Indiana Department of Education
SUPPORTING STUDENT SUCCESS

Cover Sheet *(does not count toward final page limit)*

APPLICANT DESCRIPTIVE INFORMATION	
Program submitted by: The Bloomington Project School	**Corporation number** (if applicable): 9835
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Contact person: Daniel Baron	
Number of students to be included in program: 450	
Number of teachers to be included in program: 25	
Total amount requested (no grantee will be awarded more than $500,000: $ $477,580	
Name of school (s), superintendent(s), and/or principals of school(s) involved with the program: (if applicable): The Bloomington Project School Cathy Diersing - Superintendent Daniel Baron - School Leader	

Title: Re-Making Education: A Networked Approach to Supporting Technological Innovation and Digital Entrepreneurism in Indiana Educational Institutions

STATEMENT OF INNOVATION

According to Neil Gershenfeld (2005), head of MIT's Center for Bits and Atom, and director of MIT's FabLab, there is a new Industrial Revolution brewing that will radically impact teaching and learning in schools. For example, the development of 3D software and printers allow teachers and learners to directly and rapidly create physical three-dimensional objects modeled on the computer – whether an atomic model, Lego building blocks, or a replica of the Taj Mahal. This is just one of many innovative design and manufacturing tools, exotic and fabulously expensive a decade ago, that will be ubiquitous a decade from now (Anderson, 2012). Our mission today is to better prepare youth to think, create, and innovate with these tools in order to become leaders in the field and productive citizens in Indiana -- preparing youth to compete nationally and internationally in a rapidly changing education and career landscape.

To meet this challenge, we propose a MakerSpace Network, an innovative educational community to support teaching and learning by making and doing. This network will provide

- ***college and career readiness*** for K-12 students through "new basics" teaching and learning experiences that meet rigorous 21st Century Skills and Common Core State Standard expectations.
- ***teacher effectiveness*** in extensive training in engaged and relevant learning
- **sustainable school improvement** through partnerships within a central network for digital fabrication in the Bloomington community that can be easily taken to scale.

Our vision is for the network to be dispersed across a few strategic start-up partners (including the Bloomington Project School, BloomingLabs, Indiana University, and the Monroe County Public Library) that would be dedicated to the realization of ideas and designs across a variety of settings with a diverse body of educators and learners. The network would own and operate carts with digital fabrication equipment such as 3D printer, CNC computerized vinyl cutter, sewing machine, electronics equipment and tools, and consumable supplies. This alliance fosters mutually beneficial school-community partnerships: students and teachers will have rich opportunities to learn through creative problem-solving and design innovation in authentic contexts in local businesses and researchers, designers, entrepreneurs, and artists who are currently using these technologies across the local community will gain a central repository for innovation and expertise, enabling Bloomington to remain competitive nationally in this quickly changing landscape. Building upon community expertise and local resources for making to support FabLab facilities creates a sustainable model that can be taken to scale in Indiana. The Bloomington MakerSpace Network will provide access to digital fabrication equipment, facilities, expertise, training, and support for local students, in-service teachers, and pre-service teachers as well as the local community, artists, designers, university students, and researchers. Such an alliance would allow for the bulk purchase of materials, develop a network of students and adults with expertise in teaching and learning with computing and digital fabrication equipment and materials, and enable researchers and practitioners from different settings to share their expertise. Trained part-time staff would operate equipment, teach faculty and students in the use of equipment and software, as well as help learners of all ages across

the Bloomington community and beyond understand the strengths and limitations of these technologies.

Priority 1: College and Career Readiness

Design using digital fabrication is an "essential literacy in the 21st century", evident in calls for a national network of Fab Labs. The Fab Lab is the "workplace of the future" where "the key to U.S. manufacturing is to get the next generation of students interested in building things" (Foster, 2012). Forward-looking prominent universities have already started digital fabrication centers that provide researchers, designers, artists, and students with access to these tools, and training in their use. However, the usefulness of these tools is not limited to higher education settings---digital fabrication centers are becoming more common in K-12 educational environments, with networks such as Stanford University's FabLab@School project providing a platform of support for sharing ideas and projects among schools (Eisenberg & Buechley, 2008). Locally, the uses of this equipment extend beyond the schooling landscape – industry leaders, local community clubs, libraries, museums, and others in the Bloomington area have had an outpouring of interest and support in these technologies. The Common Core State Standards, written to prepare K-12 students for college and career readiness, hint at the potential of maker technologies to provide new and powerful learning: "Use technology, including the Internet, to produce, publish, and update individual or shared writing products, *taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically*" (CCSS Writing...technical subjects standard 6).

Priority 2: Schoolwide Improvement -- The Bloomington Project School

The 21st century requires us to work across disciplines to solve problems effectively, creating an imperative to rethink the ways that we design and integrate technologies into classroom learning experiences, in order to better prepare youth to effectively shape and change their worlds. The Bloomington Project School (BPS) is currently adopting innovative professional development strategies for teacher effectiveness, as well as proven curriculum designs in conjunction with new transformative technologies, to support students and teachers in academically rigorous and future-focused project-based learning in K-8 classrooms at BPS.

Priority 3: Educator Effectiveness

The networked school-community design of the MakerSpace Network offers plentiful mentoring interactions with local professionals where mentees and mentors alike are actively engaged as learners and teachers. In this learning-by-teaching pedagogical approach, a problem-based learning model poses significant, contextualized, real world situations and provides the learner with resources, guidance and instruction as they develop content knowledge and problem-solving skills. Teachers will take on roles as learners in digital projects as well as facilitators in guiding the learning process as students assume responsibility for their own learning.

DOMAIN ONE: Program Description

Indicator 1.1: Program History

Bloomington Project School (BPS)

In the fall of 2006, a small group of passionate public school educators and education reformers in Indiana began a discussion about the current state of education and the problematic trends in education reform. By identifying shared core beliefs about teaching and learning, the group began to articulate their vision for a 21st Century School – a school where students could truly thrive as whole individuals, and a school to which they, themselves, would feel confident sending their own children and grandchildren. Through this dialogue, BPS was born. From the outset, the goal was to interrupt the status quo of low achievement for children from historically marginalized and disenfranchised families of color and/or poverty. BPS opened its doors in August 2009. The embodiment of a 21st century school, BPS has built a school-wide technology infrastructure and has increased capacity through systematic professional development around tools that leverage systems thinking concepts with the goal of developing "hooks" to be taken up by teachers in all disciplines. BPS currently infuses multiple cutting edge technologies to support the adoption of new curriculum.

BPS Curriculum: Place-based, Problem-based and Project-based Learning (P3)

Starting with the Teaching for Understanding framework and The Project School's core beliefs, the Organizing Group embedded the conceptual frameworks of project-based, problem-based, and place-based learning to create a curricular model that would lead to a highly rigorous and relevant curriculum for children that is directly connected to issues in their local and global communities. The avenue for determining the topics and issues that will provide the foundation for the year's curriculum brings students, teachers, families, and community members work together to arrive at school-wide topics or questions that guide individual, group, and community projects that directly work to solve real problems in the communities in which we live. Every BPS student is engaged in service-learning experiences that are intentionally connected to the school-wide topics and result in a real-life impact. Potential topics must meet P3 test criteria to ensure that they are conducive to a project-based, problem-based, and place-based experience for students. One of the critical components of the P3 test is ensuring that the social studies and science standards can be addressed through P3 projects. After the topic has been agreed upon by the school community, teachers and students begin the process of creating the P3 curriculum that the school community will engage in throughout the year. Each P3 unit of study is launched by an essential question that poses a problem or a situation that the students can tackle knowing that there is no one answer or solution. An essential question speaks to the essence of the topic of study and serves as project-long understanding of goals and will "uncover" the standards and skills that students will be exposed to during the project.

Each P3 project is an integrated, multidisciplinary, inquiry-based investigation of a Compelling and Generative Topic that can last for several days, weeks, or months. There are individual and group projects embedded into the study of a compelling and generative topic that tap the unique gifts and talents of each student and directly address developmental and academic skills and concepts.

BPS and Bloomington Makes!

Beginning in 2012 through partial support from the Indiana Department of Education, the Bloomington Project School began an

initiative titled "bps: makes!", a pilot initiative to explore making, digital fabrication, and physical computing within the context of the school day. The program's goal is to both to strengthen the school's commitment to project-based learning, systems thinking, and design education but updates these areas to better meet emerging STEM standards and better prepare youth for meeting the goals of the 21st century. The bps: makes! program also began exciting conversations with like minded partners across the Bloomington community about how to create and support physical computing, digital fabrication, and making more generally to further student achievement.

These conversations were the beginning of the network of partners included in this proposal, so that teaching and learning could be strengthened across the Bloomington community, in and out-of-schools. These partners included Indiana University faculty that are national leaders in STEM and literacy education, the Monroe County Public Library, and the Bloomington community MakerSpace, BloomingLabs --- all of which had independently developed interest and emerging expertise in making, computing, and digital fabrication well aligned with the Bloomington Project School. The proposed MakerSpace Network proposed here will serve to both strengthen the Bloomington Project School as well as the Bloomington capacity for high-quality teaching and learning across the city with a sustainable program plan and ease of scalability to other sites across the State of Indiana and beyond.

Indicator 1.2: Program Leadership

Across the proposed network, we have a synergistic group of community leaders poised to support this initiative. The project will be managed and led by the team at the Bloomington Project School. Daniel Baron, Project Manager, has had leadership roles in several national professional organizations including the National School Reform Faculty, the School Reform Initiative and the First Amendment Schools Project. Norm Gwaltney, BPS' Technology Infusion Specialist, has 17 years of experience in website, multimedia and curriculum design and development for the High Tech, Higher Education, and the K-12 Classroom. Christian McKay is a both a professional media artist as well as a doctoral student in the School of Education at Indiana University. McKay will serve as the MakerSpace coach at the Bloomington Project School. His role will include co-developing curriculum, provide ongoing professional development for teachers, attend school-wide meetings, meet with teachers one-on-one, lead activities with students, and lead project activities at the school site.

Professional Development for the project will be spearheaded by BloomingLabs. Jennet Tillotson is senior systems administrator for Indiana University's cluster supercomputing resources. Tillotson is a founding member of Bloominglabs, and has organized STEM outreach programs with Wonderlab, the Bloomington Boys & Girls Club, the Monroe County Public Library, and local schools. Tillotson has taught classes and workshops on physical computing, programming, and soldering. Tillotson will coordinate the professional development and training activities, and, if needed, can teach workshops on physical computing. Jay Sissom is owner of ImplMentor, LLC, a training company in Bloomington. Sissom has over five years experience in high-level technical training. A veteran industry programmer, Sissom has also designed and taught Arduino and physical computing courses at Bloominglabs. Sissom will provide Arduino and physical computing professional development training. Dr. William Byrd is a postdoctoral researcher in the Center for Research in Extreme Scale Technologies (CREST) at Indiana University; in January he will begin a postdoctoral research position at the University of Utah.

Byrd is a founding member of Bloominglabs, and is heavily involved in STEM outreach, having given 3D printing demos in New York, Utah, and throughout Indiana. Byrd designed Indiana University's A290 Arduino course, and founded Indiana University's popular 3D printing and Arduino/physical computing clubs. A former public middle school teacher, Byrd has taught digital fabrication, physical computing, electronics, and animatronics to pre-teens, teens, undergraduates, and graduate students. Byrd will act as a technical and course content advisor, and will visit Bloominglabs to give several 3D printing and digital fabrication workshops.

Additionally, the Monroe County Public Library will be our hub for informal learning and further outreach in the Bloomington community. Steve Backs is Adult and Teen Services Manager at the Monroe County Public Library, and adjunct lecturer at Indiana University's School of Library and Information Science. Backs supervises a large public service department (ten librarians, ten support staff), and is responsible for adult and teen programming, teen services, outreach and partnership projects with community organizations. Backs will coordinate the library's involvement in this project, and oversee incorporation of digital fabrication and physical computing into the library's programming, including this summer's sequence of maker events. Joshua Wolf is Children Services Manager at the Monroe County Public Library. Wolf will work with Adult and Teen Services Manager Steve Backs to incorporate digital fabrication and physical computing into the Monroe County Public Library's programming.

Karen Wohlwend from Indiana University will coordinate initiatives to partner with university courses, reaching pre-service teachers as well as mentors from the School of Informatics and Computing with expertise in computing. Dr. Karen Wohlwend is an assistant professor in the Literacy, Culture, and Language Education department at Indiana University School of Education. Wohlwend researches play with digital technologies, literacies, and media in online communities, work recognized through the International Reading Association's Outstanding Dissertation Award. She is currently the lead PI on a grant to develop a critical media curriculum that provides opportunities for digital film-making with popular media. Wohlwend will act as the faculty liaison between Indiana University early field experience and service learning courses, providing a number of mentors to the project sites to assist with ongoing activities. Additionally, Dr. Wohlwend will aid in the curriculum development and standards alignment for the workshop activities.

Dr. Kylie Peppler is an Assistant Professor of Learning Sciences Program in the Center for Research on Learning and Technology at Indiana University and will serve as the external evaluator on this project. As an educator and a new media artist by training, Peppler engages in research that focuses on the intersection of new media, maker culture, and computer science education. She has considerable experience as principal investigator for education and research projects, with over $3 million in externally-funded projects over the past five years, including projects supported by the Spencer Foundation, the Wallace Foundation, the U.S. Department of Education, the John D. and Catherine T. MacArthur Foundation's Digital Media and Learning initiative, and the National Science Foundation. Peppler was the Senior Research Assistant on the joint NSF-ITR initiative between the MIT Media Lab and UCLA to develop and study Scratch, a new networked, media-rich programming environment, designed specifically to enhance the development of technological fluency at the Computer Clubhouse Network (ITR - 0325828). Peppler is also currently a co-PI, on two recent grants from the National Science

Foundation (0855868 and 0855886) to study creativity and computational textiles in youth communities. Peppler is also the lead for the new Make thematic partnership among the MacArthur Foundation, MakerEd, and several other leading non-profits and has considerable expertise in maker culture. Peppler, along with a Graduate Research Assistant, will lead and oversee all project evaluation activities and provide both summative and formative feedback to inform the ongoing development of the project.

Indicator 1.3: Research Base

The P3 model and the BPS Makes! at BPS were intentionally created to provide students with an authentic and meaningful avenue for learning STEM content. P3 is grounded in years of lived and practical classroom experience, as well as extensive research. The work of *Project Zero* at Harvard University (Gardner, 1985), and in particular the *Teaching for Understanding Project and Framework*, served as a starting point for the P3 curricular model. *Teaching for Understanding: Linking Research and Practice,* edited by Martha Stone Wiske (1998), with contributions from world-renowned theorists Howard Gardner, David Perkins, and numerous practicing educators, outlines the body of research that supports inquiry-based instruction and fosters thinking and understanding. In addition to the extensive research and development of Project Zero at Harvard University, we also used resources and research from *The George Lucas Foundation*, the *Coalition of Essential Schools*, *the Buck Institute*, Dr. Sylvia Chard, and the *Project Approach* in the development of the P3 Curricular Framework.

Place-based, problem-based, and project-based learning at BPS is integral to the participatory designing that typifies making and learning in maker communities, creating an ideal opportunity for school-community learning partnerships. The networked systemic design of MakerSpace Network provides comprehensive scope, further enhanced by an each-one-teach-one sustainability. Our network model builds on our prior studies of a successful effort to create a youth programming culture within the Computer Clubhouse Network, a network of technology centers stationed in low-income communities worldwide designed explicitly to move underrepresented youth populations beyond basic computer skills and helping them learn to design, create, and invent with new technologies (Resnick et al., 1998). As discovered by prior research and evaluation efforts at a Computer Clubhouse in South Los Angeles (Kafai, Peppler, & Chapman, 2009: Kafai, Peppler & Chiu, 2007), the promotion of CS skills in this environment was contingent upon the development of programming with materials that appealed to youth as well as a unique mentoring partnership with a local university, which provided non-CS undergraduate and graduate mentors to the site as part of a service-learning course. Over the course of two years, we found that youth engaged in progressively more programming activities and significantly gained in their understanding of core computer programming concepts like loops, conditionals, and user-interactivity (Maloney, Peppler, Kafai, Resnick, & Rusk, 2008) -- computational concepts difficult for even computer science majors. This was mediated, at least in part, through a unique mentoring partnership model involving undergraduate liberal arts majors (Kafai, Desai, Peppler, Chiu, & Moya, 2008) as well as supported by activities that merged youths' interest in popular culture with programming activities. Ching and Kafai (2008) found that even upper elementary school-aged students successfully engage in these forms of peer teaching when they help each other to solve programming problems. In Peppler's prior work at the Computer Clubhouse, reciprocal peer learning developed through mentoring partnerships (Kafai, Desai, Peppler, Chiu, & Moya, 2008). In these mentoring partnerships,

undergraduate students mentored youth in a Community Technology Center (CTC) that provided local youth with access to creative design technologies. Such partnerships are built on the assumption that college students, who often have unprecedented access to technology use in their daily lives and schooling, might be well positioned to work on technology projects with youth from underserved communities often described as the primary victims of the digital divide (Warschauer, 2004). Yet when faced with design technologies, Peppler and colleagues found that most undergraduates, especially those from the liberal arts, had little experience beyond web browsing and game playing (Goode & Margolis, 2004) and thus found themselves in situations at the CTC where they became learners of new creative technologies. For this reason, mentoring partnerships offer the possibility of a more equitable and reciprocal relationship. The MakerSpace Network draws upon this research and expands the possibilities for digital learning by tapping into community expertise in partnering agencies as mentoring resources.

DOMAIN TWO: Impact on Student Achievement

Indicator 2.1: Mission and Vision

Mission: Our mission today is to better prepare youth to think, create, and innovate with cutting edge technology and the latest digital tools in order to become leaders in STEM fields and productive citizens in Indiana -- preparing youth to compete nationally and internationally in a rapidly changing education and career landscape.

Vision: To meet this challenge, we propose a MakerSpace Network, an innovative educational community to support teaching and learning by making and doing. This network will provide

- ***college and career readiness*** for K-12 students through "new basics" teaching and learning experiences that meet rigorous 21st Century Skills and Common Core State Standard expectations.
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Our vision is for the network to be dispersed across a few strategic start-up partners (including the Bloomington Project School, BloomingLabs, Indiana University, and the Monroe County Public Library) that would be dedicated to the realization of ideas and designs across a variety of settings with a diverse body of educators and learners.

Indicator 2.2: Program Need

We know that today's schoolchildren require skills for future occupations that we cannot yet envision. The proposed digital fabrication network aims to prepare children and youth with "new basics" (Dyson, 2006) for the increasingly digital ways of thinking that are necessary for living and working in a rapidly changing global landscape. One of these new basics for future career readiness is likely to be a flexible orientation to dynamic technologies (Gee, 2004), an "intuitive" grasp of new digital conventions and a skill set for active production rather than consumption of digital media. Importantly, what appears to be intuitive and natural is actually implicitly learned embodied practices, often taught at an early age. We posit that an early introduction to digital making through the MakerSpace Network equips young students with essential early creative skills for inventing, visualizing, designing, problem-solving, discovering, coding, and making digital projects--all basic skills in an innovative model of career-readiness

and long-term success as innovative producers.

The Maker Movement shows signs of expanding from a hobbyist DIY trend to a third industrial revolution, similar to the way that the digital era emerged from tinkering with computers in garages and basements. "[Making] could scale to have a bigger economic impact than the Web....E-Commerce was just a new way of selling existing products. What if we have a new way of making new products?" (Gustin, 2012). As fabrication technologies and cloud services become increasingly affordable, the maker movement promises to become as personal and pervasive as home computers and document copying (New York Hall of Science, 2010). News media report that millions are already self-producing their own handcrafts, art, robots, drones, and so on (Morse, 2012). Makers can also fabricate objects in steel, ceramic, wood, and glass, creating new outlets and potential businesses that reinvigorate traditional strengths of Indiana artisans such as woodworkers, metalworkers, and masons.

Indicator 2.3: Program Objectives

Short-Term Objectives

- increase student growth toward career readiness through active problem-solving with emerging technologies that will allow them to adapt to rapidly changing technologies
- increase teacher effectiveness in developing curriculum and instruction for engaged learning and designing with emerging technologies
- improve standardized test (e.g. ISTEP) scores of students and growth toward college and career readiness as benchmarked in state standards

Long-Term Objectives

- sustain educational opportunities and expand networks to support students and teachers to help them connect with and learn cutting-edge technologies from highly-skilled professionals in their communities
- create a skilled teacher workforce with knowledge of MakerSpace technologies across the State of Indiana to engage non-traditional learners in STEAM careers
- disseminate a systemic model to sustain innovation through community-based learning networks
- scale up the program to inspire similar school, university and community partnerships through a statewide MakerSpace Network to provide highly-skilled labor force for anticipated demand in economic development and industrial expansion

Indicator 2.4: Program Plan

The proposed program will consist of a network of well-integrated project partners that have been strategically selected to have impact on student achievement supported both in- and out-of-school. Partners also have a range of expertise in STEM capacities, teaching, and community outreach. As such, a team of site coordinators and educators across the Bloomington Project School (BPS), the Monroe County Public Library (MCPL), BloomingLabs, and Indiana University plan to work together to achieve the goals of the grant. To do so, we plan to have weekly meetings among the site coordinators and external evaluator during the grant planning period (June 2013) and then plan to meet monthly throughout the grant period to continue project planning and respond in time to emerging concerns from the networked partners or formative feedback from the project evaluator. Additionally, each site will have lead educator to lead educational programming (or professional development in the case of BloomingLabs) at the site. The educator will work in coordination with their site coordinator to

advertise, envision, staff, and plan for MakerSpace workshops. Each educator will draw from a common set of materials, supplies, and equipment found on identical MakerCarts across the Network partners, as well as build on existing high-quality instructional workshop models developed at the Bloomington Project in the pilot phases of this work. Additionally, Network partners will be aided by a documentation team to readily share emergent effective practice with others both through the IDOE support tools as well as through a project specific website. Lastly, formative feedback and summative evaluation will be provided through a high-quality external evaluation provided by Dr. Kylie Peppler to inform all aspects of project development and assure student achievement across the course of the project.

The following provides more detail on the proposed (a) MakerSpace Network partners, (b) the MakerCart equipment, materials, and supplies, (c) the regular Professional Development sessions to support the emergence of expertise across the Network, (d) illustrative workshop models that are already aligned to common core standards that have emerged over the course of the pilot work at the Bloomington Project School, (e) a plan for documentation and sharing the MakerSpace Network model, and (f) a rigorous, high-quality external evaluation to determine its efficacy.

Bloomington MakerSpace Network Partnership

In addition to BPS, the MakerSpace Network includes the following partners:

The Monroe County Public Library (MCPL): As an organization that is deeply involved with learning, exploring and developing 21st century skills, MCPL is committed to establishing a community network that will facilitate the Bloomington community's capacity to support digital and technological literacy. The proposed project matches well with MCPL's objectives to develop initiatives and programs that will help build a stronger infrastructure for growing our community's technology competencies. MCPL has a particular interest in helping library patrons to understand and to master tools that will help them understand and apply information more effectively to learn, to solve problems and to grow intellectually. MCPL has also begun planning a digital creativity lab and a summer 2013 series of Maker programs for all ages that will be delivered in partnership with Bloominglabs, Indiana University and other organizations. Combined, the program will impact 200 students over the course of the year in more than 20 hours of programming, cumulatively in a combined total of 4,000 hours of effective STEM learning opportunities.

BloomingLabs: Bloominglabs Inc is a non-profit makerspace located in Bloomington. Makerspaces are collaborative spaces where members can share tools and knowledge to build and make things. Formed in 2010, Bloominglabs was the first makerspace in Indiana, and is one of only two active makerspaces in the state. Bloominglabs members have expertise in electronics, metal working, wood working, crafting, music, digital media, renewable energy, and engineering. Bloominglabs builds community by reaching out to the community, providing public workshops and classes, and partnering with schools and learning organizations to help younger makers. Among other topics, Bloominglabs has offered courses and workshops on computer programming, Arduino and physical computing, basic and advanced soldering, smart materials for DIY projects, and printed circuit board etching. Currently Bloominglabs is planning a maker convention, called Makevention, to be held in the fall of 2013 at the Bloomington Convention Center where local and regional makers of all kinds will be invite to demonstrate their accomplishments to the Bloomington community.

Indiana University: Dr. Karen Wohlwend will coordinate the partnership with Indiana University Undergraduate courses, recruiting undergraduate students from the School of Education as well as the School of Informatics and Computing (SOIC) to be mentors and to extend their pre-service teacher training at project sites. Dr. Wohlwend will act as the project liaison to place two pipelines of Undergraduate mentors to assist with activities at the community partner locations, including (1) pre-service teachers in their Early Field Experience (EFE) and (2) informatics and computer science majors enrolled in service learning courses, which are further detailed below.

Pre-Service Teachers Completing their Early Field Experience. Undergraduate students in a joint course in an Educational Psychology course (P254) on learning and development with an Early Field Experience (M201) at the Bloomington Project School will be engaged in learning about and supporting computing activities in their future K-12 teaching. Based on the earlier models (Kafai et al., 2008), pre-service teachers will act as mentors with youth at the Bloomington Project School during Fall (15 weeks) and Spring (15 weeks) semesters over the proposed grant activity. Each semester, the course enrolls about 25 students in an average of 25 hours of field experience, cumulatively impacting 50 undergraduate pre-service teachers in a combined 1,250 hours in effective literacy and STEM teaching with new computational tools. We expect the Undergraduates to come to value computing through their interactions working alongside and learning from the project staff, Bloomington Project School youth, and peers majoring in Informatics and Computing that will also be placed at the Bloomington Project Schools for their service learning experiences. Additionally, we expect that this will prepare future teachers to be school site leaders when they are placed in their full-time appointments at schools across Indiana and elsewhere, building future capacity at schools beyond the local Bloomington community.

Informatics and Computer Science Undergraduates enrolled in Service Learning Courses. SOIC Undergraduates enrolled in new service learning classes with strategic placement at either the Bloomington Project School, Monroe County Public Library, BloomingLabs, or other outreach sites will act as mentors with youth at during each Fall (15 weeks) and Spring (15 weeks) semester over the 2.5 years of the proposed grant activity (beginning in the Fall 2013 semester). Each semester, the course will enroll about 20 students in an average of 25 hours of field experience, cumulatively impacting 40 undergraduates in a combined 1,000 hours of exposure to computing and teaching CS to youth. Based on successful prior SOIC service learning efforts, we expect the Undergraduates to come to value computing through their interactions working alongside and learning from the project staff, Bloomington Project School youth, and youth enrolled in programs at the Monroe County Public Library or BloomingLabs. A unique part of this of model is that SOIC Undergraduates will learn how to mentor and teach computer science concepts in cutting-edge areas that will appeal to youth.

MakerCarts

This proposal will fund portable "MakerCarts" for the MakerSpace Network to connect the Bloomington Project School to community organizations such as the Monroe County Public Library, Indiana University, and BloomingLabs, a group of digital fabrication designers. Each community organization will serve as a project location and maintain and operate a MakerCart for connected teaching and learning. Youth will engage in maker projects at school and in after-

school settings and be able to collaborate with peer and experts in community sites. Each site's MakerCart will be equipped with a 3D printer, CNC computerized vinyl cutter, sewing machines, electronics equipment and tools, and consumable supplies, such as plastic for the 3D printer. Identical carts across the network will make it easy to share knowledge and project ideas among sites, and to share information with other communities as we scale up the projects to other locations in Indiana. All equipment was chosen in close coordination with educational advisors, BloomingLabs staff, Bloomington Project School master teachers, and other input from the Bloomington community. More detail about what will be provided on the carts is found in the budget template. Additionally, a pilot MakerCart has been placed at the Bloomington Project School in the 2012-2013 academic year and will impact final purchasing decisions. The Bloomington Project School will receive a second cart in order to infuse MakerSpace activities across the school day for all grade levels.

Professional Development Sessions

Regular and ongoing workshops are crucial to school improvement and teacher effectiveness. To enhance effective teaching by BPS teachers, staff, and university mentors from the participating organizations, Bloominglabs members will run monthly training sessions to demonstrate projects using 3D printing/digital fabrication or other modes of making such as electronic textiles in Arduino/electronics. These sessions will allow educators with emerging expertise and experts to problem-solve, adapt planning and instruction to maximize student growth, and to build common capacity across sites to operate, maintain, and facilitate learning using maker technologies. The professional development will cover quarterly themes related to crucial aspects of teaching and learning, ranging from 3D printing and computer modeling to create and print 3D objects in the first quarter, to digital fabrication with vinyl, fabric, or other materials to create unique signs, costumes, and objects in the second quarter, to making and programming ArtBots with Arduino technology in the third quarter, to exploring new high-tech crafting materials in the fourth quarter with the LilyPad Arduino and programmable sewing machines. Included in the PD will be training in how to run and maintain all project equipment as well as time to respond to emerging ideas and constraints across the Network. As such, the topics of PD will change in order to meet the needs of the Network partners but will plan to cover a range of crucial aspects of making critical to 21st century teaching and learning.

MakerSpace Workshop Models

Workshops on maker projects will feature maker technologies such as 3D printing where students use computer modeling (fig. 1) to conceptualize, program, and create an original design and use a digital fabricator (such as the 3-D printer in fig. 2) to instantly manufacture a three-dimensional plastic object (fig. 3). However, maker projects are much more extensive and cover a range of materials and electronics. For example, to make computational textiles, students can sew circuits, attach Arduino electronics, or embed a variety of sensors using conductive thread to turn stuffed animals into digital puppets (fig. 4) that are interactive and bring children's written stories to life.

Project Documentation

To support the documentation, sharing, and scaling of these innovations, we plan to develop two main deliverables: (1) We plan to create a public website with MakerSpace Network documentation, including ordering information for the supplies on a MakerCart, including product specifications and suggestions, High-quality tutorials captured from the PD

offered at BloomingLabs or in the workshops offered across the Network, Workshop Models, Project ideas and how-to's, Curricular and common core alignment, as well as demonstration videos from youth across the Network. (2) We plan to regularly post curricular activities and projects to Indiana Learning Connections (LearningConnection@doe.in.gov), particularly in the Ed Tech Connect technology strand to share with partners across the State of Indiana in a timely manner. To assist with immediate turn around of these materials, we plan to hire a small professional hourly staff to assist with professional photography, videography, and routine website maintenance. These project staff will be shared across the Network and their time will be planned for in the budget.

External Evaluation

External evaluation of the MakerSpace Network will be conducted by Dr. Kylie Peppler at the Center for Research on Learning and Technology at Indiana University. More detail on the external evaluation is found in Indicator 3.1 but we see the external evaluation as critical to student achievement and the overall success of the proposed program.

Indicator 2.5: Expected Impact

Student Achievement

We expect that digital fabrication experiences supported by community partnerships in MakerSpace Network will develop *student achievement* by extending BPS rigorous curricula and integrating student abilities to design and think with cutting-edge technologies through rigorous problem-solving opportunities with expert guidance. Increased student achievement will be measured formatively through pre-/post- assessments and observational data as well as summatively through annual test scores. This entails s*tudent dispositions* to identify as capable designers and makers, assessed through pre- and post-participation surveys. We further expect that the network will support *teacher effectiveness* to facilitate student problem-solving and engaged learning with emerging technologies as measured by observational data of student work and teachers' self-assessments in survey data. Changes in *teacher dispositions* to identify as capable technology designers, makers, and learning facilitators will be measured through pre- and post-participation surveys and teachers' self-assessments

Program Need

We expect that the maker network with easy access to new technologies will create opportunities for regular, relevant, and rigorous learning, effective teaching, and expert guidance in school. The synergies across community organizations produces a *systemic, sustainable, and scalable innovation* that offers outlets to local talent and interest in the growing maker movement, which will be evident in participation tracking, survey data, user traffic and interest across the networked community sites and website.

Domain Three: Program Supports

Indicator 3.1: Program Progress

As part of their regular practice, BPS teachers use the P3 test document to ensure that the projects developed are truly project-, problem-, and place-based. During this phase of curriculum development, teachers also use the Indiana Academic Standards (CCSS) to create P3 projects that are rigorous, relevant, and engaging. Because the P3 Framework is grounded in years of practical classroom experience and a strong research-based foundation, we are confident it serves as a vehicle for creating an engaging, relevant, and rigorous curriculum and

is a perfect complement to our discipline-based approach to Linguistics and Math/Numeracy Workshops. To ensure that the comprehensive approach to teaching science and social studies increases student achievement, we use multiple forms of assessment, including informal and formal observations, unit assessments, ISTEP+ and NWEA. This project will profoundly enhance the P3 curriculum as a model of curricular innovation integration through integration directly connected to the real world.

External Project Evaluation

The external project evaluation will be conducted by the Center for Research on Learning and Technology (CRLT). CRLT, a fully self-funded center based at Indiana University (independent of the project team), regularly promotes and supports rigorous program evaluation and education policy research, including more than $3 million in funded contracts and grants. Evaluation activities have occurred on the national, regional, and local levels, including large-scale statewide and national evaluations of STEM programs, teacher professional development programs, after-school programs, and numerous other in-school and out-of-school-time K-12 education initiatives. This project will be led by Kylie Peppler with assistance from a Graduate Research Assistant with training in the latest conceptual, methodological, and organizational strategies and advances. CRLT's personnel resources are further augmented by extensive facilities and technological resources that promote in-house materials production; web-based data collection and management; state-of-the-art data analyses; and the intellectual and capital resources of a world-class research university.

The MakerSpace Network model will be evaluated to improve the project as it develops and to determine its overall effectiveness. A formative evaluation will assess ongoing project activities while the summative evaluation will assess the quality and impact of the fully implemented project. The overall project evaluation plan will be driven by project objectives to sustain learning and participation at three levels: youth in formal learning opportunities at BPS, youth in informal learning programs at MCPL or elsewhere, undergraduates in STEM and teacher education, policies and procedures in informal learning institutions, and future STEM learning and teaching for the eventual students of teacher candidates. Each participation level will be evaluated with regard to targeted outcomes: STEM learning outcomes for youth participants; STEM learning and teaching outcomes for IU undergraduates in education and computer science majors; and institutional change outcomes for The Bloomington Project School, Monroe County Public Library, and BloomingLabs.

The evaluation will focus on measuring the impact of the MakerSpace workshops on student learning outcomes. More specifically, the evaluation will measure the extent to which the sustained course of MakerSpace project activities leads to changes in youths' computing efficacy, STEM attitudes, skills and knowledge as well as an increased participation in STEM activities. Indiana University undergraduate students in Computer Science or pre-service teacher education classes, who mentor during the project activities to youth at project sites, will also be evaluated for changes in their attitudes, knowledge, and skill in STEM teaching. MakerSpace activities will be modified according to evaluation recommendations for improvement. Youths' patterns of participation in MakerSpaces and non-MakerSpace activities will be documented through field notes and data tracking measures to see how often they choose and how long they sustain STEM learning activities in these informal learning environments. Survey and participation tracking data will be shared with site leaders to inform

potential institutional policy and procedural changes. Formative assessments will inform ongoing MakerSpace program modifications to ensure that the program and its components are operating effectively; summative data will examine the overall impact of the program on key outcomes, particularly student learning outcomes, standardized test scores, and attitudinal changes.

Evaluation Data Collection & Analysis

An initial meeting between the CRLT evaluation team and the project team will be held to develop evaluation strategies appropriate to informal learning environments and to establish the working partnership necessary for program success. This meeting will address survey design for pre-post assessment of MakerSpace workshops and evaluation needs for project observations and the participation tracking system. The surveys and tracking system will be designed with the help of CRLT to provide a quick and accurate picture that shows which components work best and what needs improvement. Plans for summative evaluation data collection, analysis, and reporting also will be discussed. Evaluation design and process modifications will be made as needed. Deliverables for review of periodic reports will be established at the start. Moreover, 1) instruments will be developed and implemented by the project team; 2) the CRLT team will be responsible for all data collection activities; the CRLT evaluation team will meet with the project team for data collection assistance; and, 3) standard analysis methods will be used to evaluate pre-post session attitudes, knowledge levels, and intentions in surveys.

Indicator 3.2: Program Modifications

Formative assessment is integral to the BPS responsive curriculum, intentionally designed to meet the needs of any student who walks through the door. Through the P3 curricular design process, instructional delivery and ongoing assessment, BPS teachers continually modify the curriculum to ensure that each student develops and progresses at optimal rates. Following external feedback from surveys and the participation monitoring system, BPS teachers will modify P3 activities accordingly: for example, provide instructional support to engage more rigorous content, adjust the learning environment to enable more learner-led and peer-mediated discovery and invention, create more structured or more open-ended problem-solving. In addition, workshop presenters will use informal ongoing feedback following workshop sessions to inform and adapt MakerSpace instruction, equipment configuration for upcoming sessions. University faculty will adapt course instruction and use class discussion as a forum to address issues and challenges identified through data on university student mentors. Building on these institutional structures as well as the formative feedback from the external evaluator, ongoing program modifications will be made throughout the Network on a regular basis. Program Modifications will be central to the regular project coordinator meetings to ensure the academic success of every youth in the program as well as the overall long-term viability of the Network.

Indicator 3.3: Program Challenges

A significant challenge is finding people with the technical expertise and teaching experience required to design and conduct the professional development training. Bloominglabs serves a critical role in addressing this challenge, since its members have been been teaching physical computing, computer programming, robotics, electronics, and other STEM-related topics to children and adults since the organization was established.

Bloominglabs members have agreed to teach the professional development workshops, and a Bloominglabs member has agreed to coordinate these workshops, order necessary supplies, and so forth. Bloominglabs founding member William Byrd, who will be moving to the University of Utah in January, has agreed to return to Bloomington for several professional development workshops on 3D printing and digital fabrication, with the goal of future 3D printing workshops being taught by local Bloominglabs members.

One possible obstacle would be incompatibility between the hardware, software, and tools used by the collaborating organizations, which would make it difficult to jointly train staff, and to share experiences, techniques, and activities. Incompatible equipment and software would also make it harder for multiple partners to combine resources for larger-scale outreach events. We will avoid this problem by ensuring all MakerCarts have identical equipment, and that all core staff are trained in the same software.

Another challenge is how to ensure that the proposed equipment, training, and activities remain relevant, given the rapidly changing nature of technology. We will address this challenge in two ways. First, we will design our professional development training to cover the fundamentals of digital fabrication and physical computing, which change relatively slowly. For example, although 3D printer hardware and software is improving at a blistering pace, the fundamental skills required for 3D modeling, and the basic workflow for turning a model into a physical object, are decades old. Second, our focus on inter-organizational collaboration, joint training, and outreach will greatly improve the spread of technical and pedagogical information in the Bloomington community. As community members learn new techniques, and as member organizations acquire more advanced equipment, the skills of the entire group will grow.

Indicator 3.4: Program Sustainability

The network structure of community partnerships provide broad-based collaboration that opens multiple avenues for ongoing financial support. Further, the relatively low cost of obtaining and maintaining MakerCarts enhances the scalability of the project so that it is feasible for private donors or small grants to fund startups of similar maker networks of school/community partnerships in other Indiana communities. Lastly, small businesses may see benefits to similar local networks as many of the companies that make digital fabrication equipment are based in the US and would be approached first in the purchasing of equipment for MakerCarts; for example, IU owns 3D printers made by ZCorp (Massachusetts) and STRATASYS (Minnesota). The proposed project supports innovative US companies that make rapid production and prototyping equipment, while strengthening Indiana's economy by helping build a manufacturing base for the 21st century---one based on innovation, creativity, and knowledge rather than cheap labor.

Indicator 3.5: Program Budget

Personnel and Fringe

The vast majority of the budget will be used to support site coordinators (at 13% FTE) as well as lead educators (at 50% FTE) at formal and informal education Network partner locations, including the Bloomington Project School and the Monroe County Public Library. Additionally, BloomingLabs and Indiana University will receive a site coordinator position (at 13% FTE) to coordinate activities at their location. BloomingLabs will also receive funding for one or multiple professional development coaches (at 13% FTE) to support monthly professional development sessions as well as funding for an outside trainer with deep expertise to assist in the project (at

20% FTE). Additionally, the Bloomington Project school's site manager, Daniel Baron, will receive an extra 7% for general project management (a total of 20% FTE for his position) and a technology coach to support infusion of MakerSpace activities across the school day and handle issues for the project related to technology upkeep and maintenance (at 60% FTE). Lastly, a Business Manager will be responsible for purchasing supplies and equipment for the project over the course of the grant. Long-term these positions will be supported by the sponsoring institutions or will no longer be needed following the growth of institutional capacity at each of the partnering organizations. A base fringe rate of 28% has been applied to all personnel positions.

Contracted Services

This includes a subcontract to Kylie Peppler at the Center for Research on Learning and Technology to cover her costs (at 13% FTE) and the costs of a Graduate Assistant (at 50% FTE) to assist with project evaluation activities, associated fringe, and 15% institutional overhead for the project.

Materials and Supplies

This will include the base consumable materials for stocking the MakerCarts. Materials and supplies will include LEDs, alligator clips, switches, breakout boards, transistors, batteries, copper tape, scissors, and other supplies useful to MakerSpace workshop activities. All settings will be stocked with similar equipment but may vary slightly on the materials and supplies for each setting depending on the needs of each of the project partners.

Equipment and Technology

This will include the base equipment for the MakerCarts. Each of the four MakerCarts will be stocked with the same technology to ease teaching, learning, and maintenance as well as build capacity across the Network. Included on each of the MakerCarts will be a laser printer, programmable sewing machine, LilyPad Arduino wearable computers, squishy circuits, multimeter, sign plotter, soldering irons, digital multimeters, 3D printer, and other essential equipment for the workshops. Equipment has been tested and chosen for its reliability, durability, ease of use, promote high quality learning and multiple uses, as well as applicability to educational settings.

Other Services

To support project documentation, sharing, and scalability, we will employ a team of professionals. More specifically, we plan to employ a professional web designer to assist with the public portal with information about the project if others plan to adopt a similar model elsewhere across the State of Indiana. We also plan to hire a professional photographer and videographer to capture project activities. Based on prior experience, we have found that hiring an hourly external team is essential to fast and reliable turn around time necessary to share information in a timely manner.

Indicator 3.6: Program timeline

The proposed project will take place over the course of 1 year, beginning in June 2013 and coming to an end in May 2014. The following summarizes the key project and evaluation activities throughout the grant cycle:

	2013		2014	
	July-	Sep-	Jan-	Apr

	Aug	*Dec*	*Mar*	*-Jun*
Project Planning Period, including the ordering of the supplies, sub-contracting, IRB submission, and project meetings.				
Project Meetings to plan the quarterly thematic events, align with purchasing supplies, and think about workshop coordination across sites.				
Hire 1 50% FTE Graduate Research Assistant (GRA) to assist in project evaluation.				
Offer Pre-Service Teacher Education Early Field Experience course, providing 25 new undergraduate mentors to the BGC site.				
Plan and seek approval for Service Learning Courses in Informatics and Computing to being in Spring 2013 semester.				
Offer Informatics and Service Learning Courses, providing 20 undergraduate mentors to BGC and other outreach sites at schools, after-school, and/or summer programs.				
Offer training to research staff and project sites from BloomingLabs.				
Offer daily programming to middle school students at BPS.				
Ongoing formative and summative evaluation activities.				
Project staff to grant write to fund project staff beyond grant cycle.				
Outreach planning to other sites including Girl Scouts, Fairview Elementary and Tri-North Middle School. Program as opportunities emerge in coordination with granting partners.				
6-week Passions programming for the Bloomington Project School (BPS) students plus liaison building at BGC. Minimum of 20 middle school students to be part of the weekly seminars (2 hr/day).				
AY programming at the Monroe County Public Library (3-4 hours weekly).				
1-week summer programs at the Monroe County Public Library (5-6 weekly sessions).				
Website development and project documentation / Posting to the IDOE portal				
Write interim and final progress report for IDOE.				