Objective 6: Materials Design Plan for STEM Lessons with Teach for America
Materials Design Plan for STEM Lessons with Teach for America

It has been noted that there is a shortage in teachers, especially in the mathematics and science disciplines throughout the United States. Due to these shortages, alternative routes to becoming teachers have increased throughout the years. Instead of a teacher gaining certification through the traditional route of earning a bachelor’s degree from higher institutions, more teachers are gaining their certification through alternative routes such as Teach for America, Troops to Teachers, etc. These alternative certification routes vary in the amount of training offered and the length of time it takes to complete the necessary requirements to earn certification.

It is the goal of this research to infuse the curriculum of Teach for America (TFA) with STEM (Science, Technology, Engineering, and Mathematics) education based on project based learning. Through the use of project based learning along with technology, such as graphing calculators and scientific probes for gathering data, students who are pursuing teaching jobs through Teach for America, will be better prepared to handle the needs of students for the 21st century. Training these TFA recruits in the fundamentals of using Project Based Lessons (PBL’s) in the classroom will allow for more cross-curriculum education opportunities or higher levels of multiple curriculum lessons to be used in the classrooms of these fledgling teachers.

Need for the Project

As of August 2010, TFA does not offer any training using PBL’s along with the use of graphing calculators or probes for gathering data (K. Gastrock, personal communication, August 3, 2010). TFA’s scope and sequence of curriculum consists of a five week summer training course that focuses on teaching during the summer programs, observation and feedback from experienced teachers, rehearsal lessons, clinics in developing and writing lesson plans, sessions on curriculum used in the classroom, and reflection sessions for students to think of how certain aspects of the lessons occurred and how they could be better. There is no mention of educating corps’ members in the use or writing of PBL’s. There is also no mention of integration of technology such as the graphing calculators or science probes.

Teach for America does state that there are six core strands at the heart of the curriculum. These strands are: Teaching as Leadership, Instructional Planning and Delivery, Classroom Management and Culture, Diversity, Community and Achievement, Learning Theory, and Literacy Development (Teach for America, n.d.). These are all very important aspects of teaching in the classroom, but could be improved through the implementation of education through PBL’s and technology.

According to Prince and Felder (2006) project based learning and other forms of inductive learning allows for educators to present new knowledge in the context of what the students already know or what is referred to as “prior knowledge.” Many traditional classrooms introduce new information as isolated knowledge disconnected from all others, but through the use of PBL’s this new information is presented in context with other knowledge that students may already poses, which makes learning relatively easy. Then if the new knowledge is in contradiction to the learner’s prior knowledge, there will be a time of confusion, but this confusion can cause the learner and teacher to work through to a resolution causing greater understanding (Prince & Felder). In addition to connecting prior knowledge and the content
being taught in the classroom, the use of PBL’s also allows for students to take control of their learning and feel a sense of ownership. This ownership allows the students to go back and think about their thinking, a process that is called “metacognition” (Barron et al., 1998).

It is also important to note that when results from a national achievement test were compared between students who learned through Project Based Science (PBS) to the national average, PBS students scored significantly higher on many items. “Even when compared to groups that traditionally score higher on achievement tests (middle class and white students), on average the PBS students, including minorities, outscored the national sample on almost half of the items” (Schneider et al., 2002). In the same study, Schneider et al. discovered that the PBS students were vastly superior to the national average when it came to questions that had longer answers. PBL’s, PBS, and inquiry learning allow for students to extend their thinking and learning. The education system is calling for students to have the capability for higher level thinking; it appears that these project based learning styles allow for student achievement to improve in this category and allows for teachers to nurture this phenomena.

To instill this type or education program in the majority of schools in the United States, it is imperative that teachers from all educational backgrounds be given the information and skills to implement PBL’s in the classroom. This includes educating recruits for Teach for America in the use of PBL’s and to use technology along with it. Barron et al. (1998) stated that new models of professional development for pre-service teachers are needed to enhance the process of using PBL’s in the classrooms. One item that Barron et al. specifically mention is the creation of environments specifically for pre-service teachers, where they can learn in a project based style and by doing so can see the big picture of learning through inquiry. By being a part of this process, these pre-service teachers can also see some of the pit falls that many teachers encounter and solutions to enhance learning.

To enhance the learning through the PBL’s, technology is an integral component. Koschmann et al. (1996) described the use of technology to enhance learning by allowing students to save their data and work. Through the use of technology, all of the students’ work and findings can be easily searched and organized, not to mention much easier to read (type versus hand written). In the same line of thinking, Koschmann et al. also described making the PBL as authentic as possible and also allow students the opportunities to use mechanisms that enable the collection of valid data. This is the reasoning behind the addition of technology into the PBL education for Teach for America pre-service teachers. The pre-service teachers will need to feel comfortable using the technology so that they are better able to use them in classroom situations and at the same time explain to the students how to best use the equipment. The use of the graphing calculators and attached probes will allow students to collect data and display it in multiple ways. This will allow for students to see data sets in raw data, graph, and table and chart forms which could help students who have different learning styles.

**Goals and Outcomes**

The goal of this initiative and research is to create a curriculum program for the pre-service teachers who are members of Teach for America. The curriculum program will include workshop type activities to involve the pre-service teachers in working through project based learning lessons and discuss the best practice for implementation. The program will also focus on
cooperative work between educators from different disciplines. Teachers with diverse subject backgrounds such as mathematics, English, language arts, science, technology, engineering, health education, physical education, etc. will work to create a professional learning community (PLC). Through these PLC’s, the teachers will begin to develop their own PBL’s based on state and national standards. Each of the PBL’s created will be infused with the use of technology in some format. It could include basic computer functions (spreadsheets, word documents, email, etc.), graphing calculators, electronic probes, or online capabilities (instant messaging, video conferencing, wiki pages, etc.). Other technological materials that will be in use include multi-media presentations of actual teachers using PBL’s in the classroom effectively. TFA students would then be able to comment on what was viewed and online discussions would be held to determine what was learned through the observations. These opportunities would allow for TFA students to not only review and observe PBL’s in the classroom, but allow them to work with technology that they might not be familiar with.

The outcomes that the researchers are looking for include: educators with better understanding of the project based learning style, teachers better prepared to work collaboratively in schools, teachers trained to work with the ever changing technological resources, and for teachers to be enabled to use the inquiry method to facilitate higher level problem solving skills in students.

Activities and Timeline

The first year of the program will involve researchers and educators collaborating on materials to be implemented of the Project Based Lessons into Teach for America classes. Each of the materials will be created to enhance the program already in use by Teach for America during their summer courses. STEM experts along with TFA educators will also be involved in the creation of the materials to ensure that the objectives stay true to the STEM procedure, while at the same time fulfill the needs of the teachers who will be ultimately in charge of using the materials in the classrooms (see Figure 1). Figure 2 demonstrates the flow of the content that will be devised for the courses that will be involved in the TFA STEM initiative.

The TFA student education timeline will consist of three five week courses offered during the summer time (in consecutive years) through Teach for America. Each year, the courses will follow the same basic timeline (see Figure 3) and will become progressively more intense and in depth. These courses will maintain the same attributes that Teach for America already has in place, but throughout the training sessions, project based learning with technology will be implemented. For example, during the portion of study where the pre-service teachers are working with students, they will be implementing a project based lesson. Then the pre-service teachers will receive feedback from the veteran teachers. The course would also have time for writing curriculum, but portions of that time will be spent working in heterogeneous groups developing project based lessons. Again, there will be constant feedback from mentoring teachers to improve the lessons and how to apply them.

Year one will focus students’ attention on interacting with students in the classroom while at the same time build up the comfort level of the TFA students. This year’s main goal is to make the students comfortable working with school aged children. The TFA candidates would also be working in classes with other students on writing lesson plans, understanding the curriculum for different levels, classroom management techniques, how to implement technology
into lessons to enhance the learning experience, and reflecting on their own personal learning, metacognition.

The second year would allow for further growth of the TFA students. They would be working on furthering all of their understanding from the previous year while working on different delivery styles that can enhance student learning and understanding in the classroom. This year would also allow for students to interact with the expert teachers and their classmates to continue working on the STEM lessons that they have begun to write. Students would also have the opportunity to observe expert teachers in the classroom to critique and learn about how to handle different situations that occur often inside the classroom.

In the final year of the course work, TFA students will be working on finalizing the STEM lessons that they have been revising and working on the previous two years. The students will also be working more closely with mentoring, expert teachers to enhance their personal teaching styles while maintaining classroom management techniques that fit their needs. Each of the courses that will be taken by the TFA students can be viewed in Figure 3 with more detail pertaining to each individual class.

Figure 1. Year 1 - Creation of PBL/TFA materials.

| Sept. - Oct. | Identify staff: TFA educators, experts in science education, mathematics education, technology education, engineering education |
| Nov. - Feb. | Create syllabus for classes to be taken by prospective TFA students. Creation of classwork to supplement current TFA courses with STEM education and technology infusion. Educational experts will evaluate and make suggestions for revisions. |
| Mach - May | Trial testing of materials with current pre-service teachers. Materials will be revised by teachers, students, and STEM experts to ensure highest quality. |
Figure 2. Content map for the Teach for America STEM lessons

Throughout the three years, the new teachers will have mentors whom they work with and discuss teaching issues that will include the project based lessons. The teachers will document their lessons and how well their students mastered the objectives that were to be covered by the lesson. Further professional development will be held throughout the school year to cover any problems or questions the teachers might encounter. After the three years is over, the teachers are then expected to share information with Teach for America to better serve the new pre-service teachers whom have just begun the program. It will be a cyclical process where new pre-service teachers are guided or mentored by successful veteran teachers creating new forms of professional learning communities.
Figure 3. Course timeline for students involved with Teach for America infused with Project Based Lesson creation.

Summer Session 1

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<tr>
<th>Summer Class 1:</th>
<th>Summer Class 3:</th>
<th>Summer Class 5:</th>
<th>Summer Class 7:</th>
<th>Summer Class 9:</th>
<th>Summer Class 11:</th>
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<tbody>
<tr>
<td>Working with Students - Working with small groups of students with expert teachers, to get the feel of the classroom environment</td>
<td>Curriculum Sessions - Looking at curriculum guides and how to implement them with PBL’s</td>
<td>Lesson Plan Clinics - Revising lessons to streamline and ensure they are of top quality</td>
<td>Technology Integration - Integrating lessons with technology, such as the use of graphing calculators &amp; science probes</td>
<td>Reflection Sessions - Reflect with experts on the lesson, discuss positive aspects, &amp; items to be changed</td>
<td>Classroom Management - Classroom management techniques discussed &amp; implemented</td>
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<td>Summer Class 2:</td>
<td>Summer Class 4:</td>
<td>Summer Class 6:</td>
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<td>Lesson Writing - Creating lesson plans and incorporating PBL by working with the basic outlines of a good lesson plan</td>
<td>Rehearsal Sessions - Teachers work with PBL experts on how to execute the PBL’s in the classroom</td>
<td>Instructional Planning &amp; Delivery - Standards based approach to planning &amp; delivery of lessons with PBL’s in mind</td>
<td>Implementing Lesson - Working in a classroom setting, use the lesson created with a small class of students</td>
<td>Revision of Lessons - Expert teachers help re-work the lessons to ensure best practices</td>
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### Summer Session 2

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<th>Summer Class 9:</th>
<th>Summer Class 10:</th>
<th>Summer Class 11:</th>
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<tr>
<td>- Working with groups of students with expert teachers, to review classroom techniques</td>
<td>lesson plans with other curriculum members to incorporating PBL’s</td>
<td>Looking at rubrics of multiple disciplines and how to implement them with PBL’s</td>
<td>Teachers work with PBL experts on how to execute the PBL’s in the classroom with team teaching</td>
<td>Revising lessons to streamline and ensure they are of top quality</td>
<td>the standards &amp; PBL’s created, discuss delivery methods, with focus on student involvement</td>
<td>integrating lessons with technology, such as the use of graphing calculators &amp; science probes</td>
<td>Working in a classroom setting, use the lesson created with a small class of students</td>
<td>Reflect with experts on the lesson, discuss positive aspects, &amp; items to be changed</td>
<td>Expert teachers help re-work the lessons to ensure best practices</td>
<td>Student guided learning is discussed &amp; reviewed</td>
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### Summer Session 3

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<th>Summer Class 5:</th>
<th>Summer Class 6:</th>
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<th>Summer Class 9:</th>
<th>Summer Class 10:</th>
<th>Summer Class 11:</th>
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</thead>
<tbody>
<tr>
<td>Working with Students</td>
<td>Lesson Writing – Creating more</td>
<td>Rubric Sessions –</td>
<td>Rehearsal Sessions –</td>
<td>Lesson Plan Clinics –</td>
<td>Delivery – Using the</td>
<td>Technology Integration</td>
<td>Implementing Lesson –</td>
<td>Reflection Sessions –</td>
<td>Revision of Lessons –</td>
<td>Leadership – Using teaching as a leadership approach to motivate students &amp; other educators</td>
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<tr>
<td>- Working with groups of students with expert teachers, to review classroom techniques</td>
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Project Team

The project team will be comprised of the Project Director, the Host Institution, the Project Team, the STEM Advisory Group, and mentor teachers (see Figure 4). The role of the Project Director will be one of leadership. The director will have the final say in all decisions regarding the project, from financial decisions to curriculum decisions that he/she sees as the best interest for the project’s outcome. The Director will work closely to the project team by being a member of that team to create all materials used during the project all while at the same time overseeing the progress of the project to ensure all goals are met on time.

The Host Institution will be Teach for America. Utilizing the educators, classrooms, and materials this group already has in place, costs will be lower due to the fact that these attributes will already be in place and paid for by Teach for America. TFA will not need to implement more spending because these costs would have already been in place because of the courses that had traditionally been offered by the group.

The Project Team will consist of 10 – 12 educational experts in the fields of science, technology, engineering, and mathematics, along with officials from TFA and TFA educators. The group will be responsible for creating the course work for the TFA classes, implementation of the materials, training TFA educators to proficient levels, and maintaining all STEM criteria. The Project Director will also be a member of the Project Team and be working collaboratively with the group to produce high quality materials.

The STEM Advisory Group will consist of 4 – 5 STEM educational experts who will serve a vital role of overseeing the materials created for the TFA courses. This group will read and revise all materials, to their satisfaction, to maintain the high quality the project is aiming for. All team members will meet jointly at least twice a month to go over goals, project progress, and materials to keep the project on the timeline and to increase communication between all members involved.

Mentor teachers will be vital to this project. These professionals will be selected based on a criterion of understanding the STEM initiative, the implantation and use of PBL’s in the classroom and the use of, and understanding of high level teaching qualities. Mentor teachers will be responsible for visiting TFA teacher classrooms and evaluating the use of the PBL’s with the students. They will also give tips and instructions to better the educational experiences taking place within the walls of the schools. These mentor teachers will be in charge of 8 – 10 TFA educators who have been placed in different schools.
Purpose of the Project

The purpose of this project is to enable alternatively certified teachers, namely those who complete their training through Teach for America, to be better prepared to use technology in the classroom, enhance lessons through the use of PBL’s and create an educational environment that is suited for higher achievement from students. These first year teachers come in to the classroom with many needs, and by giving them the skills to work successfully with other, more experienced teachers, it will allow for a mentoring process to occur. Through this collaboration, first year teachers can gain insight for success in the classroom and at the same time, introduce project based learning to others who are not currently using this strategy.
Partnerships

Teach for America, Texas Instruments, and Vernier Software and Technology will be involved in the project through the use of materials and equipment. The project will utilize the Texas Instruments handheld device known as the TI-Nspire. This “calculator” will be used during most course work to store and manipulate data collected by the students. Through the use of the TI-Nspire, students will develop an understanding of how to formally collect real world data and use it in the classroom setting with students. The TI-Nspire also allows the students and educators to connect directly to Vernier Software and Technology’s science probes that allow data to be easily collected. Examples of these probes are the temperature probe, motion detector, salinity sensor, and many others (To see a full list of the Vernier probes and sensors go to: http://www.vernier.com/probes/index.html).

Other multimedia devices to be employed throughout the TFA STEM trainings will include online tutorials for students to examine PBL’s that were already created and make connections to each of the STEM parts that are visible in the lesson. Students will also be responsible for adding comments about how they would change the lesson to make it more streamlined or to better fit the needs of the learners or educators. These interactive materials will allow for hints to be given to the student which may include definitions of terminology, guidelines for assessments, the STEM process and approach, or other helpful tidbits of knowledge that can help the student’s understanding of how STEM PBL’s should work in classrooms. These online tutorials will also have an area for online discussions that will be led by mentor teachers, STEM experts, or content experts to push TFA students to better understand the profession of education.

Impact

The impact of this program/research will be to educate pre-service teachers in the use of project based learning and in turn allow for more successful students. The impact should be greatest in the areas of mathematics and sciences, while at the same time allowing for more cross-curriculum or multi-curriculum lessons to improve students’ awareness of the interconnectedness of knowledge. The impact should also be seen by the amount of hands-on/minds-on activities that take place in the classrooms. Instead of the teacher being the holder of all of the knowledge, the teacher becomes a facilitator for the students to make connections between prior knowledge and new knowledge.

Evaluation and Assessment of the Project

In the initial stages of the learning project, TFA students will be learning the process of creating PBL’s and also how to implement them into the classroom setting. At the same time, students will be attending other classes that offer insight into the everyday aspects of becoming a member of the teaching profession. To assess how well these TFA students are understanding concepts and teaching methodology, during the course, teaching experts will be showing clips of teachers in the classroom and will have the students observe and critique what they see happening in the classroom. By doing this, it will become clear whether or not the TFA students have grasped the understanding of good teaching practices. Also during these classes the TFA students will be expected to work in collaborative groups to develop simple STEM lessons that will be used later in their course work to become fully developed PBL’s. The STEM experts will
evaluate the simple STEM lessons that the student groups have developed and will discuss with the group the positive aspects of their lesson and also offer constructive criticism for the students to use as they revise their lessons.

After the TFA students become educators, the project will be assessed on how often the Teach for America teachers use the project based learning system and the level at which the PBL’s are used (determined through classroom observations of mentor teachers and TFA trained officials) and how well students of these teachers perform on national and state standardized tests (not just looking for pass/fail rates, but also looking for improvements from year to year). Also, discussions will be conducted by the mentoring teachers with the TFA educators about how to better their delivery styles, classroom management skills, lesson writing skills, and their overall PBL teaching ability.

**Sustainability**

This partnership between Teach for America and the project group will be in place until the grant period is over. Leading edge technology, such as laptop computers, graphing calculators, science probes, and software will be purchased that can be used for years. The curriculum is pertinent for each pre-service and veteran teacher and as new teachers come in, trainings will be held to ensure they are updated on project based learning enhancements.
References


