning experiences where the interns must think about how to improve the lesson for the future. Most interns are proud of the materials they develop, and if the lesson does not go as planned, they see opportunities to modify their lessons to address unexpected concerns. Faculty and mentor teachers emphasize the fact that lessons do not go as planned for even the most experienced teachers and that this is part of the profession.

2. *Offers discipline-specific, culturally relevant methods instruction.*

Interns in TI courses have at their immediate disposal disciplinary experts, discipline-based science education researchers, and experienced K-12 science teachers. Each of these mentors contributes unique, discipline-specific expertise. Together with the interns, the community brings together knowledge of:

- Science-specific pedagogical skills and methods
- The content and epistemology of the discipline
- Research on how children learn science, knowledge of the local community
- Secondary teacher preparation programs
- The local community, including the realities of high school, the culture of the students, and administrative constraints on curriculum
- What is fun and exciting to learn
- Student life outside of school
- State and national standards

In particular, the presence and mentorship of Chicago and Seattle K-12 science teachers offers TI students culturally relevant methods instruction. Because society and policy play such an important role in the development of individual teachers and students, discussion of student learning focuses on the socio-cultural and educational policy frameworks of the

city. Passehl, Weisenburger, Anderson, and Christensen share their knowledge about what it means to be a *Chicago* or *Seattle* physics teacher. One CSU student reflected on the importance of this mentorship, writing: *"It also helped that they are currently teaching in a urban setting, so they are familiar with the struggles that teachers will face in an urban setting. I feel like I will really use Kara and Jennie as professional contacts in the future as I begin my first years teaching."*

3. Promotes deep study of science topic.

TI interns have often been exposed to their lesson content as learners. However, lesson planning requires TI interns to choose and sequence relevant content in a way that attends not only to the content to be understood but also the means by which students understand it (*i.e.,* process skills). Implementation requires that TI interns listen and understand alternative solution paths. And assessment requires discerning *progress* toward canonical or epistemological (*i.e.,* the nature of scientific knowledge and how to learn it) understanding, even if the product does not match the teacher's existing understanding [35]. The TI course's extended focus on a single science topic promotes the kind of deep understanding – and application of that understanding – that is required of practicing teachers. A number of interns have reflected positively on this opportunity to study one topic in depth and to grapple with the content in the way that their students will [36]. One CSU intern wrote: *"At first, I thought working on one lesson all semester would be redundant and that I would lose interest. That was not the case. In fact, I came to appreciate the time spent on each component of the lesson. We came up with ideas, they evaluated them, we revised ideas, they evaluated them, we finalized ideas, they approved them...etc. "* An SPU intern reflected: *"I have become aware and more confident in my own knowledge. Throughout the class, I have learned things that I already 'knew' in more depth. Planning a lesson makes you really think about why a mechanism works the way it does. This quarter I have really learned to appreciate the way that electricity and power generation works. I have gained the confidence to be able to explain the system to someone with very little physics understanding. I think this is part of the very definition of being a teacher, becoming so invested in a subject that you want to pass it on to someone who doesn't know anything about it – this can only be done by intimately knowing the subject yourself."*

4. Familiarizes interns with state and national standards and teacher performance assessment.

With the advent of the Next Generation Science Standards (NGSS) and the commitment of twenty-five states, including Illinois and Washington, to adopt the Teacher Performance Assessment (edTPA) the TI model may help secondary education programs address new teaching and learning standards and assessments [37, 38]. The NGSS promote the mastery fewer content standards in greater depth, with more cross-discipline connections and an emphasis on scientific processes and the nature of science. During the TI course, students examine standards documents, including the NGSS, and try to focus on core content and process standards in their lesson development. The extensive amount of time they devote to one topic allows them to view the NGSS as a guide and to endeavor to make the advocated-for application connections.

The edTPA was designed to be educative and predictive of effective teaching and student learning. In this assessment, teacher candidates must provide, explain, and reflect on evidence of teaching effectiveness for a three- to five-day lesson. The targeted competencies include planning, instruction, assessment, reflection, and academic language. CSU and SPU, like many universities, are finding that they must implement curricular changes to teacher education programs to prepare candidates for the deep reflection on practice required by the edTPA. In particular, rich early teaching experiences like the TI course – which requires students to think deeply and reflect on planning, instruction, and assessment – are needed.

E. Empowers In-Service K-12 Teachers to Participate in the Preparation of Future Teachers.

The TI course structure empowers in-service K-12 teachers to participate in the preparation of future

physics teachers. One CSU teacher explained, *"This experience has changed…how I view my role in the science education community…I have a lot more confidence in my abilities and I now believe I have a lot of ideas to offer the community of Physics teachers."*

CSU mentor teachers have become very invested in the physics education program. The CSU collaboration has led to presentations by the high school teachers, co-authorship on a paper published in *The Physics Teacher* magazine, two workshops co-led by the high school teachers given at the National PhysTEC Conference and a local conference for science and math educators in Chicago, and invitations to give talks on science teacher preparation. The high school teachers we work with continue to lead the TI course and assist in efforts to recruit physics education students.

Mentor teachers have also described the role of the TI course in their own professional development. One SPU teacher wrote: *"The mentor teacher can engage in rich dialogue with the STIE students about physics concepts, assessment strategies, and the challenges of classroom management. Revisiting these ideas is important for veteran teachers, and can have a rejuvenating effect on our own instructional practices."*

IV. CHALLENGES OF IMPLEMENTING AND SUSTAINING A TEACHING IMMERSION COURSE

A. Funding for Mentor Teachers

One challenge to the sustainability of the Teacher Immersion Course is funding for mentor teachers. (University faculty can be paid by course load.) Early on, both SPU and CSU benefited from APS PhysTEC funding. Currently, both CSU and SPU have negotiated or are in the process of negotiating institutional funds to pay mentor teachers. CSU has found university support through a commitment from our university President. SPU is collaborating with the School of Education to transform the TI course so that it is also appropriate for students obtaining a Masters in Teaching. The course would then be cross-listed in Physics and the School of Education, and mentor teachers would be listed as co-instructors of the course and paid by the university for their time and expertise. Teachers at CSU are hired for approximately $1200 a semester, and teachers at SPU are hired for approximately $1200, split over two quarters.

Although funding for the TI course presents a challenge, the cost is relatively small compared to other models that employ in-service teacher experts and thus allows for easy adoption. For example, many successful teacher preparation programs incorporate a Teacher in Residence (TIR) [39, 40, 41]. The cost of a full-time TIR is often infeasible for university departments, particularly those with smaller secondary education programs. The TI course is an alternate model that includes many elements of a TIR model.

B. Course enrollment

An additional challenge to the sustainability of a TI course is low course enrollment [42].[4] Both CSU and SPU are small universities with proportionally small physics departments, and hence there are few potential teacher candidates. This means that there may be insufficient enrollment to offer the course on a yearly basis. CSU has mitigated this challenge by opening the course to students already committed to science teaching (in addition to those considering it) and encouraging chemists with a strong interest in physics to also enroll. As we say above, SPU is currently negotiating with the School of Education to transform the TI course so that it is suitable for students obtaining a Masters degree in STEM teaching.

[4] At CSU, years one and two of TI implementation involved only those students considering careers in physics teaching, while in year three the course was opened to students already committed to science teaching. There were three interns in year one, four in year two, and six in year three. At SPU, six interns participated in the first and only implementation of the TI course, five who were simultaneously participants in SPU's Learning Assistant Program and one who was enrolled in SPU's Master of Arts in Teaching Program.

C. Incorporating Additional Courses into Existing Secondary Education Programs

An additional challenge that may be encountered when implementing a TI course is how to fit additional coursework into a secondary education program that is already at capacity. A course based on the TI model may substitute for a previous requirement, or the content of a current education class could be altered to fit elements of the Teacher Immersion model and its links to the edTPA.

Furthermore, many physics departments recognize the importance of discipline-specific education courses in quality science teacher preparation. At CSU, the TI course fills the same place in the physics secondary education degree option as does an upper level physics elective in the general physics degree option. Similarly, SPU has a "teaching physics" degree track, and the TI course counts as an upper-division physics elective for students pursuing that path.

D. Mentor teacher recruitment

Choosing mentor teachers whose objectives and goals are aligned with those of your teacher education program, who use research-based best practices, and who adhere to the ideas put forth by the Next Generation Science Standards is crucial so that students are not receiving mixed messages [43]. Because TI interns are new to the teaching profession, any presentation of conflicting ideas by the high school teachers, the college faculty, and outside sources such as NGSS can derail ideas that, at this point, may be somewhat tenuous. CSU and SPU have established strong relationships with teachers who are experienced in reform-oriented teaching pedagogy and who have been in the classroom for more than five years. All teachers were originally involved in professional development courses at CSU or SPU before becoming involved with the TI courses.

It is important that these teachers be employed by the university and teach the course at the university. Doing so highlights a level of respect for the experience and knowledge of the high school teacher partners. This aligns with the TIR model in which the teacher is brought to the university to offer the secondary education program their unique, critical wisdom and expertise.

In addition, hiring a high school teacher by the university sends an important message to interns in a secondary education program. It lets interns know that the university respects and values what these teachers have to offer and highlights the fact that these teachers bring something unique to the university. This endorsement of the skills, current experiences, and knowledge of high school teachers plays an important role in our new teachers seeking mentorship from teachers in the field [44].

V. SUMMARY

In this chapter we describe a course that immerses university students in physics teaching and provides an early teaching experience for prospective and committed pre-service teachers. The course capitalizes on the expertise and mentorship of in-service K-12 teachers as students in the course focus on a single topic and develop a lesson that they then implement in their mentor's high school classroom. The course supplements the existing methods courses and student teaching experiences typical in many secondary education programs. It provides a recruiting tool for students who want to consider – in a low-stakes way – a career in teaching and provides exposure to the profession for students who may have committed to teaching but have limited experience in the classroom.

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