Table of Contents

(f2) Partnership will carry out activities required under the absolute priority	**7-23**
(f3) If using funds under section 202(f) of the HEA, how activities will be carried out	**N/A**
(f8i) Describe high-quality PD activities to strengthen content knowledge / teaching skills	**7-23**
(f8ii) Describe training to implement literacy programs…	**23**
(f9) Partnership will design, implement, enhance preservice clinical program component	**8-23**
(g1) Schools/departments in IHE induction program will effectively prepare teachers…	**14-18**
(g2) Partners' capability/commitment to… the use of empirically based practice and scientifically valid research on teaching and learning	**Exmpl 9**
(g3) Program will design/implement induction program to support teachers ….	**18-21**
(g4) Faculty will substantially participate … including release time/credit for participation	**34-38 Budget**
QUALITY OF PROJECT EVALUATION	**41-50**
1.Evaluation methods will provide valid / reliable performance data on relevant outcomes	**41-50**
2.Evaluation is thorough, feasible & appropriate to goals, objectives & outcomes	**41-50**
(f11) Partners will collect, analyze, and use data … to evaluate effectiveness …	**41-50**
Stipends and agreements to serve	**3**
Logic Model	**24, App G**

THE INDY STEM TEACHER RESIDENCY PROGRAM:

A Teacher Quality Partnership Between Indianapolis Public Schools and Purdue University

INTRODUCTION

Today's K-12 students will be the nation's next generation of the talent—a population who will need increasingly sophisticated knowledge and skills in science, technology, engineering and mathematics (STEM). Numerous reports link K-12 STEM education to the U.S. effort to maintain its scientific and economic leadership in today's global economy (e.g., National Academy of Science [NAS], 2010; National Research Council [NRC], 2011a, 2011b; National Science Board, 2006). Yet, those same reports provide data indicating our nation is not yet prepared to populate the "STEM pipeline" because of systemic challenges in science and mathematics classrooms. For example, research has shown that high school students are often disinterested in science because the subject is frequently taught in an isolated, disjointed fashion, limiting students' ability to see connections among concepts and to real world applications (Hidi & Harackiewicz, 2000; Swarat, Ortny & Revelle, 2012). Furthermore, there is growing inequality of K-12 students' access to exemplary science and mathematics education, especially among African American, Hispanic, and Native American students as well as students in urban areas (Rodriguez, 2015). This has resulted in a persistent disparity in achievement and threatens to widen the educational gap that exists between different economic strata and between our nation's majority and growing minority populations (NRC, 2011a; President's Council of Advisors of Science and Technology, 2010).

Promising responses to these challenges involve collaboration among K-12 education, postsecondary education, business and government—and Purdue University in partnership with Indianapolis Public Schools (IPS) is positioned to deliver such a response. The ***Indy STEM Teacher Residency (ISTR) Program*** is a collaborative partnership between Purdue University's

Center for Advancing the Teaching and Learning of STEM (CATALYST), Purdue University's Department of Curriculum and Instruction, and IPS, which responds to the following priorities: *Absolute Priority:* Partnership Grants for the Establishment of Effective Teaching Residency Programs; *Competitive Preference Priority 1:* Projects designed to improve student achievement in computer science; *Competitive Preference Priority 2:* Projects submitted by novice applicants; and *Invitational Priority:* Spurring Investment in Opportunity Zones.

The overarching vision of this project is to *strengthen the educational outcomes of students in the largest urban school district in Indiana, IPS, by preparing culturally competent, highly qualified career teachers who will elevate student achievement in middle and high school science (including chemistry, computer science, earth science, life sciences, and physics), technology, engineering, and mathematics (STEM)*. This project will accomplish this goal by expanding the number and diversity of individuals possessing a strong academic or professional background without extensive teaching experience, but who are interested in pursuing a career in secondary (grades 7-12) STEM teaching and developing enhanced knowledge, skills, and disposition for integrating engineering and technology design into science and mathematics instruction through project-/problem-based, inquiry-oriented approaches.

The Indianapolis Public Schools-Purdue University (IPS-PU) partnership is committed to continuous improvement, excellence and innovation. The IPS-PU partnership strives to be on the forefront of what is best for teacher education and students based on time-honored and contemporary research and practice. By preparing top-tier 21st Century STEM teachers to teach a STEM content, skills, and practices through the integration of engineering design in culturally and socially relevant ways, teachers will have highly positive impact on elevating K-12 STEM learning

as well as increasing STEM interest among a diverse population of Indiana students. Thus, the IPS-PU partnership proposes to design, develop, and execute the *ISTR Program*, an 18-month teacher residency program focused on teaching opportunities within IPS in which Resident Teachers will earn a Master's degree and K-12 Integrated STEM Degree Certificate, followed by a two-year induction program that will support up to 60 participants over 5 years as they develop the knowledge, skills, and dispositions of highly effective STEM teachers. The ISTR Program was designed to embody the eight key characteristics of strong teacher residency programs (Figure 1):

KEY CHARACTERISTICS OF STRONG TEACHER RESIDENCY PROGRAMS

1. Strong district/university partnerships
2. Coursework tightly integrated with clinical practice
3. Full-year residency teaching alongside an expert mentor teacher
4. High-ability, diverse candidates recruited to meet specific district hiring needs, typically in fields where there are shortages
5. Resident cohorts placed in schools that model good practices with diverse learners and are designed to help novices learn to teach
6. Expert mentor teachers who co-teach with residents
7. Ongoing mentoring and support for graduates
8. Financial support for residents in exchange for a 3-year teaching commitment in the district

Figure 1. Key characteristics of strong teacher residency programs (adapted from Guha, Hyer, & Darling-Hammond, Learning Policy Institute, 2016)

Each ISTR Resident Teacher will receive financial support of $46,500 for their 18-month residency. In return, they will commit to teaching in IPS schools for three years following completion of their licensing and Master's degree requirements. The stipend will be structured as a forgivable loan through Purdue University's Division of Financial Aid—Loan Operations. IPS will provide teachers with all appropriate certification of employment during this period.

RATIONALE

By 2020, there will be over 170 STEM occupations in Indiana's workforce, accounting for 12.1% of all jobs in Indiana (Leeuw, Baer, & Zimmer, 2017). Numerous reports detail how STEM-related

industries are rapidly increasing in Indiana and are expected to generate thousands of jobs in key STEM occupational groups each year (e.g., TEConomy Partners, 2016). For example, the health and life sciences industry alone in Indiana has grown over 22% in employment since 2001 and, according to the Indiana Department of Workforce Development (2019), is expected to continue to generate 12,000 job openings in key occupational groups annually. It accounts for one in ten private sector jobs across all skills levels and has higher average wages in almost every occupational group. The demand for talented, skilled STEM workers in the state makes a telling case for educators and workforce professionals to focus efforts on innovation, job creation and development in STEM. Meeting this demand starts with placing highly-qualified teachers in the K-12 classrooms, a call that the ISTR Program is positioned to answer.

This partnership is focused on impacting the greater Indianapolis metropolitan area. This Midwest urban landscape in education is facing critical challenges in attracting high quality teachers and ensuring retention for some of the most high-need students in the state. Diverse in both population and opportunity, IPS is an agile, innovative educational organization committed to academic excellence built through individualized, relationship-based learning. IPS is an urban school district covering 80 square miles in central Indiana, serving over 30,000 students and employing 2,600 educators through their schools and special programs.

Demographic Data

According to Census data, 20.1% of the population in Indianapolis is living in poverty, compared to the national average of 12.3% (Department of Commerce, 2018). As the largest district in the state of Indiana, IPS is a high need Local Educational Agency (LEA) that proudly serves an ethnically, culturally, linguistically, and socioeconomically diverse population of students and

families (see Figure 2) with a majority of minority populations enrolled and high concentrations of exceptional needs compared to the rest of Indiana. Approximately 65% of IPS students qualify for free and reduced lunch (Indiana Department of Education [INDOE], 2019). However, INDOE more recently established IPS as a 100% free and reduced lunch within ALL schools through the IPS Title 1 Department. According to the SAIPE School District estimates (U.S. Census Bureau, 2019), IPS serves approximately 17,217 students ages 5-17 years old who live in poverty and are related to the householder. IPS has selected three high need schools for the ISTR Program: Arsenal Technical High School, George Washington High School, and Henry W. Longfellow Middle School (See *High Need School Selection***,** p. 27).

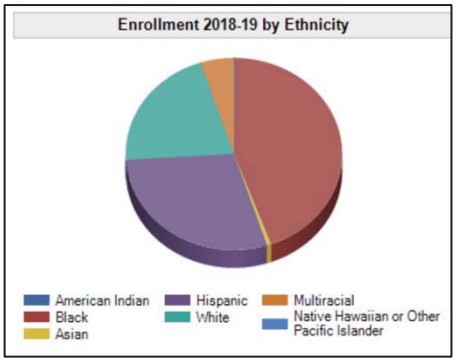

Figure 2: IPS Enrollment by ethnicity

Teacher Needs: Recruitment, Retention, and Preparation

IPS hires roughly 400 teachers per year, of which nearly 200 are novice teachers, and experiences approximately 27% annual teacher turnover. In addition to hiring hundreds of teachers annually, IPS has a significant number of teachers who are working under emergency permits, a trend that has continued to climb for the past three years. IPS issued 105 emergency permits in the 2016-17 school year, 136 emergency permits in the 2017-18 school year and 169 emergency permits in the 2018-19 school year.

IPS has seen increasing demand for STEM teachers, and more specifically, mathematics and science teachers (see Appendix C: Needs Assessment). Across the state of Indiana, there are significant gaps in the ability to meet the demand for high quality STEM teachers in grades 5-12 classrooms. Within the IPS high-need schools participating in ISTR, for example, Arsenal

Technical High School currently is seeking to fill 13 vacancies in mathematics, and Henry W. Longfellow Middle School is seeking to fill 2 vacancies in mathematics. When IPS searches for high quality teachers to fill these positions, the candidate to vacancy ratio for mathematics is a mere 2.08 per position vacancy, and science is only 1.47 per position vacancy. This is strikingly low compared to other fields; for example, the district receives approximately 14 applicants per counselor position vacancy.

Moreover, the teacher retention rate in IPS, particularly in math and science classrooms, is another challenge the district is facing. The three-year retention rate for all IPS teachers is 46%. The rate is even lower for math and science teachers across the district at just 33%. These statistics are a clear indicator that additional strategic investments are necessary to better prepare and equip novice teachers to be effective and enduring teachers.

IPS and Purdue University Teacher Education Reform

For the past 4 years, IPS has been engaged in intensive collaborations with its higher education partners, including Purdue University, to review teacher matriculation data, analyze teacher survey feedback, and examine deeper partnership opportunities. Through this process, IPS worked with a subcommittee of which Purdue was a lead partner to revamp its student teaching experience in 2018, and as a result, is now positioned to launch a teaching residency program in the hardest-to-fill subject areas, including STEM subjects, across the district.

Concomitantly, Purdue University's College of Education (COE) is undertaking a major effort to reform its Teacher Education Program through innovative programs that ensure graduates are fully prepared to address the needs and provide equitable and effective education for all learners in the 21st Century. These efforts will directly inform all phases of the ISTR Program. In

2018, COE identified four broad categories for reform: (1) *field experiences*, focusing on the of high quality field experiences at both the elementary and secondary levels, including residency models; (2) *meeting the needs of all learners*, which focuses on how to better prepare teacher candidates to meet the needs of the diversity of learners, such as English language learners and special education students, among others, as well as an increased focus on data-driven decision instruction; (3) *teacher preparation research*, which focuses on ensuring that reform is research-based, includes evidence-based practices and advances teacher preparation nationally; and (4) *induction and mentoring*, focusing on reframing the Purdue Promise into an expectation that all completers will be supported through at least their first year of teaching.

THE INDY STEM TEACHER RESIDENCY (ISTR) PROGRAM

Strong and robust initial teacher preparation is key to becoming a highly qualified, effective, and confident STEM teacher. The ISTR Program will prepare the next generation of top-tier STEM teachers who possess: (a) deep subject matter knowledge and pedagogical content knowledge in at least one STEM field, (b) well developed knowledge, skills and dispositions to integrate cross-cutting content, processes, and practices beyond their discipline of expertise; and (c) well developed knowledge, skills, and dispositions for teaching ethnically, culturally, linguistically, and socioeconomically diverse student populations. The ISTR Program will afford resident teachers rich and varied opportunities to develop the craft of teaching as they apply what they learn in coursework in a more immediate timeframe than traditional teacher education programs. Further, while resident teachers assume increased teaching responsibilities under the guidance of an experienced classroom teacher, they will receive structured real-time feedback and coaching to refine their developing practice.

Furthermore, coursework within the ISTR Program has been designed to align with Indiana's Academic STEM Standards (INDOE, 2016), in science and computer science, mathematics, and engineering and technology, as well as the *Indiana STEM Strategic Plan* (INDOE, 2018). The ISTR Program also reflects current national recommendations and reforms in STEM education (e.g., *Next Generation Science Standards,* NGSS Lead States, 2013; *Engineering in K-12 Education*, Katehi et al., 2009; *Principles to Actions: Ensuring Mathematical Success for All*, National Council of Teachers of Mathematics, 2014). Teachers who complete the ISTR Program will understand the nature of STEM through the study of the *practices* of scientists, technologists, engineers, and mathematicians. The term *practice* is used to denote that these four disciplines contain specific knowledge and skills that form distinct practices of their respective disciplines (NRC, 2012). Identifying and defining activities, knowledge, skills, artifacts, processes, and procedures are crucial for building a strong community of practice (Lave & Wenger, 1991) and are recognized as critical to subject integration (Frykholm & Glasson, 2005; Berlin & White, 1995; NRC, 2012). ISTR teachers will exhibit attributes of educational leadership—they will take the lead in implementing innovations and breaking the boundaries of "siloed" subject area instruction; they will share and disseminate what they know and know how to do; they will lead in developing collaborations that enrich the learning experiences of their students; they will possess the disposition of a life-long learner.

ISTR Program Conceptual Framework

The expectations and rigorous demands for success beyond high school require more than rote learning and memorization of disconnected facts. Students need teachers who are able to create and sustain learning environments that allow students to construct deep content knowledge while

cultivating problem-solving, communication, and collaborative skills. To this end, the IPS-Purdue partnership will ensure coherence and rigor throughout the ISTR Program components by grounding it in a conceptual framework that embodies *five core principles* of highly effective STEM teaching and learning based on time-honored and contemporary research:

- ***Core Principle 1:*** Highly effective instruction in the STEM disciplines will be standards-based (state and national) and will integrate science inquiry, engineering and technology design and practices, and/or mathematical problem solving (Bryan, et al., 2015; Moore, Guzey, & Brown, 2014; NGSS Lead States; NRC, 2014).
- ***Core Principle 2:*** Learning is a process of knowledge construction; entails the development of conceptual constructs, reasoning processes, and patterns of activity; and is situated in specific cultural contexts and practices and is socially negotiated (NRC, 2000; 2005).
- ***Core Principle 3:*** Highly effective teaching requires deep, flexible content knowledge and pedagogical content knowledge. (Jeanpierre, Oberhauser, & Freeman, 2005; Loucks-Horsley, Stiles, Mundry, Love, & Hewson, 2010; NRC, 2012; Shulman, 1986)
- ***Core Principle 4:*** Instruction is culturally inclusive, socially relevant and situated in authentic contexts (Ares, 2011; Cobb, 1994; Lemke, 1997; Vygotsky, 1986; Wilson-Lopez et al., 2016)
- ***Core Principle 5:*** Reflective teachers participate not only in the purposeful, systematic and critical examination of values, knowledge, and beliefs about what one is learning, but also in acting on those aspects that confuse, frustrate, and perplex to improve and refine understanding and teaching. (Bryan, 2012; Cochran-Smith & Lytle, 1999; Dewey,1933; Schön, 1987)

ISTR Program Components

Research has demonstrated that high-quality residencies offer teacher candidates a curriculum that is tightly integrated with their clinical practice (Berry, Montgomery, and Snyder, 2008; Guha et al., 2016; Zeichner, 2010). The interconnectedness of "theory to practice" reinforces research-based practices for ISTR Resident Teachers and is synergistic—that is, the residency experience is designed to inform and enrich learning in the coursework and reciprocally, the coursework is designed to inform and enrich learning to teaching in residency experience. This deep blend of theory and practice helps ISTR Resident Teachers draw meaningful connections between their daily classroom work and the latest in education theory, research, and practice.

The ISTR Program developed by the IPS-PU partnership prioritizes classroom practice and deep clinical experience that integrates: (1) a rigorous plan of study that leads to state licensure at the secondary level (Grades 5-12) in at least one STEM discipline (i.e., Chemistry, Earth/Space Science, Life Science, Physics, Engineering and Technology, or Mathematics); (2) a Purdue University 18-month online Master of Science in Education degree program in Curriculum and Instruction with a STEM concentration; (3) a Purdue University K-12 Integrated STEM Education Graduate Degree Certificate augmented by up to three computer science courses, and (4) a two-year induction program that supports and mentors teachers in residency in their professional growth and development. Immediately following the completion of state licensure requirements and university coursework, ISTR teachers will be employed full-time in IPS while engaging in a two-year induction program that continues to support and mentor them in their professional growth and development. Below is a timeline of the

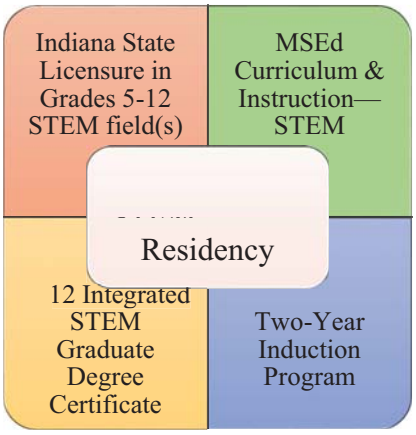

Figure 3: ISTR Program Components

complete ISTR Program (Table 1) followed by a description of the individual program components.

Teacher Residency in IPS

The three IPS schools selected to serve as ISTR Program Teacher Residency host sites have STEM-focused programming or career pathways, high need students, and teaching positions that are difficult to fill. ISTR Resident Teachers participate in an 18-month Teacher Residency that takes place during the academic year and two summer sessions (one before the academic year and one following the academic year). The two summer sessions will allow Resident Teachers a continuous experience in the district atmosphere as they work with students during summer school.

During their residency, ISTR Resident Teachers will complete the MSEd, K-12 Integrated STEM Education Graduate Degree Certificate, and computer science coursework—academic year courses online and summer courses online or in person at IPS. Each ISTR Resident Teachers will be partnered with an IPS Clinical Prep Teacher Leader (CPTL) in the IPS classroom during her/his residency. Additionally, through carefully targeted instructional strategies paced throughout the academic year, ISTR Resident Teachers and their supervisors (CPTLs) will be able to test, practice and refine each strategy applied to content instruction with real time feedback and reflection. This will be executed by a tightly aligned partnership with CPTLs in a co-teaching model throughout the year. A timeline for all ISTR Program, including the teacher residency, coursework, and induction components are mapped in Table 1. In addition, examples are provided throughout the table to represent the robust integration of coursework and classroom teaching during the residency.

Table 1: *ISTR Program Teacher Residency and Coursework Timeline*

	Spring 2020 January-April		**Summer 2020 May- July**		**Fall 2020 August-December**	
Purdue Courses	EDCI 59100-3 EDCI 59100-5 EDCI 59100-7	EDCI 55800 EDCI 59100-6	EDCI 58500 EDCI 59100-4	EDPS 53000 EDCI 59300	EDCI 539000	EDCI 54900
	Content Courses* Science or Math Methods*		EDCI 59000-4			
Residency Phase	Pre-Residency		Summer and Academic Year Teacher Residency			
Example of Course-Classroom Integration	EDCI 59100-5 Teach eng/tech design activities analysis of student learning to inform revision of learning tasks and/or teaching strategies	EDCI 55800 Teach full iSTEM lesson; analysis of student learning to inform revision of learning tasks and/or teaching strategies	EDCI 58500 Culturally relevant pedagogy project for IPS Fall 2020 classroom instruction		EDCI 539000 Teach full iSTEM lesson; analysis of student learning revision of learning tasks and/or teaching strategies	EDCI 54900 Design STEM assessments; pilot selected assessments; analyze learning data to inform instruction

	Spring 2021 January-April		**Summer 2021 June- July**		**Academic Year 2021/2022**
Purdue Courses	EDCI 59000-1	EDCI 69500	EDCI 59000-2** EDCI 59100-2 EDCI 59000-3**	EDCI 59100-1 EDCI 59400	1st Year Full-Time Teaching and Induction Phase
Residency Phase	Academic Year and Summer Teacher Residency				
Examples of Course-Classroom Integration	EDCI 59000-1 Pilot computer science lesson; analysis of student learning revision of learning tasks and/or teaching strategies		EDCI 59100-2 Constructing portfolio from teaching and coursework	EDCI 54900/EDCI 59100-1 Design teacher action research project	Implement teacher action research project; present and discuss project outcomes at professional learning community meeting

*Additional courses may be required for some ISTR Resident Teachers, depending on transcript evaluation for state licensure.
** Optional Computer Science courses for ISTR Resident Teachers who wish to develop deeper knowledge and skills

Resident Teachers will move through a scaffolded process in which the Resident Teacher assumes increasingly greater classroom responsibility while experiencing varied co-teaching approaches including: one teach, one observe; one teach, one assist; parallel teaching; station teaching; alternative teaching; and team teaching (see Figure 4). Students of all academic levels will benefit from the variation in co-teaching approaches, receiving greater teacher attention in small group activities that co-teaching makes possible. Co-teaching allows the Resident Teacher and the CPTL to deliver more intense and individualized instruction, and a tiered level of accountability and practice. It allows for debrief and reflection between resident and CPTL and a structured approach to daily lessons.

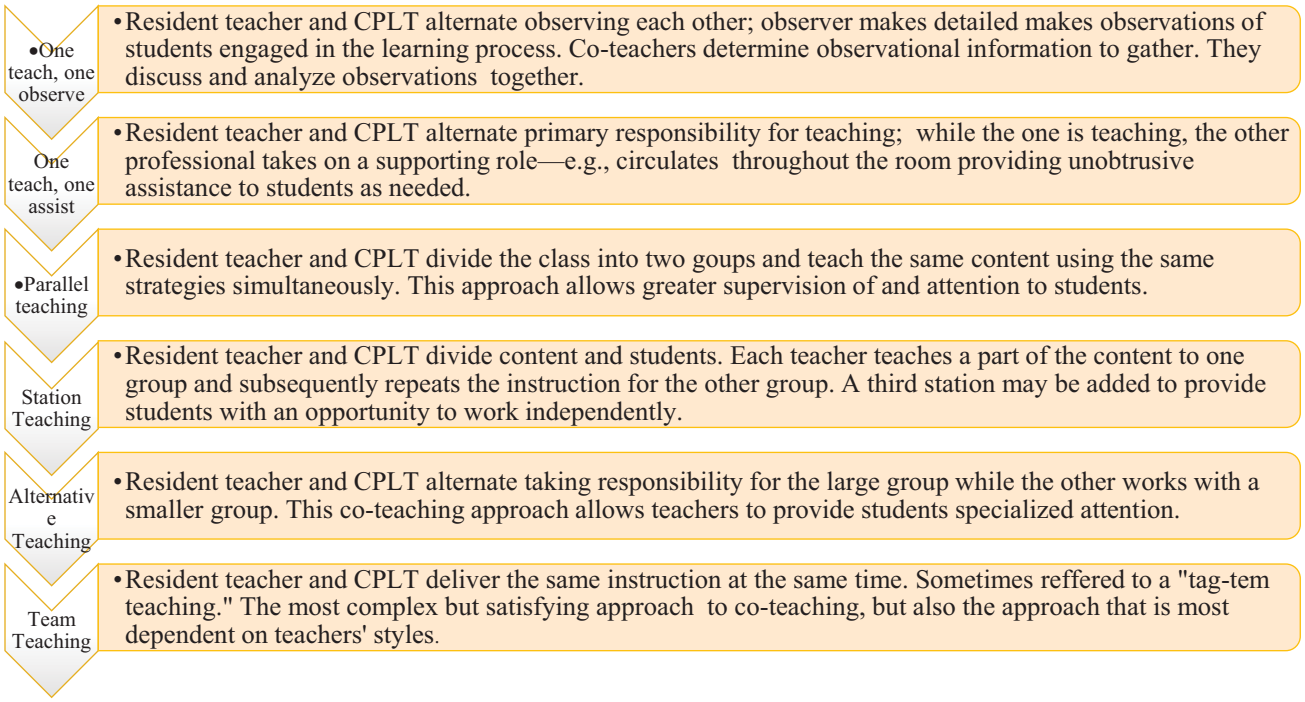

Figure 4. ISTR's Six Co-Teaching Approaches (adapted from State Education Resource Center, 2016)

Indiana State Licensure in a Secondary STEM Discipline

Upon acceptance to the program, the ISTR Resident Teacher will be admitted as a graduate degree-seeking student to Purdue University's Transition to Teaching (TTT) Program to complete the

requirements for Indiana State Licensure in at least one secondary (Grades 5-12) STEM discipline. The TTT Program is based on the premise that a candidate already has the subject matter training and knowledge to teach in a secondary area. The TTT program builds upon those skills to help residents become teachers in an area of their choosing and gain licensure as a teacher. Each Resident Teacher will receive a transcript evaluation and credential review to determine the courses needed to meet the requirements for Indiana State Licensure in a Secondary STEM discipline. *Several of the required courses that Resident Teachers will take to meet the requirements for Indiana State Licensure in a secondary STEM discipline may be completed through Purdue's online Master of Science in Education (MSEd) Program*. If an ISTR Resident Teacher's transcript evaluation shows that courses are needed in addition to those offered by the ISTR Program (e.g., additional content courses, subject-specific teaching methods courses), then the ISTR Resident Teacher will be able to enroll in the necessary courses at Purdue University.

Master of Science in Education

STEM Resident Teachers will complete an 18-month, 30-credit online MSEd program at Purdue University in Curriculum and Instruction with a STEM concentration. Purdue's Online Master of Science in Education is ranked No. 1 in value for an online education degree, and the College of Education is ranked nationally at No. 29 for Best Online Graduate Education Programs by *U.S. News and World Report*.

The online MSEd program consists of 7 core courses (15 credits) in Curriculum and Instruction, 4 courses (12 credits) in the STEM concentration, and 1 elective course (3 credits) (see Table 3). The STEM Education concentration focuses on the knowledge, skills, and dispositions necessary to effectively teach STEM disciplines by leveraging the integration of engineering and technology design. Purdue University's online courses are taught by the same world-class faculty

members and are just as rigorous and challenging as their on-campus versions. The main difference is the online format, which allows ISTR Resident Teachers greater convenience in when and where they learn. The MSEd courses systematically integrate opportunities for ISTR Resident Teachers to contextualize and apply their learning within their IPS residency experiences (See Table 1, "Examples of Course-Classroom Integration"). Faculty and staff in the IPS-PU partnership teach the online courses and/or will liaise with course instructors to optimize ISTR Resident Teachers' understandings and applications of theory to practice.

K-12 Integrated STEM Graduate Degree Certificate

Drawing on the work of scholars who are credited with inspiring the movement to more meaningfully integrate the STEM disciplines at the K-12 level, we define integrated STEM (iSTEM) as *the teaching of STEM disciplines through the integration of engineering and technology design/practices for solving problems in culturally and socially relevant contexts.* (Bryan, et al. 2015; Childress & Sanders, 2007; Sanders, 2009; Sanders & Wells, 2010). ISTR Resident Teachers who earn the K-12 Integrated STEM Education Graduate Degree Certificate will demonstrate deep, flexible subject-matter knowledge and pedagogical-content knowledge in at least one STEM field; well-developed knowledge and skills to integrate cross-cutting content, processes, and practices beyond their discipline of expertise; and well-developed knowledge and skills for teaching diverse student populations. They will understand the nature of STEM through the study of the practices of scientists, technologists, engineers, and mathematicians—that is, the specific knowledge and skills that form distinct practices of these respective disciplines (NRC, 2014). ISTR Resident Teachers will benefit from STEM instruction that actively engages them in science, mathematics, technology and engineering practices that help them deepen their understanding of not only the core ideas of STEM disciplines but also the cross-cutting concepts

that are shared among STEM disciplines (NRC, 2011; 2014). They will have opportunities to learn science, mathematics, and technology/engineering design by conceptualizing, developing and optimizing authentic, viable solutions to problems that have real-world applications and connect to local, national and global issues and translating their knowledge into practice in secondary STEM classrooms. Below are the learning goals articulated for the K-12 Integrated STEM Education Graduate Degree Certificate (Table 2):

Table 2. *K-12 Integrated STEM Graduate Degree Certificate Learning Goals*

K-12 Integrated STEM Graduate Degree Certificate Learning Goals	
	Students will be able to:
Goals of K-12 Integrated STEM Education	Become aware of and implement various models of STEM integration in the K-12 classroom
Nature of K-12 Integrated STEM Education	Explore current and past educational reforms in K-12 STEM education and integrated STEM education.
Outcomes of K-12 Integrated STEM Education	Review research on the impact of integrated STEM approaches on various student outcomes, e.g., learning and achievement, interest and identity.
Design and Implementation of K-12 Integrated STEM Approaches	Identify and characterize existing approaches to K-12 integrated STEM education, both formal and informal setting, including affordances and limitations for implementation in K-12 classrooms
Issues of Equity, Diversity in K-12 STEM Education	Explore and articulate current trends in the research, policy and practices of STEM education, identifying sources of inequities across classrooms, schools, districts, and communities.
K-12 STEM Professional Development	Evaluate current and past models and approaches to STEM professional development. Develop a professional growth plan, identifying areas of strength and need for improvement.
Challenges of K-12 Integrated STEM Education	Compare and evaluate existing STEM programs across the state and nation.

To achieve these learning goals, ISTR Resident Teachers will complete a comprehensive suite of five courses for the Integrated STEM Education Degree Concentration (see Table 3). Four of the five K-12 Integrated STEM Education Graduate Degree Certificate courses have been incorporated within the online MSEd in Curriculum and Instruction—STEM program and will systematically integrate opportunities for Resident Teachers to contextualize and apply their learning within their IPS residency experiences.

Augmenting the K-12 Integrated STEM Education Graduate Degree Certificate courses will be three computer science (CS) courses for ISTR teachers. The first CS course will be required of all ISTR Resident Teachers and will provide instruction on the basics of computer science; introductory programming topics such as variables, functions, loops and logical expressions; and best practices for teaching an introductory CS course. The second and third courses will be offered to ISTR Resident Teachers who wish to learn and teach more advanced topics such as data structures, recursion, and object-oriented programming. ISTR Resident Teachers will be strongly encouraged complete the second and third courses, so that they may not only add more CS classes to the IPS curriculum, but also find creative ways to embed programming lessons into their STEM instruction. In turn, IPS students will be afforded greater access to opportunities for not only learning basic coding skills but learning broader, multidisciplinary concepts, including ways to think about technology and how it will continue to impact society.

Table 3: *Purdue University Course Work for ISTR Program*

	Meets Requirements for:			
	Indiana Teaching License	MSEd in C&I—STEM	Integrated STEM Degree Certificate	Induction Program
EDPS 53000 Advanced Educational Psychology	X			
EDCI 53900 Introduction to K-12 STEM Integration		X	X	
EDCI 54900 Assessment in STEM Education		X	X	
EDCI 58500 Multicultural Education	X	X		
EDCI 58800 Integrated STEM Education Methods	X	X	X	
EDCI 59000-1 Intro Computer Science for Teachers			X	
EDCI 59000-2 Teaching Computer Science II				X
EDCI 59000-3 Teaching Computer Science III				X
EDCI 59000-4 Engineering in Community Service		X	X	X
EDCI 59100-1 Capstone: Inquiry into Practice	X	X		X
EDCI 59100-2		X		

Curriculum and Instruction Portfolio				
EDCI 59100-3 Curriculum & Instruction Seminar I		X		
EDCI 59100-4 Curriculum & Instruction Seminar II		X		
EDCI 59100-5 Intro to Teaching Eng. & Tech. Design		X	X	
EDCI 59100-6 Teachers as Leaders		X		
EDCI 59100-7 Theories and Trends in C&I		X		
EDCI 59300 Intro to Secondary TTT Seminar	X			
EDCI 59400 Concluding Seminar TTT	X			
EDCI 69500 Internship in Education	X			

Induction Program

Part of the ISTR Program's strategy is to deepen the both Purdue's and IPS's investment in enhanced field experiences and residency models as well as new, rigorous teacher induction supports to address the retention issues seen in difficult subject areas and hard-to-staff schools. Research has shown that induction programs with components such as a mentor, planning time with other teachers, seminars, and an external network, lead to greater retention of teachers in the field (Smith & Ingersoll, 2004). In particular, two elements were found to be especially useful: instructional resource teachers and peer collaboration (Nielsen, Barry, & Addison, 2007). An instructional resource teacher serves as a resource, guide, and support. Instructional resource teachers also observe beginning teachers, promote reflection on practice and provide constructive feedback. Peer collaboration offers beginning teachers an opportunity to be part of a community that fosters camaraderie and works together to analyze and improve their classroom practice much like professional learning communities.

The ISTR Program includes a comprehensive plan to support and retain new STEM teachers through their first two years of full-time teaching in IPS classrooms. ISTR's induction

plan was developed based on significant challenges to retain a diverse population of students from matriculation to graduation as well as retain teachers in the profession.

First, the ISTR Program will to utilize two resources similar to an instructional resource teacher: *CPTLs* and *Mentor Teachers*. The CPTL plays a crucial role in training, supporting, and inspiring a student teacher. The CPTL helps orient the teacher in residence to classroom students, routines, and procedures already in place in the classroom, school-building facilities and resources, school personnel (e.g. special education teachers, guidance counselors, administrators, school secretaries, etc.), and school policies. The CPTL is a skilled mentor who has at least three years of teaching experience with demonstrated effective teaching, a willingness to mentor adults, a professional demeanor, and an unwavering confidence that all students can learn. CPTL's will help identify and provide ISTR Resident Teachers with opportunities to engage with families in a meaningful way (e.g., interacting with parents at an event or participating in parent-teacher conferences, as appropriate). The CPTL will share responsibility for classroom instruction by gradually increasing opportunities for the teacher in residence to provide full-class instruction or by adopting a co-teaching model (see Figure 4). While the CPTL and a Purdue University Supervisor will decide together when and how to increase the Resident Teacher's instructional responsibility, the CPTL will support the Resident Teacher to practice with independence. The CPTL will provide regular informal and formal feedback, including evaluations of the ISTR Resident Teacher as required by her/his University Supervisor and by IPS central office. Mentor Teachers and their roles and responsibilities are discussed in *Selection of Mentor Teachers* (p. 26).

Second, the ISTR Program will cluster ISTR Resident Teachers in *cohorts*. Each new project year, the partnership will welcome a new cohort of Resident Teachers who will participate in onboarding, coursework, residency, professional development, and induction activities at IPS.

The cohort model will allow ISTR Induction Level Teachers, CPTLs, Mentor Teachers and/or Purdue faculty to create a Professional Learning Community (PLC) in which they will attend regularly scheduled meetings that will provide a venue for timely seminars on topics that are relevant to ISTR Induction Level Teachers experiences (e.g., engaging the hard-to-engage student; differentiating instruction for diverse learners). The development of a PLC recognizes that scholars must work collaboratively to achieve a collective purpose—in this case, not only successful completion the program, but also learning how to achieve high quality K-12 STEM student learning. Engaging ISTR Induction Level Teachers in a PLC will set a precedent for avoiding working in isolation. Instead, ISTR Teachers will participate in a community of colleagues who will join forces to develop a systematic process in which teachers work together to analyze and improve their classroom practice (DuFour, 2004).

The ISTR retention model for supporting Project ISTR Induction Level Teachers in their first two years will be delivered through a hybrid online and face-to-face STEM teacher induction program. Year 1 is focused on teachers' growth as a reflective practitioner. ISTR Induction Level Teachers will engage in online professional development through the Department of Curriculum and Instruction. In year 2, the focus is on discipline specific induction to assist ISTR Induction Level Teachers in honing their discipline-specific knowledge and skills for teaching STEM disciplines. Additionally, Induction Level Teachers will be mentored to develop an individual self-directed professional growth plan. The ISRT induction plan is summarized in Table 4.

Table 4: *ISTR Induction Plan*

Phase	**Induction Year**	**Focus**	**Community Interactions**
Growth as a Reflective Practitioner	1	Develop and refine STEM teaching, reflective analysis, and classroom management skills; Provide support and resources for STEM teaching in high- need environments.	PLCs with CPTLs, ISTR Cohort, IPS Colleagues, and/or Purdue instructors

Discipline Specific Induction Self-Directed Professional Growth	2	Individualized mentoring in discipline-specific instructional skills; reflective analysis on discipline-specific teaching and learning; design an individualized professional growth/development plan	PLCs with CPTLs, ISTR Cohort, IPS Colleagues, and/or Purdue instructors

Additional ISTR Program Features

In this section, we briefly discuss: (a) the preparation of teachers to understand/use research data to improve instruction; alignment with state academic standards under section 1111(B)(1) of the ESEA; (b) alignment with state early learning standards for ECE programs, as appropriate, and with the relevant domains of early childhood development; (c) the preparation of general education teachers to teach students with disabilities, including training related to participation as a member of individualized education program teams, as defined in Section 614(D)(1)(B) of the IDEA; and (d) preparation of general education and special education teachers to teach students who are limited English proficient.

Preparation of Teachers to Understand/Use Research Data to Improve Instruction

The ISTR Program will prepare Resident Teachers to effectively create and analyze formative and summative assessments in the classroom in several ways. As part of the online MSEd program, ISTR Resident Teachers will complete the course, EDCI 54900: Assessment in STEM Education, in which they will learn to use Indiana STEM Education Standards (INDOE, 2016) and national standards (e.g., Next Generation Science Standards, NGSS Lead States, 2013) to design and interpret effective formative and summative assessments. In addition, ISTR Resident Teachers and CPTLs will collaboratively collect, review and analyze classroom data and standardized test scores from assessments such as Northwest Evaluation Association (NWEA), Indiana Learning Evaluation Assessment Readiness Network (ILEARN), and Indiana Statewide Testing for Educational Progress (ISTEP). ISTR Resident Teachers will learn to use the results to inform and

enact next steps in classroom instruction. IPS district- and school-based professional development also will be offered to ISTR Resident Teachers to effectively analyze data from a variety of IPS departments including Special Education, ESL, and Curriculum and Instruction. The IPS Professional Learning Plan, which is research and data driven, will be employed to inform best practices for all teachers including residents throughout the school year.

In addition to student assessments, ISTR Resident Teachers will learn to use assessment of their own instruction to reflect upon and revise their instruction. For example, ISTR Resident Teachers will receive real time feedback from their CPTLs. Purdue University Supervisors, CPTLs, and ISTR Resident Teachers will individually complete and collaboratively discuss results from at least two administrations of the Candidate Preservice Assessment of Student Teaching (CPAST) evaluation during the residency period. Evaluation feedback and data from these assessments will be used to drive instructional outcomes.

Alignment with State Academic Standards Under Section 1111(B)(1) Of The ESEA

As the LEA for this partnership secures funding for many schools within the district through Title 1 funds, The ISTR Program was developed with consideration and alignment to Indiana State Academic Standards under section 1111(b)(1) of the ESEA. IPS and Purdue will work closely with the ISTR Resident Teachers ensuring their understanding of state level assessments. Furthermore, all field-based academic assignments in the Purdue MSEd, K-12 Integrated STEM Education Graduate Degree Certificate, and computer science coursework will require Resident Teacher to align their instructional materials and practices with the Indiana Academic Standards.

Alignment with State Early Learning Standards for ECE Programs, as Appropriate, and with the Relevant Domains of Early Childhood Development

The ISTR Program does not focus on early childhood education.

Preparation of General Education Teachers to Teach Students with Disabilities, Including Training Related to Participation as a Member of Individualized Education Program Teams, as Defined in Section 614(D)(1)(B) of the IDEA

IPS will expand its "school of special education" that supports preservice and novice teachers to include residents in preparing for teaching in IPS schools. This includes a series of seminars executed by IPS special education leadership team, as well as adaptation of STEM curriculum to include SPED focus. Effective accommodations, social emotional learning practices, multi-systems of support, and UDL instructional approach within STEM fields. In Purdue University College of Education teacher preparation programs, all teacher candidates receive Individualized Education Program training and are evaluated according to measures on the CPAST.

Preparation of General Education and Special Education Teachers to Teach Students Who are Limited English Proficient

IPS-ELL team will co-facilitate a series of professional development seminars on sheltered instruction so that ISTR Resident Teachers are equipped to ensure English learners will be able to succeed in their learning plan. The IPS District ELL team has a secondary learning coach who can directly support ISTR Resident Teachers and provide one-to-one coaching to ensure their daily instruction includes accommodations in individualized learning plans, problems of practice, and effective instruction students. In Purdue University College of Education teacher preparation programs, all teacher candidates receive training teaching students who are limited English proficient. Teacher candidates evaluated according to measures on the CPAST.

ISTR RECRUITMENT AND IMPLEMENTATION

Immediately upon notification of funding, The IPS-PU partners will convene to launch the ISTR Program and recruitment efforts. Each spring semester for 4 years, a new cohort of ISTR Resident

Teachers will be welcomed into the program. *The ISTR Project timeline is included in Appendix G after the Logic Model.*

Multi-Level Recruitment and Marketing Approach

The IPS-PU partners will coordinate a suite of recruitment efforts to attract talented, high-achieving professionals to become secondary STEM teachers, particularly professionals from culturally, linguistically, and socioeconomically diverse backgrounds as well as those with disabilities. Part of this plan will leverage successful strategies and resources from previous STEM teacher education recruitment initiatives at IPS and Purdue as well as new recruitment resources.

Purdue Recruitment– As a national leader in educating students in the STEM disciplines, Purdue offers excellent access to highly talented STEM students who may be interested after graduating with a STEM degree in becoming teachers in a STEM discipline and learning to implement integrated STEM instruction. To promote the ISTR Program through Purdue resources, Purdue and IPS partners will offer informational sessions each semester. To ensure that we reach as diverse a population of prospective applicants as possible, the Purdue Partners will hold recruitment and information sessions at Purdue's Cultural and Resource Centers including but not limited to the Black Cultural Center, Latino Cultural Center, the LGBTQ Center, and Native American Educational and Cultural Center. Additionally, partnering with the STEM advisors on campus will have a multiplier effect—advisors meet with students each semester and will be able to promote and recommend the ISTR Program to students who are interested in becoming a STEM teacher post-baccalaureate. Purdue recruitment also will include use of social media outlets to reach Purdue's vast alumni network (e.g., Twitter, Instagram, Facebook, YouTube, website).

Regional Recruitment Outreach– Regional recruitment outreach efforts will focus within 150 miles of greater Indianapolis, rather than having a broad and shallow national approach. This

structure is critical as most teachers within IPS typically do not apply if they live more than 150 miles away. The strategic direction is aimed at recruiting new teachers, particularly early education career individuals. The ideal candidate for the ISTR Program is a recent graduate who holds a bachelor's degree in a STEM-related field.

ISTR Selection Processes

The partnership will employ a selection process to ensure that the most qualified applicants are selected based on academic merit, with consideration given to increasing the participation of culturally and linguistically diverse applicants, persons with disabilities, and underrepresented genders relative to specific teaching areas.

Selection of Residents— To be eligible for the ISTR Program, candidates must be admitted to the Purdue University online Master of Science in Education degree program with the intention of completing not only an online Master's degree with a STEM focus, but also the K-12 Integrated STEM Education Graduate Degree Certificate. Recent baccalaureates should have achieved a minimum GPA of 2.8/4.0 during their degree program. Mid-career professionals should possess strong content knowledge or a record of professional accomplishment. The application for the ISTR Program is an online application that will include a statement of teaching interests and goals; demonstration of academic excellence (e.g., academic transcript); two letters of recommendation; a statement of commitment to participating in all ISTR Program residency, mentoring, and induction activities and to teaching a minimum of three years in a STEM discipline in a secondary IPS school. Applications will be reviewed by a Recruitment Leadership Team of at least two representatives from each of the partners project staff and at least one Purdue STEM faculty from the disciplinary field of the candidate's interest. Recipients will be selected based on strength of academic record, statement of teaching interests and goals, and letters of recommendation. The

partnership will seek a balance of content disciplines and diversity including ethnic, linguistic, gender, and socioeconomic background.

Selection of CPTLs: IPS identifies opportunities for CPTL positions based on the needs within schools across the District. IPS teachers are eligible to apply to be an IPS CPTL on a rolling basis, however IPS central services will typically identify and assign CPTLs in the end of the spring semester prior to the upcoming fall semester. IPS central services staff will also specifically coordinate with school leadership including the principals at the targeted secondary schools to help encourage strong applicants to apply to serve as CPTLs. The IPS human resource department will manage the application and interview process for all potential CPTLs. IPS has the following expectations for the qualifications of a CPTL: (a) have an overall evaluation within IPS rated as an effective or highly effective educator, (b) have at least three years of teaching experience, (c) demonstrate excellent communication skills, (d) be an enthusiastic member of the IPS community, and (e) have the capacity and demeanor necessary to mentor adults.

Selection of Mentor Teachers— IPS New Teacher Mentors **(“**Mentors Teachers”) will play a vital role in shaping the experience for ISTR Induction Level Teachers beginning their careers in IPS. Mentor Teachers will connect with the ISTR Induction Level Teachers at the onset of their first induction year—that is, once ISTR Teachers have received their teaching license, have been hired by IPS as a secondary teacher in a STEM discipline, and transition from being an ISTR Resident Teacher to an ISTR Induction Level Teacher. IPS’s human resource department will manage the application and interview process for all potential Mentor Teachers. IPS’s expectations for the qualifications of Mentor Teacher include: (a) valid Indiana Professional Educator License, (b) three years of teaching experience, (c) three years of ratings of at least

"Effective" on IPS Teacher Evaluation System, and (d) agree to participate in IPS New Teacher Mentor Training in person.

Mentor Teachers will be responsible for helping ISTR Induction Level Teachers navigate their role as a new induction level teacher. Mentor Teachers are also responsible for cultivating constructive dialogues with ISTR Induction Level Teachers about their performance, while being a supportive and approachable figure with whom the teachers can discuss their experiences, triumphs and challenges in the IPS classroom. Mentors Teachers will support ISTR Induction Level Teachers' classroom management and instructional skill development, coaching and providing feedback on their practices. The ideal Mentor Teacher is an experienced IPS teacher who has demonstrated mastery of highly effective instructional practices and understands the skills necessary for IPS teachers to succeed. Mentor Teachers must also have a demonstrated passion for professional learning and willingness to share their expertise with novice teachers. Additional information about the Mentor Teacher Roles and Responsibilities may be found in Appendix H.

High Need School Selection—IPS has identified an exponential need across secondary schools for STEM related teachers. Three schools—Arsenal Tech High School, Longfellow Middle School and George Washington High School—have been selected as the initial schools in which the ISTR Program's Teacher Residency will be launched. These three schools were selected for a variety of reasons including their qualifications as high need schools, current teaching staff vacancies, their ability and capacity to provide a CPTL. For example, all three schools selected for the ISTR Program exceed the free and reduced lunch rates for qualifying as high need schools (Table 5). Special preference was considered in the initial school host selection for schools that reside within the opportunity zone designation, and will contribute to decisions to expand to other

high need schools that fit within an opportunity zone. Arsenal Technical High School currently resides within the opportunity zone designation.

Table 5: *Selected IPS Schools: Free and Reduced Lunch Rates*

	Arsenal Technical H.S.	George Washington H.S.	Henry W. Longfellow M.S.	IPS
Free/Reduced Lunch Rate	68.9%	58.3%	72.1%	64.8%

BUILDING CAPACITY AND YIELDING RESULTS BEYOND PROJECT PERIOD

Excellent teacher leaders create a positive multiplier effect in teaching and student learning outcomes. Excellent teachers make approximately three times the progress of others. Students with excellent teachers make well over a year of progress each year. IPS is the first district in the State of Indiana to develop an Opportunity Culture. An Opportunity Culture model leverages the impact of excellent teachers and their teams by reaching more students, compensating excellent teachers more, and designing an innovative teacher leadership model. Investing in excellent teachers transforms schools, creates empowered teams of educators and positively impacts teaching and student learning outcomes in the City of Indianapolis.

The funding utilized within this grant will allow IPS to help close the immense talent gap facing classroom leadership within the largest school District in Indiana. The funding will provide a catalyst for addressing gaps through the ISTR Program. Once the ISTR Resident Teachers have completed the program and remain within IPS district for three additional years (per their minimum requirements), IPS will be able to decrease the vacancies in critical STEM related classrooms. Thus, the volume of teachers that IPS will need to enroll in this program will be significantly less. IPS will utilize their Opportunity Culture strategy to still sustain the program, but on a smaller scale, as the vacancies will be fewer.

Beyond the project period, Purdue University College of Education will continue to foster their partnership with IPS to sustain and expand the teacher residency model. Purdue undergraduate and graduate preservice teachers pursing Indiana State Licensure will have the opportunity to be placed in IPS schools for a full year residency during their teacher preparation program. Graduate level STEM prospective teachers will be encouraged to complete the online MSEd program, Integrated STEM Graduate Degree Certificate, and induction program as in the ISTR teacher residency model.

ADEQUACY OF RESOURCES: FUNDS FROM RELATED SOURCES, FACILITIES, EQUIPMENT, SUPPLIES

In this section, the adequacy of resources including of funds from related sources, facilities, equipment, supplies and other related sources are described.

Integration of Funds from Related Sources

The Purdue University COE Associate Dean for Research and Faculty Development and Purdue University Office of Sponsored Program Services (SPS) provide support and guidance concerning financial and operational matters for grants, including but not limited to assisting with ongoing monitoring of expenditures. Currently, the College of Education manages approximately $8.8 million in annual external funding and awards, with over 50 funded research projects or initiatives, many of which have a STEM focus. Awards include major federal research projects funded by for example, the National Science Foundation, Institute of Education Sciences, National Institute of Health, as well as state, foundation, and corporate awards and contracts. Additionally, Purdue and IPS are undergoing education reform initiatives that will inform the curriculum and instruction of the proposed project (see p. 6).

Facilities, Equipment, Supplies and Other Related Sources

Purdue University

Purdue University is a leading land-grant and research-extensive university located in the State of Indiana. Founded in 1869 and named after benefactor John Purdue, the institution is a comprehensive research university with a strong reputation for excellence in science, technology, engineering, and agriculture. Purdue ranks 18th among the nation's public universities and 56th among all universities in the U.S. according to the most recent *U.S. News & World Report* rankings. The university enrolls nearly 75,000 students across all campuses with nearly 40,000 on the West Lafayette campus alone. The West Lafayette campus offers more than 200 majors for undergraduates, over 70 master's and doctoral programs, and professional degrees in pharmacy and veterinary medicine.

Purdue plays a leadership role in education in Indiana through a variety of engagement efforts with K-12 schools. For example, Purdue is the managing partner of the Indiana STEM (Science, Technology, Engineering, and Mathematics) Resource Network, a statewide partnership of public and private higher education institutions, K-12 schools, business, and government. I-STEM supports K-12 teachers and school leaders working to implement high academic standards towards STEM literacy for all students through professional development and resources for teaching. Purdue's College of Science K-12 Outreach Programs work with pre-college students and teachers to increase interest and achievement in science and mathematics. This program offers professional development for teachers and student programs such as Physics on the Road that demonstrate scientific and mathematic principles in fun and exciting ways. Purdue administers Indiana's Project Lead the Way program, a pre- engineering/engineering technology program for high school students. Project Lead the Way is offered in more than 3,000 schools nationwide, and, with 300 Indiana schools participating, Indiana boasts the highest number of schools enrolled. In

addition to these efforts, Purdue's College of Education prepares teachers who will play a critical role in educating Indiana's youth.

College of Education. Purdue University's College of Education evolved from a department of education that was originally created in 1908; the unit became a school in 1989 and a college in 2005. It is accredited by the National Council for Accreditation of Teacher Education (NCATE) and the Indiana Professional Standards Board and ranks in the top 50 colleges of education according to *U.S. News & World Report*. The College of Education serves as the leader of teacher preparation activities on Purdue's West Lafayette campus, providing pedagogical course work and field experience supervision for secondary teacher preparation programs offered in collaboration with the Colleges of Agriculture, Consumer and Family Sciences, Liberal Arts, Science, and Technology. More than 1,600 students are enrolled in undergraduate teacher preparation programs and more than 200 students are enrolled in graduate teacher preparation programs on the West Lafayette campus.

In addition to its impact on schools and student learning through teacher preparation, the College of Education is home to various initiatives that affect students and teachers including: the Center for Advancing the Teaching and Learning of STEM (CATALYST), which is a joint effort of the Colleges of Education and Science, focuses on improving STEM education for students from preschool to college; the Gifted Education Resource Institute (GERI); and the Ackerman Center for Democratic Citizenship. Together, these various initiatives have made significant contributions to student and teacher development throughout Indiana.

College of Science. For more than 100 years, College of Science has been a vital part of Purdue University. Founded by Stanley Coulter in 1907, the College has helped foster some of history's greatest minds within its seven departments. All undergraduate secondary science and

mathematics teacher candidates at Purdue earn bachelor's degrees in their content disciplines and enroll in the College of Science. The secondary science and mathematics teacher education programs at Purdue University prepare science and math teachers to work with students in grades 5-12. The teacher education certification program is under the auspices of the Purdue University Teacher Education Council. All secondary science and mathematics education program faculty have joint appointments between one science/mathematics department in the College of Science and the Department of Curriculum and Instruction in the College of Education. The secondary science and mathematics education programs are committed to preparing science educators for the 21st Century who value life-long learning, have a strong science content background, utilize the latest research-based science education teaching methods to enhance student learning, and who value positive equity and diversity perspectives.

All partners and participants in this project will have access as needed to large classrooms and office buildings located in the central part of Purdue's main campus in West Lafayette. Spaces available to ISTR partners and participants include faculty and graduate student offices, dedicated classrooms and computer laboratories, a multi-purpose rooms that support both students and faculty, and facilities for centers and laboratories.

In addition, the College of Education Technology Resources Center (TRC) houses a variety of information resources and teaching/learning technologies for both students and faculty members. The facility includes a library of books and other materials and serves as State of Indiana textbook adoption review site. The TRC provides equipment checkout (laptops, LCD projectors, still cameras, video cameras, etc.) to students and faculty members. In addition, it houses an on-site 22-station computer laboratory for access to electronic resources.

In addition to the resources listed above, project staff and participants will have dedicated space equipped with secure data storage facilities, the requisite computational facilities (hardware and software) including desktops, laptops, and SPSS and SAS computational packages. Furthermore, Purdue Instructional Technology has a dedicated Academic Site Specialist for each department to assist with the higher-level research/teaching/learning needs specific to their respective department.

Assessment That Describes the Intended Use of Grant Funds

The ISTR project budget was developed with support of the Office of Sponsored Program Services (SPS) and business offices from both the Purdue College of Education and IPS to ascertain that costs were both appropriate and adequate for project completion. The budget allows for sufficient mentorship of resident teachers, as well as adequate administrative efforts for monitoring activities and advice from external experts for evaluation.

As demonstrated in the cost match, IPS intends to hire the teachers who will be trained within the TQP teacher residency program when they complete their coursework. Likewise, Purdue University will continue with preservice teacher preparation using models like the one developed in the proposed project.

MANAGEMENT PLAN

Adequacy of Management Plan to Achieve Objectives On-Time/Within Budget, Including Clearly Defined Responsibilities, Timelines, and Milestones for Accomplishing Tasks

This Teacher Quality Partnership Program is spearheaded primarily by two organizations, Purdue University and Indianapolis Public Schools (IPS). This partnership will also leverage support of other community partners and align with state and national guidelines to achieve improved student outcomes and increasing the number of high-quality teachers within IPS. The ISTR will leverage

leadership teams from both organizations to ensure successful development and implementation of this program. Purdue will serve as the PI, receive and manage the funds for the partnership. Specifically, the Center for Advancing the Teaching and Learning of STEM (CATALYST) will take the lead in managing and administering the ISTR Program. CATALYST is a joint effort of the College of Education and College of Science at Purdue University whose mission is to meet the regional, national, and global challenges of the 21st century in STEM education. CATALYST is an interdisciplinary research-oriented unit focused on building and supporting a community of educational professionals who are dedicated to advancing K-12 STEM (science, technology, engineering, and mathematics) teaching and learning through research.

The ISTR Project Organizational Chart, which articulates the basic structure of the ISTR leadership team may be found in **Appendix J.** Key personnel in the IPS-PU partnership for the ISTR Program, their roles, and their responsibilities are elaborated in the next section.

Key Personnel

***Dr. Lynn Bryan | ISTR Program Director, Purdue University*:** Dr. Bryan is the Director of the Center for Advancing the Teaching and Learning of STEM (CATALYST) and a jointly-appointed Full Professor in the Department of Curriculum and Instruction and Department of Physics and Astronomy. She has extensive experience in overseeing and coordinating more than $10 million in externally funded projects. Dr. Bryan is a former chemist (Eli Lilly) and Indiana high school physics teacher, who since then has devoted her career to working with K-12 science teachers to bring contemporary practices and leading-edge science content into pre-college classrooms. Her research focuses on science teacher education, particularly teachers' development and enhancement of knowledge and skills for teaching science through the integration of STEM disciplines and teaching science through modeling-based inquiry approaches. In 2015, Professor

Bryan was named one of Purdue University's Distinguished Women Scholars. She is a past-president of NARST: A Worldwide Organization for Improving Science Teaching and Learning through Research and former co-editor of the *Journal of Science Teacher Education*.

Dr. Siddika (Selcen) Guzey | ISTR Program Co-Director, Purdue University: Dr. Guzey is a jointly-appointed Associate Professor in the Department of Curriculum and Instruction and Department of Biology Purdue University. She is also an Affiliated Faculty of the School of Engineering Education. Dr. Guzey serves as the Associate Director of Research Initiatives for CATALYST. She is a former high school biology teacher. Dr. Guzey been awarded more than $10 million in external research funding. Her research expertise is in integrated STEM education and engineering/ technology integration in K-12 biology teaching and learning. Dr. Guzey is the faculty lead for the induction and mentoring component of Purdue's COE teacher education reform initiative.

Dr. William S. Walker | ISTR Project Manager, Purdue University: Dr. Walker is the Assistant Director of Program and Partnership for CATALYST. He is a former Indiana high school mathematics teacher and holds Ph.D. in Mathematics Education from Purdue University. For 13 years was the Director of Purdue Science K-12 Outreach where he led professional development programs for K-12 teachers on research-based practices in mathematics and STEM. Through this work he has negotiated challenges that teachers face when creating integrated STEM lessons using discipline-based content, especially focused on K-12 academic standards. He worked with a team to publish a framework to develop integrated STEM curriculum and enact integrated STEM pedagogy. He also worked closely with the Indiana Department of Education and other stakeholder groups to develop strategic plans for science education and mathematics education in Indiana. Dr. Walker recently transitioned to CATALYST from serving as the Associate Director of Indiana

GEAR-UP. During three years with Indiana GEAR-UP he developed and facilitated 75 professional development workshops with 21 school partners for 890 teachers resulting in 4,861 continuing education hours. He has extensive experience designing and delivering professional development for K-12 schools, advises the K-12 mathematics education and integrated STEM education projects, and conducts research for CATALYST.

MSEd and Integrated STEM Graduate Degree Certificate Faculty Instructors | Purdue: CATALYST recently built the infrastructure to develop and sustain the Integrated STEM Education Degree Certificate program through a "cluster hire" of six new faculty members. This cluster hire builds on and leverages the current strengths of faculty, contributing to the budding "esprit de corps" around K-12 Integrated STEM teacher education. A hallmark of Purdue's teacher education programs in the STEM disciplines is the productive, synergistic joint appointments of faculty in the Colleges of Education, Science, Technology, Engineering, and Agriculture. Our integrated STEM faculty will provide ISTR Resident Teachers with access to a unique depth of expertise in specific STEM disciplines and integration across disciplines, including the discipline of education. K-12 Integrated STEM Teacher Education faculty will work directly with ISTR Resident Teachers course instructors and university supervisors.

Katie Knutson | Teacher Preparation Coordinator, IPS: : *A former high school teacher within IPS, Katie* is now a teacher preparation coordinator supporting the CPTL's and mentor teachers. She is responsible for leading partnerships with higher education and teacher preparation programs to help establish premier student teaching and residency programs. Analyze human capital data and stakeholder data to inform decisions based around student teaching and residency programs. Serve as primary contact between IPS and external stakeholders; including consultants, area non-

profits, funders, national partners, and teacher prep programs. Maintain program data related to cohort diversity, matriculation, effectiveness, and retention.

To be hired | Senior Clinical Prep Teacher Leader, IPS: This position will help provide the day-to-day leadership necessary to ensure implementation of the teacher residency across the district is being conducted in fidelity by managing and supporting the CPTL's within ISTR ***Mindy Schlegel | Human Resource Officer, IPS,*** leads talent strategy, change management, and operations for IPS. She led the development of a new compensation model and the design and rollout of new performance management system and career path development of over 200 teacher leader roles. She initiated and is currently implementing a talent long-term strategic plan. Mindy brings extensive and robust education leadership experience to the IPS team. She has earned a Master of Education; Administration and Social Policy from Harvard University, as well of a Bachelor of Science in Psychology from the University of Illinois.

Alex Moseman | Senior Coordinator of Talent Acquisition, IPS; is a leader in talent recruitment and retention efforts. HE regularly works closely with colleges and universities to establish a pipeline of potential teachers for IPS. As such, Alex will provide critical support and feedback in the development and selection of the ISTR candidates. Alex holds a master's in teaching from Marian University, and a Bachelor of Arts in Political Science from Wabash College.

April Tramil | Teacher Development & Mentorship, Teacher on Special Assignment, IPS: April has been teaching in Indianapolis for the last ten years, and has recently stepped into a new role within IPS to help support new teacher induction, and will play a critical role in supporting the teachers in residency as they move towards the induction phase of the program. April holds an MBA in Educational Leadership from the University of Indianapolis and was a Woodrow Wilson

MBAE Fellowship as well as earning her Bachelor of Science degree in Elementary Education from Indiana University.

IPS- LEA Partnership Responsibilities and Commitments

As the high need LEA, IPS will leverage staffing at the District level as well as at the identified high need schools to best support the STEM Teacher Residency Program. IPS has identified several critical staff to help support the development and implementation of this residency program. To launch the program, IPS will leverage support from the IPS Human Resource Officer, Senior Clinical Prep Teacher Leader, Executive Director of Professional Learning, Senior Coordinator of Talent Acquisition, and Teacher Development & Mentorship, Teacher on Special Assignment. Each leader will play a critical role in the design, scope and sequence, and implementation of the residency and induction process.

Within IPS, this teacher residency program will be led by Katie Knutson a Teacher Preparation Coordinator (TPC) for the District. She will serve as the point of contact for Purdue, and will oversee a new hire, a Senior Clinical Prep Teacher Leader (CPTL). The TPC provides oversight at the IPS District level for implementation, and the Senior CPTL liaise directly with Principals and ISTR Resident Teachers.

As the high need LEA, IPS will leverage staffing at the District level as well as at the identified high need schools to best support the STEM Teacher Residency Program. To do so, the leader of this program for implementation within IPS will be Katie Knuteson, a Teacher Preparation Coordinator for the IPS District. She will work directly with a Senior CPTL who will help coordinate with school principals and mentor teachers.

In the fall, IPS will identify teachers within each school to help serve as mentors and Clinical Prep Teacher Leaders (CPTL) to launch the ISTR program. Within the three schools

targeted for housing teachers in residence for year one, six teachers have been identified to serve as a CPTL, and each CPTL will support at least two residents. In year two, IPS will begin to identify Mentor Teachers to support the program participants during their induction phase.

How partnership will support in-service PD strategies and activities

IPS has established a professional development plan for CPTLs across the IPS District that is delivered in fall and spring semester each year as outlined in the table below.

Semester	Training Strategy
Fall	**Orientation** (in person)**:** review requirements of the position, expectations of the position and goal setting.
	Professional Development Session #1 (in-person): collaborative teaching through a gradual release model and the co-teaching do's and don'ts, followed by asset-based mentoring.
	Professional Development Session #2 (online): IPS Student teaching evaluation webinar.
Spring	**Orientation** (Online): review expectations for student teachers and CPTL's as well as the IPS online teaching evaluation instructions.
	Professional Development Session #1 (online): Providing effective adult feedback and how to effectively collaborate with a student teacher.
	*CPTL's will submit three online student teacher evaluations via online google form throughout the semester.
Optional	Teacher Leader Development Series: CPTL's and Mentor Teachers will be able to attend three sessions in IPS' development series aimed to improve the leadership skills in the teacher leaders in the District. Special guests have included the District's Superintendent.

ISTR GOALS, OBJECTIVES, AND OUTCOMES

Through the development and implementation of The ISTR Teacher Residency Model, the partnership seeks to increase student achievement within IPS schools by developing and supporting teachers who meet applicable state certifications focusing on STEM, with a particular emphasis on computer science. The IPS and Purdue partnership has established three goals within this residency. The first goal focuses on supporting teachers within the residency, the second focuses on academic improvement for students, and the third is highlighting the sustainability of the program itself.

GOAL 1: Increase the number of high-quality teachers that are well prepared to teach in a secondary level, urban and STEM classroom.

To achieve this goal, the partnership has established the following objectives:

- *Objective 1:* Attract and recruit a diverse candidate pool reflecting the student population enrolled within IPS.
- *Objective 2:* Completion of a secondary STEM licensure program, online Master of Science in Education—STEM, and K-12 Integrated STEM Degree Certificate program through Purdue.
- *Objective 3:* Teacher performance growth during the residency through evaluation with input from both the school leadership and Purdue.
- *Objective 4:* Expansion of professional development opportunities to support teacher leaders with adult coaching and honing their classroom skills.

Through successful achievement of goal number one, the partnership seeks to see positive growth towards goal number two.

GOAL 2: Increase students' academic performance in secondary schools within IPS.

To achieve this goal, the partnership has established the following objectives:

- *Objective 1:* Increased growth in ILEARN in classrooms with residency teachers.
- *Objective 2:* Growth in NWEA scores among students in classrooms with residency teachers.

GOAL 3: Create sustainability through retention and program expansion.

To achieve this goal, the partnership has established the following objectives:

- *Objective 1:* Increase the ability to retain high quality teachers through this teacher residency model, by helping them establish critical skills through a comprehensive training program.
- *Objective 2:* Residency model will be sustained within IPS high need schools through an Opportunity Culture Model.
- *Objective 3:* Continue expansion of additional disciplines within the teacher residency model.

The continued sustainability of this program is critical to the long-lasting impact of this program. IPS and Purdue are invested to supporting this program beyond the life of the grant period. The funding provided through this grant opportunity would serve as a catalyst to develop the infrastructure for a teacher residency program that can be expanded into more of IPS' high need schools. After each year of the grant period, IPS will assess the vacancies and high need schools to best determine more host schools to facilitate and implement this process.

PROJECT EVALUATION

External evaluation to determine the overall effectiveness of the Indy STEM Teacher Residency (I-STAR) program on participating teachers, teacher-mentors, and impacted students will be conducted by the Evaluation and Learning Research Center (ELRC). The ELRC, a Center within Purdue University's College of Education, is a campus-wide asset focusing on effective education research and evaluation using evidence-based approaches. ELRC collaborates with faculty in all colleges across campus and external partners. ELRC professional staff provide expertise in educational research and theory; research and evaluation design and methodology (including WWC reviewer certified); front-end, formative, summative, and program evaluation; and evaluation frameworks.

ELRC staff are experienced in program (or external) evaluation that examines the effectiveness and efficiency of a program or project. Drawing on a portfolio of tools, ELRC staff work with partners to identify appropriate research and evaluation models (i.e., theory driven, outcomes or activity approaches) and develop logical research and evaluation frameworks that guide proposal development and project implementation. ELRC leads research and evaluation efforts for projects funded by a wide array of public and private organizations, including: National Science Foundation, National Institutes of Health, Centers for Disease Control, U.S. Department of Education, U.S. Department of Agriculture, USAID, U.S. Department of Health and Human Services, Lilly Endowment, Howard Hughes Medical Institute, Kresge Foundation, and the Lumina Foundation.

ELRC will work with the project leadership team to develop a holistic evaluation plan with both formative and summative components. Formative evaluation activities will examine the project's progress towards goals; identify process strengths, weaknesses, and quality of implementation; and make recommendations to enhance teamwork and drive continuous quality improvement. Summative evaluation activities will examine the degree to which the stated objectives are attained; examine contextual and implementation variables that impact outcomes; and identify project successes, challenges, and lessons learned.

The ELRC evaluation team will work with the management team to insure project implementation and evaluation are aligned; develop a comprehensive mixed-methods evaluation plan; meet monthly with the management team to provide feedback and ensure implementation fidelity; collect and analyze both qualitative and quantitative data; conduct periodic (annual) comprehensive reviews of program data, reports and related documents; conduct periodic interviews with key project staff; offer regular recommendations to the management team during

implementation of the program on management practice and other factors that might impact project efficacy and validity. The evaluation reports produced by the ELRC will provide a third-party, non-biased summary of project results, challenges and successes, and recommendations and will not be subject to the approval of the PI.

Evaluation Methods Providing Valid, Reliable Performance Data on Relevant Outcomes

ELRC will use a mixed-methods longitudinal study approach to examine project outcomes relative to teachers participating in the residency programs, the students they teach, the mentors that work with the residents, and the school district implementing this model. The study design will compare comparable non-participant teachers and their students (controls) to teachers participating in the residency program and their students (treatment). In this study, comparable non-participant teachers are new teachers, with similar levels of prior experience, hired at the same time within the IPS district in the same grades and subjects. These non-participants will represent the business as usual condition and will participate in standard on-boarding and professional development offered by IPS to new teachers, without the additional residency/mentorship activities that are part of this study. ELRC will utilize a quasi-experimental, pretest-posttest control group design to evaluate and compare between- and within group differences on key study variables. The study design will examine outcomes and impacts relative to both participant and non-participant teachers as well as differences in student achievement from participant and comparable non-participant classrooms. The treatment and control groups (both teacher and student level) will be balanced with respect to baseline characteristics by matching participants or students using propensity scores. These scores will be represented by the predicted values obtained by regressing group membership (0 = comparison, 1 = treatment) on selected baseline predictors (e.g., pre-survey results, socioeconomic status). The project team intends to recruit around 60

teacher participants (15 teachers per cohort), the evaluation team will recruit around 100 comparable non-participants (25 in each year). IPS hires around 400 new teachers every year. A larger sample of comparison group will increase the quality of propensity score matching results and increase the study's statistical power (i.e., enable a lower minimum detectable effect size), making it easier to detect a statistically significant effect of the intervention. Control group teachers will receive appropriate compensation for the time they commit to data collection activities. Students' achievement data will be analyzed at the end of the project when we have enough cumulative numbers of participants.

Project data will include quantitative and qualitative data collected from students, participant teachers, comparable non-participant teachers, Purdue faculty, teacher mentors, clinical prep teacher leaders, and the project team. Data collection methods include: surveys, interviews/focus groups, standardized assessments, classroom observations, course documents, course evaluations, online course usage and other approaches as needed. The evaluation data collection table below describes the research/evaluation questions, data collection procedures, data analysis methods and measurable outcomes to address project objectives.

Surveys and interview protocols will be prepared based on the specifics of the project activities. Periodic (biannual) interviews with participants, mentors, teacher leaders, professors, will include topics such as satisfaction with the program, types of supports provided, feelings of efficacy, major successes and challenges, and etc. ELRC will work with the project team to develop/adapt appropriate teacher participant surveys, mentor teacher survey, teacher-leader reflection survey, and classroom observation rubrics. The pre-participation survey will include teacher candidates' backgrounds, teacher candidate's program expectations, teaching efficacy and career intentions; periodic (biannual) post-participation surveys will include program evaluation

questions, teaching efficacy and career intentions. Pre-participation survey will be administrated when teacher candidates are recruited. Post-participation survey will be collected from teacher candidates every 6 months. Baseline surveys for comparable non-participants will be collected at the time when they are recruited; other survey and interview data for comparable non-participants will be collected at the same time, and in the same format as participants.

Teacher quality of instruction will be assessed by Charlotte Danielson's Framework for Teaching (FFT). The Framework for Teaching provides a common language for instructional practice, as well as a philosophical approach to understanding and promoting great teaching and learning. IPS use this assessment currently with all novice teachers. Student math and science achievement will be assessed by ILEARN and MAP (Measures of Academic Progress). ILEARN measures student achievement and growth according to Indiana Academic Standards INDOE, 2016). MAP is an online assessments that is aligned to the Common Core Standards developed by NWEA. Students' previous year's math and science achievement will be used as a baseline. Students' demographic data (gender, ethnicity, free/reduced lunch, and etc.), baseline and achievement data will be collected through the IPS data system as well.

Standard quantitative analysis methods, e.g., frequencies, percentages, t-tests, factor analysis, will be used for surveys. Thematic coding methods will be used for content analysis of interviews/focus groups and open-ended survey questions; Qualitative Content Analysis (QCA) will be used to conduct systematic comparative analyses to compare participants vs. comparable non-participants (Schreier, 2012). Rubrics will be used to evaluate instructional materials and other products. The random effects model allowing correlations between observations listed below will be used to model the longitudinal repeated measures process for teachers:

$$\text{Outcome}_{ti} = \alpha_0 + \beta_1 X_{ti} + \beta_2 Z_i + \beta_3 (\text{Group})_i + u_i + \varepsilon_{ti}$$

An individual i's responses at time t, Outcome t_i, will be a function of time, time varying covariates, time-constant characteristics, and an unobserved individual effect; β_3 captures covariate-adjusted treatment/control differences in the outcome variable. u_i is a residual having certain properties: independence between individuals, normal distribution with constant variance, and also exogenous to X's and Z's.

The evaluation will use a two-level Hierarchical Linear Model (HLM) to estimate program impacts on student achievements. HLM takes into account the nested structure of the data—students nested within classrooms—to estimate program effects and can incorporate relevant variables from the different levels to examine potential moderators in light of evaluation questions. Impacts of the I-STAR program (aggregating multiple cohorts) will be estimated by comparing outcomes for students who were assigned to the treatment and control groups. To increase the precision of the estimates, a set of students' characteristics (e.g., free/reduced lunch status, baseline achievement, and ethnicity) will be included in the model as covariates. The project team will provide ELRC access the participants and project data as needed, maintain participation and records, document all project activities, assist with data collection activities, and help recruit comparable non-participants. ELRC will prepare data collection instruments and procedures. ELRC will analyze data on an ongoing and timely basis and share formative results during monthly management team meetings. ELRC will also prepare annual evaluation reports, along with periodic reports based on specific data collection efforts. Both formative and summative evaluations utilizing objective performance measures will be used to triangulate data on the intended project outcomes.

ELRC evaluators will monitor fidelity of implementation through periodic site visits and classroom observations. Evaluation staff will conduct the site visits to ensure that the study is

carried out as intended. This will involve checking on progress, ensuring that participants are accepting program assistance as intended, making sure there is no cross-contamination with control teachers/students, and assisting participants who have questions concerning the study.

Extent to Which Methods of Evaluation are Thorough, Feasible, and Appropriate to Goals, Objectives, and Outcomes of the Project

Please see Table 6 below.

Table 6: Evaluation Data Collection

Goal 1: Increase the number of high-quality teachers that are well prepared to teach in a secondary level, urban, STEM classroom.			
Research/Evaluation Questions	Data Collection	Data Analysis	Measurable Outcomes
Objective 1: Attract and recruit a diverse candidate pool to reflect the population enrolled within IPS			
How many teacher candidates are recruited?	Recruitment activities	-#of activities conducted -#of follow up communications -Correlations between recruitment activities and # of enrolled candidates	Yr1: Enroll 15 teachers in residence Yr2: Enroll 15 teachers in residence Yr3: Enroll 15 teachers in residence Yr4: Enroll 15 teachers in residence
How are teacher candidates selected? Are recruitment strategies effective in attracting a diverse candidate pool?	-Program enrollment data -pre-participation survey (teacher background, teaching efficacy, teacher career intentions)	- # applications received -# of person selected -Frequencies and percentages of teacher candidates' background and career intentions	A diverse range of prospective teachers are selected each year.
What are the effective strategies in recruiting and selecting candidates?	-Interview with project team and teacher candidates	Content analysis of interview	Recruitment strategies, challenges, lessons learned are shared periodically to enhance teamwork and drive continuous improvement
Objective 2: Candidates complete the license program, online masters, and STEM certificate program through Purdue			
Do teacher candidates' skills in teaching STEM improve as a result of participating the program?	-Participants' course performance data including course grades, course documents, online course usages and etc. -Classroom observations	-Frequencies and percentages -content analysis of course documents -Observation data will be analyzed under rubrics	Participants meet program's course requirements.
How does program participation effect teacher candidates' STEM teaching practices? What types of support do teacher candidates need to improve their teaching and self-efficacy?	-Participation survey (program evaluation, teaching efficacy and career intention) -Focus groups with participants -Interviews with faculty and teacher candidates	-Multiple time points survey analysis: Repeated Measures ANOVA -Content analysis of interview or focus group transcripts.	Program effects on participants and professors are reported periodically to identify progress, process strengths and weakness, and make recommendations to drive continuous quality improvement. (Surveys and interviews every 6 months)
How many teacher candidates complete STEM licensure or a master's degree?	Certification data	-# of teacher candidates attaining State of Indiana license for teaching in at least on secondary STEM field -# of teacher candidates completing of the Purdue University Master of Science in Education – STEM focus	85% of teachers will meet the applicable State Certification and licensure requirements.

		-# of teacher candidates completing of the Purdue University Graduate Degree Certificate in K-12 integrated STEM Education	
Objective 3: Teachers exhibit performance growth during the residency			
How does participation in the residency program impact teacher performance and professional growth?	-Observe new teachers' growth on the Charlotte Danielson's Framework for Teaching (FFT) assessment -Compare the progress of new teachers completing the program to comparable non-participants using performance on Charlotte Danielson's Framework for Teaching (FFT) assessment	-longitudinal data analysis -Quasi-experimental design: The treatment and control groups will be balanced with respect to baseline characteristics by matching teachers using propensity scores. Random effects model will be used to estimate growth difference in FFT between participating teachers vs. comparable non-participating teachers	Participants improve their performance on FFT assessments across years. Program participants exhibit better performance on FFT assessments than their comparable non-participants.
What are the effects of the residency program on teachers' STEM teaching practice, confidence, and readiness?	-Participation survey (program evaluation, teaching efficacy and career intention) to both participants and comparable non-participants -classroom observations -interview with participants and comparable non-participants -survey and interview with mentors, CPTLs	- Multiple time points survey analysis: Repeated Measures ANOVA, t-tests -Content analysis of interviews -Qualitative Content Analysis (QCA) be used to conduct systematic comparative analyses to compare participants vs. comparable non-participants' interview data -Classroom observations will be analyzed under rubrics	Periodic surveys, classroom observations and interviews with all parties identify progress in residency, process strengths and weakness, and make recommendations to enhance teamwork and drive continuous quality improvement. (Surveys and interviews every 6 months.)
Objective 4: Teacher leaders gain knowledge and experience with adult coaching and classroom skills			
What are the effects of the residency program on teacher leaders?	-Surveys -interviews with teacher leaders	-content analysis of interviews	Periodic surveys and interviews can identify efficacy for mentoring, impact on practice, challenges and lessons learned to enhance teamwork and drive continuous quality improvement (surveys and interviews every 6 months).
Goal 2. Increase academic performance in secondary schools within IPS.			
Research/Evaluation Questions	Data Collection	Data Analysis	Measurable Outcomes
Objective 1&2: Students exhibit increased growth on state and national standardized tests in classrooms with residency teachers compared to controls			

Do students in classrooms with better trained and supported teachers outperform their peers in non-participant teacher classrooms on standardized math and science exams?	-students' demographics data -students' previous year's math achievements on ILEARN and MAP assessments developed by NWEA as baseline -students' current performance data on math and science achievement on ILEARN and NWEA assessments	Quasi-experimental design: The treatment and control groups will be balanced with respect to baseline characteristics by matching students using propensity scores. HLM models will be used to estimate students' achievement growth difference between participants' classrooms vs. comparable non-participants' classrooms.	Students in participants classrooms have better math and science achievement on ILEARN and NWEA assessments than students in comparable non-participants' classrooms. (Students' achievement data will be analyzed at the end of the project when we have enough cumulative numbers of participants.)
Goal 3. Create sustainability through retention and adaption.			
Research/Evaluation Questions	Data Collection	Data Analysis	Measurable Outcomes
Objective 1: Residency model will be sustained within IPS high need schools through an Opportunity Culture Model			
To what extent does the residency model help retain teachers in high need schools?	-Teachers' retention -Teachers' career intention surveys	-percentage of teachers retained, comparing with normal teachers' retention data -multiple time points survey analysis: Repeated Measures ANOVA	80% teacher retention in IPS; more teachers intend to stay in IPS across years.
What elements of the residency model are most important for teacher retention?	-Interview of teachers -Interview of mentors, teacher leaders -Interview of project team	content analysis of interviews	Periodic interviews identify progress in residency, process strengths and weakness, and make recommendations to enhance teamwork and drive continuous quality improvement. (Surveys every 6 months)
What strategies or procedures does IPS employ to ensure continuation of residency model beyond the funding period?	-Key stakeholder interviews -Document review	Content analysis of interviews and documents	Identify ways of continuation of residency model beyond funding period.
Objective 2: Expand teacher residency model to include additional disciplines			
To what extent does IPS extend the teacher residency to include other disciplines?	-Interview of project team	content analysis of interviews	Disciplines other than STEM are added to the residency model

*Note: "Comparable non-participants" refers to non-participating new teachers hired at the same time within the district in the same grades and subject

REFERENCES

Ares, N. (2011). Multidimensionality of cultural practices: Implications for culturally relevant science education. Cultural Studies of Science Education, 6, 381-388.

Berlin, D. F., & White, A. L. (1995). Using technology in assessing integrated science and mathematics learning. *Journal of Science Education and Technology, 4*(1), 47–56.

Berry, B., Montgomery, D., & Snyder, J. (2008). Urban teacher residency models and institutes of higher education: Implications for teacher preparation. *Center for Teaching Quality*.

Bryan, L. (2012). Science education research on teacher beliefs. In B. Fraser, K. Tobin, & C. McRobbie (Eds.), *International Handbook of Science Education (2nd Ed.),* pp. 477-498. Dordrecht: Springer

Bryan, L., Moore, T., Johnson, C., & Roehrig, G. (2015). Integrated STEM education. In C. Johnson, E. Peters-Burton, & T. Moore (Eds.), *STEM Road Map: A Framework for Implementing Integrated STEM Education*. New York: Routledge.

Childress, V., & Sanders, M. (2007). Core engineering concepts foundational for the study of technology in grades 6-12. Retrieved from http://conferences.illinoisstate.edu

Cobb, P. (1994). Where is the mind? Constructivist and sociocultural perspectives on mathematical development. *Educational Researcher, 23,* 13 - 20.

Cochran-Smith, M., & Lytle, M. (1999). Relationships of knowledge and practice: Teacher learning in communities. *Review of Research in Education*, *24*(1), 249-305.

Department of Commerce. (2018). U.S. Census Bureau quickfacts: Indianapolis city (balance), Indiana.https://www.census.gov/quickfacts/fact/table/indianapoliscitybalanceindiana

Dewey, J. (1933). *How we think: A restatement of the relation of reflective thinking to the educative process.* Boston: DC Heath.

DuFour, R. (2004). What is a" professional learning community"? *Educational Leadership*, *61*(8), 6-11.

Frykholm, J., & Glasson, G. (2005). Connecting science and mathematics instruction: Pedagogical context knowledge for teachers. *School Science and Mathematics, 105*(3), 127-141.

Guha, R ., Hyler, M.E., and Darling-Hammond, L. (2016). *The teacher residency: An innovative model for preparing teachers*. Palo Alto, CA: Learning Policy Institute.

Hidi, S., & Harackiewicz, J. M. (2000). Motivating the academically unmotivated: A critical issue for the 21st century. *Review of Educational Research*, 70(2), 151– 179.

Indiana Department of Education. (2016). *Indiana Academic Standards | IDOE*. Retrieved from www.doe.in.gov/standards.

Indiana Department of Education. (2019). INDOE: Compass—Indianapolis Public Schools. Retrieved from https://compass.doe.in.gov/dashboard/overview.aspx?type=corp&id=5385

Indiana Department of Workforce Development. (2019). Hoosiers by the Numbers. Retrieved from http://www.hoosierdata.in.gov/nav.asp?id=216

Katehi, L., Pearson, G., Feder, M. A., & Committee on K-12 Engineering Education. (2009).

Engineering in K-12 education: Understanding the status and improving the prospects. Washington, DC: National Academies Press.

Jeanpierre, B., Oberhauser, K., & Freeman, C. (2005). Characteristics of professional development that effect change in secondary science teachers' classroom practices. *Journal of Research in Science Teaching, 42,* 668-690.

Lave, J., & Wenger, E. (1991). Legitimate peripheral participation in communities of practice. In *Situated learning: Legitimate peripheral participation* (pp. 90-107). New York, NY: Cambridge University Press.

Leeuw, A., C. B., & Zimmer, T. (2017). *Indiana's STEM Pipeline.* (Rep.). Retrieved from http://www.incontext.indiana.edu/2014/july-aug/article2.asp

Lemke, J. (1997). Cognition, context, and learning: A social semiotic perspective. In D. Kirshner & J. Whitson (Eds.), *Situated cognition: Social, semiotic, and psychological perspectives*. Mahwah, NJ: Lawrence Erlbaum Associates.

Loucks-Horsley, S., Stiles, K. E., Mundry, S., Love, N., & Hewson, P. W. (2010). *Designing professional development for teachers of science and mathematics* (Third ed.). Thousand Oaks, CA: Corwin.

National Academy of Sciences. (2010). *Rising above the gathering storm, revisited: Rapidly approaching category 5.* Washington, DC: National Academies Press.

National Council of Teachers of Mathematics. (2014). *Principles to actions: Ensuring mathematical success for all*. Reston, VA: National Council of Teachers of Mathematics.

National Research Council. (2005). *How students learn: History, mathematics, and science in the classroom.* Committee on How People Learn, A Targeted Report for Teachers, M.S. Donovan and J.D. Bransford, Editors. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

National Research Council. (2011a). *Successful K-12 STEM education: Identifying effective approaches in science, technology, engineering, and mathematics.* Washington, DC: National Academies Press.

National Research Council. (2011b). *Successful STEM education: A workshop summary.* Washington, DC: National Academies Press.

National Research Council. (2014). *STEM integration in K-12 education: Status, prospects, and an agenda for research.* Washington, DC: National Academies Press.

National Science Board. (2006). *America's pressing challenge: A companion to Science and Engineering Indicators-2006*. Arlington, VA: National Science Foundation.

NGSS Lead States. (2013). *Next Generation Science Standards: For States, By State**s**.* Washington, DC: The National Academies Press.

President's Council of Advisors of Science and Technology (2010). *Prepare and inspire: K-12 education in science technology, engineering, and math (STEM) for America's future*. Retrieved from: http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-stemed-report.pdf

Rodriguez, A. (2015). What about a dimension of engagement, equity, and diversity practices? A critique of the next generation science standards. *Journal of Research in Science Teaching, 52,* 1031– 1051.

Sanders, M. (2009). STEM, STEM education, STEMmania. *The Technology Teacher.* Retrieved from: http://esdstem.pbworks.com/f/TTT+STEM+Article_1.pdf

Sanders, M., & Wells, J. (2010). *Integrative STEM education*. Retrieved from www.soe.vt.edu/istemed/index.html

Schön, D. A. (1987). *Education the reflective practitioner: Toward a new design for teaching and learning in the professions.* San Francisco: Jossey-Bass.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15,* 4-14.

Smith, T. M., & Ingersoll, R. M. (2004). What are the effects of induction and mentoring on beginning teacher turnover? *American Educational Research Journal*, *41*(3), 681-714.

State Education Resource Center. (2016). Six approaches to co-teaching. Retrieved from https://ctserc.org/component/k2/item/50-six-approaches-to-co-teaching

Swarat, S., Ortony, A., & Revelle, W. (2012). Activity matters: Understanding student interest in school science. *Journal of Research in Science Teaching, 49,* 515–537.

TEConomy Partners, LLC. (2016). *Indiana's health and life sciences talent and workforce: Developing strategies to compete in a global economy* (pp. 1-144, Rep.).

United States Census Bureau. (2019). SAIPE School district estimates. Retrieved from https://www2.census.gov/programs-surveys/saipe/datasets/2017/2017-school-districts/sd17-in.txt

Vygotsky, L. (1986). *Thought and language*. Boston: MIT Press.

Wilson-Lopez, A., Mejia, J. A., Hasbún, I., & Kasun, G. S. (2016). Latino/a adolescents' funds of knowledge related to engineering. *Journal of Engineering Education, 105,* 278-311.

Zeichner, K. (2010). Rethinking the connections between campus courses and field experiences in college-and university-based teacher education. *Journal of Teacher Education*, 89-99.