Introduction

The proposed research is a pilot project designed to improve understanding about the processes involved in prospective teachers transferring what they learn online working with a virtual fieldwork experience, the Virtual Fieldwork Sequence (VFS), to their work in the face-to-face elementary classroom student teaching context and its impact on their pupils’ learning. I am presently using the VFS in my teaching of prospective teachers and have permission to conduct pilot work for my own unfunded research program. Funding to conduct this work from the Program Evaluation and Research Center (PERC) at West Virginia University would enable me to better understand the strengths and needs of prospective student teachers as they work with the mathematics that they need to support their own pupils as they learn, and to develop knowledge that will enable me to eventually adapt this learning to synchronous technology.

The proposed pilot work focuses on two of the eight Standards for Mathematical Practice (SMP; CCSSI, 2001) using non-routine challenge problems as a vehicle for engaging prospective teachers and elementary students in learning experiences: (1) making sense of problems and persevering in solving them, and (2) developing and critiquing arguments. Funding will facilitate tracking prospective teacher work with the VFS as it progresses into elementary classroom placements. The research will focus on the development of prospective teacher facilitation of student abilities to make sense of problems and persevere to solve them, as well as their ability to justify (provide a rationale, or argument for) their work.

The pilot project will extend prior work being conducted by Drs. Amy Brown, Jennifer Wall, and Sarah Selmer through continued observations of prospective teachers as they progress from online work to application in the classroom. There has been an increasing trend in the use of online learning environments, both courses and entire programs, at our university as well as others. Presently, our university is one of the 30% of institutions with education related degrees (teaching credentials and graduate degrees) that have completely online programs (Allen & Seaman, 2008). This increase in online learning (Allen & Seaman, 2008) makes it essential that we understand how prospective teachers transfer those experiences to face-to-face teaching. Ultimately the primary investigator would like to use synchronous technology (i.e., interactive video) in adapting successful elements of the asynchronous model targeting practicing teachers, prospective teachers, and elementary classroom students in the state of West Virginia.

Contextual and background information is provided in the following sections describing the VFS, the targeted SMP, and previous research. The final section of this proposal provides project objectives, action steps, timeline, connections to the primary investigators research interests, and specific connections to PERCs goals.

Virtual Fieldwork Sequence (VFS)

The VFS is a series of three online modules developed with National Science Foundation funding by the Math Forum@Drexel (mathforum.org) to prepare and engage prospective teachers in the asynchronous—outside the constraints of time and place—mentoring of students’ solutions to non-routine challenge problems that was developed by the Math Forum @ Drexel. Prospective teachers prepare to become a student mentor by completing a series of online learning modules. The modules challenge prospective teachers to solve non-routine challenge
problems, critique the reasoning of their peers, analyze student work using assessment rubrics, and practice mentoring student solutions. After completion of the three VFS modules the prospective teachers engage in live online mentoring of Elementary students through the Math Forum @ Drexel’s Problem of the Week. For more information on this topic refer to http://mathforum.org/problems_puzzles_landing.html.

In the VFS and during live mentoring, the prospective teachers use a problem specific rubric to help assess and scaffold student learning in the areas of problem solving (interpretation, strategy, and accuracy), communication (completeness, clarity) and reflection. As the prospective teachers mentor the elementary students, mathematics teacher educators make suggestions and give ultimate approval for the prospective teacher communications with elementary students. Non-routine challenge problems and problem specific rubrics, such as those published by The Math Forum @ Drexel, are used in the VFS to engage and assess prospective teachers and elementary students in learning experiences which are primarily focused on two of the eight SMP. An example rubric is found in Appendix A.

**The Standards for Mathematical Practice (SMP)**

The common core state standards for mathematics (CCSSM) outline the mathematical content that must be taught in K-12 schools and describes how students should be learning that content. The SMP serve to proscribe how students should be learning mathematical content (CCSSI, 2001). The SMPs that are the focus of the VFS are: SMP 1, make sense of problems and persevere in solving them; and SMP 3, construct viable arguments and critique the reasoning of others. For more detailed SMP information see http://www.corestandards.org/math/practice.

**Previous Research Focused on Prospective Teacher Engagement in SMP**

A key responsibility of teacher education is to support prospective teachers as they foster mathematical practices among their students (Li, 2013). Using the VFS in teacher preparation provides this support in two distinct areas. First, as mentioned above, the prospective teachers are engaged in two of the SMP, making sense of problems and persevering in solving them (SMP 1) and constructing viable arguments and critiquing the reasoning of others (SMP 3). Second, the VFS provides asynchronous online experiences for the prospective teachers in fostering these mathematical practices among students.

A group of mathematics education faculty members (including the author) from three different universities specifically investigated how the engagement by prospective teachers in solving non-routine challenge problems through the VFS affected their growth as teachers of mathematics specifically in reference to their own engagement in SMP1 and 3. Each prospective teacher’s ability to find and communicate solutions to non-routine problems was analyzed before, during, and after they experienced the VFS. Results from that study showed growth in a majority of participants and that there are reliable characterizations (still being analyzed for further/varied characterizations) of the growth of prospective teachers as result of participation in the VFS. The purpose of the proposed research is to build on and extend this work.
Proposed Pilot Study

The proposed pilot study aims to understand how prospective teachers transfer experiences from the VFS to face-to-face elementary classroom teaching by analyzing the factors that influence the process. The asynchronous aspect of the online experiences provided to prospective teachers by VFS is different from what might be experienced in face-to-face classroom settings. The goal of the proposed pilot study is to extend the previous research to include planning and implementation of face-to-face classroom teaching by prospective teachers that have participated in the previous VFS research. The following objectives will guide this pilot study.

Objective 1

Conduct the described pilot study, including:

- Look beyond immediate course content and consider other factors (including previous data) that influence the prospective teacher in order to better understand observed interactions in a face-to-face teaching situation.
- Observe planning and enactment by student teachers as they teach a non-routine challenge problem in a face-to-face classroom setting.
- Explore the following research question: How do we describe and characterize teachers’ interactions with The Math Forum @ Drexel curriculum materials?

Rationale: The proposed pilot study examines a complicated, multi-layered relationship between the teacher and the curriculum. The only way to effectively study this relationship is to provide a sound theoretical and analytical frame for the research. This framework and related analysis are described in Appendix B and the project action steps. The characterizations of prospective teachers identified in previous research will be expanded where necessary to more comprehensively describe the results from observing the planning and implementation of face-to-face teaching.

Objective 2

Engage doctoral student in on-going research project from inception to dissemination of findings.

Rationale: This grant will support agenda for the primary investigator as well as provide learning opportunities for a doctoral student to engage in the entire research process. It is anticipated that the doctoral student will participate in collaborative conversations with the primary investigator, collect and analyze qualitative data, and work with the primary investigator to disseminate the findings.

Objective 3

 Improve virtual learning experiences used in teacher preparation and better understand the transfer from asynchronous teacher preparation to face-to-face classroom settings.
Rationale: The intent will be to develop a richer understanding about how prospective teachers are able to transfer asynchronous teacher preparation experiences to face-to-face classroom settings.

**Objective 4**

Pursue funding to develop and support synchronous, real time, virtual resources for use in ongoing professional development related to learning about and teaching the SMP in the state of West Virginia, specifically targeting rural areas.

Rationale: Currently the primary investigator makes use of the asynchronous materials from The Math Forum @ Drexel that target prospective teachers nationwide. The primary investigator would like to adapt successful elements of the asynchronous model using synchronous technology (i.e., interactive video) and to target practicing teachers, prospective teachers, and elementary classroom students in the state of West Virginia.

**Action Items**

The pilot study objectives will be achieved through the following action steps:

1) The participants for the proposed study will be recruited from the group of prospective teachers that completed the VFS and mentored elementary students during the fall 2013 semester. The goal is to have 20 (of the previous 42 prospective teachers) for the proposed study.

2) A theoretical lens will be adapted from Remillard’s (2005) framework and used to conceptualize the potentially complicated relationship between the teacher and the curriculum in the proposed research context. For more detailed information about the theoretical framework see Appendix B.

3) The characterizations (as described by Remillard and adapted for this project in Appendix B), such as resources, experiences, stances, and perspectives, of the prospective teachers will be isolated using data from two sources.

   a. Each participant will have previously completed a descriptive survey in conjunction with the VFS. These surveys will enable identification of the interests, self-efficacy, level of prior mathematics and mathematics anxiety for each participant.

   b. Previous research covering the same prospective teachers assessed the growth over time on the part of these participants with respect to SMP1 and SMP3 concepts. The various characterizations of the growth in these areas for each prospective teacher, which are still being analyzed, will be used to isolate and articulate additional characterizations of the prospective teachers.

4) The participants will be observed during lesson planning activities.
a. The prospective teachers will each choose a non-routine challenge problem from the Math forum @ Drexel curriculum to be taught in a face-to-face elementary classroom.

b. The available problems cover a variety of grade levels and content foci and each has an accompanying teacher packet with teaching considerations, assessment tools, example student work, and classroom handouts.

c. The prospective teacher will bring his/her chosen curriculum materials to scheduled lesson planning observation with the teacher educator.

d. The participants will be interviewed using a Think Aloud protocol (Afflerbach, 2000; Clement, 2000).

e. Each will respond to the following instructions:

   "I would like you to look at this non-routine challenge problem and related teaching materials just like you do when you are lesson planning. Tell me everything that you are thinking about as you are looking at the curriculum."

f. During the observation the teacher educator will ask probing questions designed to seek explicit aspects of the reasoning and decision making processes of the prospective teacher.

g. The lesson planning observation session will be videotaped and transcribed.

5) Observe each participant as they teach the non-routine challenge problem he/she selected for the lesson planning observation as it is actually taught in a face to face classroom setting.

   a. Classroom artifacts such as student work and photos of group work will be collected.

   b. Actual curriculum materials utilized by the prospective teacher will be collected.

   c. The classroom session will be videotaped and transcribed for further analysis.

6) Data from the planning and enactment of the non-routine problem will be analyzed using an open coding (based on the work of Glaser & Strauss, 2009) that incorporates both deductive and inductive coding of the prospective teacher activities and the resulting student learning. The use of the following analytical frames will be used for the deductive coding:

   a. For prospective teachers Sherin and Drake (2009) identify reading, evaluation, and adaptation as three critical elements of how teachers use curriculum materials. The initial coding will use these elements to establish the provisional coding scheme of the lesson planning interview and classroom observations.

   b. For prospective teachers and students the lesson planning and enactment observations will be analyzed using a coding scheme based on the rubric criteria established by the Math Forum @ Drexel. This coding will focus on both student
engagement and the prospective teachers providing students opportunities to engage in SMP 1 or SMP 3.

7) Interpret and represent data based on characterizations of the participatory relationship between the prospective teacher and the curriculum. For example, do prospective teachers who were previously characterized as having a "low mathematics disposition" and who show high ability to engage in SMP 1 and 3 throughout the VFS show similar patterns in the face-to-face classroom enactment and related students learning?

8) Submit peer-reviewed journal manuscripts and national/international conference proposals based on the findings.

   Targeted Journals May Include: The Mathematics Teacher Educator; Contemporary Issues in Technology and Teacher Education; Journal of Mathematics Teacher Education

   Targeted Conferences May Include: Association of Mathematics Teacher Education Annual Conference; National Council of Teachers of Mathematics Annual Conference (research pre-session)

9) Seek external funding for additional program development and research in virtual learning platforms. A goal of this proposed research is to submit a grant proposal to fund a synchronous virtual learning platform to engage prospective teachers and practicing teachers with rural-based elementary students in the state of West Virginia. The pilot study will provide direction and support to pursue funding toward this goal. Targeted External Funding Sources May Include: Improving Teacher Quality State Grants; The Bill & Melinda Gates Foundation; The Spencer Foundation
### Timeline

This study will begin in the spring 2014 semester.

<table>
<thead>
<tr>
<th>Action</th>
<th>Date</th>
<th>Who</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action 1: Recruit participants</td>
<td>Spring 2014</td>
<td>Primary Investigator</td>
</tr>
<tr>
<td>Action 4 &amp; 5: Conduct 5 observations (lesson planning and enactment)</td>
<td>Spring 2014</td>
<td>Doctoral Student</td>
</tr>
<tr>
<td>Action 2: Adapt framework</td>
<td>Summer 2014</td>
<td>Primary Investigator</td>
</tr>
<tr>
<td>Action 3: Organize pre-existing characterizations of participants</td>
<td>Summer 2014</td>
<td>Primary Investigator</td>
</tr>
<tr>
<td>Action 6: Initial coding of conducted observations</td>
<td>Summer 2014</td>
<td>Primary Investigator</td>
</tr>
<tr>
<td>Action 4 &amp; 5: Conduct remaining observations (lesson planning and enactment)</td>
<td>Fall 2014</td>
<td>Primary Investigator</td>
</tr>
<tr>
<td>Action 6: Initial coding of conducted observations</td>
<td>Fall 2014</td>
<td>Primary Investigator</td>
</tr>
<tr>
<td>Action 6: Initial coding of observations</td>
<td>Spring 2015</td>
<td>Primary Investigator</td>
</tr>
<tr>
<td>Action 7: Data interpretation</td>
<td>Spring 2015</td>
<td>Primary Investigator</td>
</tr>
<tr>
<td>Action 8: Submit conference proposal</td>
<td>Summer 2015 and ongoing</td>
<td>Primary Investigator</td>
</tr>
<tr>
<td>Action 8: Submit conference proposal and manuscript writing</td>
<td>Summer 2015 and ongoing</td>
<td>Primary Investigator</td>
</tr>
<tr>
<td>Action 9: Seek and submit grant proposal</td>
<td>Summer 2015 and ongoing</td>
<td>Primary Investigator</td>
</tr>
<tr>
<td>Action 10: Develop synchronous learning environment</td>
<td>Summer 2015 and ongoing</td>
<td>Primary Investigator</td>
</tr>
</tbody>
</table>
Connections to Personal Interests

I am currently an Assistant Professor in the Department of Curriculum and Instruction, Literacy Studies, West Virginia University (WVU). During my time at WVU, my primary research focus has been in the area of prospective teacher learning. I have conducted original research on prospective teacher learning in both face-to-face and virtual learning environments. I have also published and presented the findings from this research.

I am interested in extending this work in understanding the connections between virtual learning experiences of prospective teachers, focusing on developing their ability to foster mathematical practices among their students and how that learning transfers to their actual classroom teaching. As previously described, the proposed study will use information from earlier studies in which I have been involved. I anticipate that successful application for this PERC grant will serve to demonstrate to external funding agencies my commitment to virtual teacher and student learning.

The doctoral student to be engaged in this project has experience in working with prospective teachers using the VFS. Participation in this project will provide her a deeper understanding of how to plan and implement research. This will also support her research agenda at WVU.

Connections to PERC

This project specifically addresses three of the PERC and WVU Strategic Plan Goals.

Goal 1: Engage undergraduate, graduate, and professional students in a challenging academic environment. Funding from this grant proposal will allow for a doctoral student to engage in mentored research. This funding will also have an impact on prospective teachers and elementary students who will be experiencing the VFS during fall 2014, spring 2015, and beyond in that the information gleaned from this study will drive implementation refinements. These implementation refinements will allow the primary investigator and the doctoral student to continue to engage undergraduate and graduate students in a challenging academic environment. Additionally, the pursuit of funding and the ultimate creation of a synchronous learning environment will provide the opportunity to engage prospective teachers, practicing teachers, and elementary students in academically challenging professional learning experiences.

Goal 2: Excel in research, creativity and innovation. The proposed pilot study provides an opportunity for the primary investigator’s research agenda to excel in the areas of virtual teacher preparation experiences and the transfer of those experiences into classroom teaching. The pilot project objective of pursuing funding in the development and support of a synchronous virtual learning network is an innovative way to reach teachers and students rurally located in the state of West Virginia.
Goal 5: Enhance the well-being and quality of life for the people of West Virginia. The proposed study enhances the well-being and quality of life for the people of West Virginia through insights as to how a teacher educator can effectively prepare a prospective teacher to foster mathematical practices among students. West Virginia based prospective teachers who then find teaching positions within the state will be able to pass this understanding to students within the state. Further if this pilot study leads to the necessary funding and support for a synchronous virtual learning platform it will enhance professional learning opportunities for West Virginia practicing and prospective teachers, and in turn, provide opportunities for elementary students to benefit from improved effectiveness in the teaching of mathematics.

Budget Narrative

The PERC funding that is being requested totals $3000.00. If funded it will be used to support costs associated with recruiting and conducting the pilot study. Funding is being requested for resources for the participants and doctoral student ($628.00[including fringe]). Each participant will be given a $20.00 gift certificate for project participation. The doctoral student will be given $228.00 [including fringe] for summer research assistance. The doctoral student intends to use this research to fulfill course requirements during the 2014-2015 school year. Funding is being requested for transcription of data ($293/[including fringe] for 13.5 audio hours at $20.00/hour). Funding is being requested for the primary investigator to design, organize, monitor, participate in, and supervise this research ($2316 [including fringe]).
References


### Appendix A: Example of a task specific rubric from The Math Forum @ Drexel

<table>
<thead>
<tr>
<th>Problem Solving</th>
<th>Novice</th>
<th>Apprentice</th>
<th>Practitioner</th>
<th>Expert</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interpretation</strong></td>
<td>Understands few of the criteria listed in the Practitioner column.</td>
<td>Understands most but not all of the criteria listed in the Practitioner column.</td>
<td>Understands that • the problem asks how much money was saved buying two tubs of salsa instead of jars of salsa. • a 20-oz jar costs $2.29. • a 4 lbs. 6oz. tub costs $3.49. • she bought two tubs. • there are 16 ounces in 1 pound.</td>
<td>Is at least a Practitioner and comes up with the correct solution for the Extra.</td>
</tr>
<tr>
<td><strong>Strategy</strong> (Note: based on the solver’s interpretation of the problem)</td>
<td>Has no ideas that will lead them toward a successful solution or shows no evidence of strategy.</td>
<td>Uses a strategy that uses luck instead of skill, or doesn’t provide enough detail to determine whether it was luck or skill.</td>
<td>Uses a strategy that relies on skill, not luck, which might include: • thorough noticing and wondering • draw a picture • use manipulatives • make a table</td>
<td>Does one or more of these: Uses two different strategies. Uses an unusual or sophisticated interpretation of the evidence of strategy.</td>
</tr>
<tr>
<td><strong>Accuracy</strong> (Note: based on the chosen strategy)</td>
<td>Has made many errors.</td>
<td>Some work is accurate. May have one or two errors.</td>
<td>Makes few mistakes of consequence and uses largely correct vocabulary.</td>
<td>[Generally not possible – can’t be more accurate]</td>
</tr>
<tr>
<td><strong>Communication</strong></td>
<td>Has written very little that explains how the answer was achieved.</td>
<td>Might show that their solution works without saying anything about how they figured it out. Might summarize their strategy without showing any math work to justify their answer.</td>
<td>Tells all of the important steps taken to solve the problem, which should include: • any relationships used. • the rationale behind each decision they made. • explaining why their answer is correct.</td>
<td>Adds one more to be complete</td>
</tr>
<tr>
<td><strong>Completeness</strong> (Note: an incorrect solution can be complete)</td>
<td>Explanation is very difficult to read and follow.</td>
<td>Another student might have trouble following the explanation. Long and written in one paragraph. Many spelling errors/typos.</td>
<td>Explains the steps that they do explain in such a way that another student would understand (needn’t be complete to be clear). Uses level-appropriate math language. Makes an effort to check formatting, spelling, and typing (a few errors are okay).</td>
<td>Formally correct, although not exceptionally clear.</td>
</tr>
<tr>
<td><strong>Clarity</strong> (Note: incomplete and incorrect solutions can be explained clearly)</td>
<td>Does nothing reflective.</td>
<td>Does one reflection.</td>
<td>Does two reflections.</td>
<td>Does three or more reflections or does an exceptional job with two.</td>
</tr>
<tr>
<td><strong>Reflection</strong> (Note: see the items in the gray box)</td>
<td>The items in the columns to the right are considered: • Revises and improves a previous submission. • Reflects on the reasonableness of the answer, prior knowledge/experience. • Comments on and explains the ease or difficulty of the problem. reflective, and might be in • Checks the answer using a different • Describes any errors made and how she/he found and corrects them. • Summarizes the process used. the solution or comment: method. • Describes any “aha!” moments. • Explains a hint she/he would give • States any assumptions made in the solving process. • Describes any “aha!” moments. another student. • Described something learned from the problem.</td>
<td>Does nothing reflective.</td>
<td>Does one reflection.</td>
<td>Does two reflections.</td>
</tr>
</tbody>
</table>
Appendix B: Description of pilot study Theoretical Framework

Prior research in education shows that, even when teachers have access to the same resources and experiences, there are differences in how they implement new programs or curricula (Ball & Cohen, 1996). Experience has shown us that prospective teachers, when asked to teach a non-routine challenge problem using the curricular resources from The Math Forum @ Drexel, will engage in planning and implementation in both individual and common ways. Like Remillard (2005), I believe that these similarities and differences are the result of an interaction between the teacher (his/her knowledge, goals, beliefs, experiences, etc.) and the curriculum (text, media, professional development, etc.). The framework highlights what Remillard refers to as the knowledge, beliefs, perceptions, and experiences that teachers draw on as they interact with a curriculum (Remillard, 2005). Figure 1 adapts Remillard’s framework (2005) to describe this complicated relationship between the teacher and the curriculum in the proposed research context.

Remillard’s framework as modified reflects the interplay between the characteristics of the prospective teacher and the curriculum content. The left side reflects the relevant characteristics of the prospective teachers in the context of the proposed research. The right side depicts the characteristics of the course material, in this case the non-routine challenge problems and related curricular materials. The interplay between the two aspects will be explored through analysis of both planned and enacted curriculum developed by the prospective teachers.

Figure 1: Remillard’s adapted framework of components of this teacher-curriculum relationship
While previous work acknowledges that the participatory relationship is itself multi-faceted and embedded in larger contexts, the primary investigator along with others recognizes the need to explicitly isolate elements of it for meaningful study (Remillard, 2005). The proposed study uses pre-existing data—described in the proposed research action steps—to isolate certain resources, experiences, stances, or perspectives that the prospective teacher brings to the relationship with the curriculum (see Figure 2).

Figure 2: Remillard’s adapted framework with isolated characteristics in bold