Deliberate Investigations of a Flipped Class

Rachelle Meyer Rogers
Baylor University

With

Douglas W. Rogers
Baylor University

John Choins
Robinson Junior High

Herb Cox
Midway Middle School

Abstract: This article summarizes two action research projects completed under the direction of an eighth-grade mathematics teacher, who served as the mentor teacher for two teacher candidates from the University's School of Education. This new professional development school was in its first two years of a one-to-one initiative. In AY15, the mentor teacher, intern, and university faculty collaborated on a study of their adoption of a flipped classroom approach to instruction. Two focus questions were examined: 1) What are eighth grade mathematics students' perceptions of a flipped classroom instructional approach? and 2) What impact does a flipped mathematics classroom have on eighth grade mathematics student homework submission? In AY16, the mentor teacher, a new intern, and the university faculty continued the examination of the flipped approach and added a third question; 3) What impact does a flipped mathematics classroom have on eighth grade mathematics student engagement during class? Results from both years indicate a majority of student participants reported favorable responses to the flipped classroom approach. Homework submissions throughout the flipped segment of both studies remained high and student engagement in the flipped setting was higher than in the traditional setting. In the flipped setting sampled students spent more time working on mathematics topics and collaborating with peers than in the traditional setting; while sampled students in the traditional setting spent more time taking notes.

KEYWORDS: inquiry, technology, flipped classroom, mathematics, teacher preparation

NAPDS NINE ESSENTIALS ADDRESSED:

2. A school–university culture committed to the preparation of future educators that embraces their active engagement in the school community;
3. Ongoing and professional development for all participants guided by need;
4. A shared commitment to innovative and reflective practice by all participants;
5. Engagement in and public sharing of the results of deliberate investigations of practice by respective participants

Introduction

The National Association for Professional Development Schools' Nine Essentials define what it means to be a professional development school (PDS). Essential five calls for participants to engage in and routinely reflect upon best practice (Brindley, Field, & Lessen, 2008). In 2009-2010 the University's School of Education and their PDS partnership decided that all interns (senior-level teacher candidates) would engage in action research projects to investigate classroom practices as a capstone experience. While action research has many definitions and can fall under a variety of paradigms, Yendol-Hoppey and Franco (2014) summarized the concept as a form of practitioner research where individuals systematically study their own practices and identified it is a signature pedagogy of professional development schools. Dana and Yendol-Hoppey (2008) also stressed the value of action research to the education process, "Rather than sweeping the problems under the carpet and pretending they don't exist, teachers who conduct action research…welcome problems by deliberately naming them, making them public, examining them, and making a commitment to do something about them" (p. 11).

In spring 2014, the School of Education established a new PDS partnership with a local middle school. This new partnership committed itself to research and to examine best practice as collaborative partners. This article highlights a pair of collaborative action research projects that examined a flipped classroom instructional approach over the period of two academic years. The case serves as an exemplar of action research conducted on the newly established PDS campus.

Rationale for the Study

The current studies rest upon converging concepts: a) that teacher effectiveness is critical to student success (Schacter & Thum, 2005); b) that action research as a form of teacher-directed professional development encourages instructional experimentation (Jones, Lubinski, Swafford, & Thornton (1994); c) that engaging in deliberate investigations of practice is critical for all PDS participants (Brindley et al., 2008); and d) while one-to-one initiatives are gaining popularity, more teachers are experimenting with a flipped classroom instructional approach (Project Tomorrow, 2015).

Related Literature

Schacter and Thum (2005) state that teacher effectiveness is "the single most important school-related factor responsible for increasing student achievement" (p. 328). Additional factors, such as lesson design and classroom activities, contribute significantly to teacher effectiveness (Henson, 2002). Teacher effectiveness may be improved through professional development by encouraging teachers to study their own practices and influence the profession from the inside out (Moran, 2007). Guskey (2000) suggested that professional development was not an event that was separate from one's day-to-day professional routine. Successful professional development is on-going and embedded in the process of developing lessons, instructional activities, and student assessments. Since teachers are in the trenches of the classroom, decisions about instructional changes should come from teacher-directed professional development.

Action research is one form of teacher-directed professional development. As a model of teacher-directed professional development, action research provides a structure for teachers to

systematically investigate their instructional practices in order to improve effectiveness (Dana & Yendol-Hoppey, 2009). According to Jones et al. (1994), educational challenges are best identified and investigated at the classroom and school levels. Local investigation is an essential role of being a professional development school (Brindley et al., 2008).

Researchers have considered the value of professional development that is driven and conducted by teachers rather than by people outside the school community. The theory behind this approach is that the teachers in a school or district are truly the experts when it comes to what the other teachers and students in that district need to increase success. Castle and Aichele (1994) emphasize the need for autonomy and personal decision-making for the classroom teacher. Like students, Castle and Aichele (1994) note that, "when teachers are told what to do, they do not think: they just respond. Since the activity was not of their choice, they do not find it personally meaningful" (p. 5). Models that are much more collaborative in nature are classified as inquiry models of professional development (Loucks-Horsley et al., 2003). Action research is a model that falls into this category.

Action research is a teacher-driven form of research wherein teachers decide what will be studied. There is no formalized research design specific to action research. Teachers work in collaborative teams to answer a question that is of concern to all of them or work individually on a question that is only a concern to a single practitioner. The research question can be driven by concerns about curriculum, student behavior, parent participation, classroom management, or test results. The literature agrees, however, that action research has certain characteristics (Hendricks, 2006; Merther, 2006; McNiff & Whitehead, 2006; Holly, Arhar, & Kasten, 2005; Thomas, 2005; Dana & Yendol-Silva, 2003; Tomal, 2003). Action research is meant to be carried out by educators, ideally in cooperation with at least one other educator. Action research is a reflective process that is meant to provide a framework for educators to analyze what goes on in schools with students. Finally, action research is a way for teachers to feel empowered to find solutions to their own problems.

A growing body of scholarship indicates action research is an important component to developing teachers as researchers (Auger & Wideman, 2000; Capobianco & Ríordáin, 2015; Moran, 2007; Chant, Heafner, & Bennett, 2004;); however, uncertainty plays a significant role when *preservice* teachers conduct action research. Preservice teachers question the effectiveness of their instructional strategies and their students' understanding. Compounded with the task of studying their own practice through action research, teacher candidates face a myriad of concerns. Capobianco and Ríordáin (2015) report four uncertainties identified by preservice teachers engaged in action research: 1) the validity of action research data; 2) the time demands of action research in addition to their course requirements; 3) the perceived value of action research by self and others; and 4) the complexity of the action research process. Capobianco and Ríordáin concluded that school context and support provided to preservice teachers is critical for teacher candidates to embrace and become teacher researchers.

Subramaniam (2010) sought to determine the images that preservice teachers used to frame themselves as teacher researchers. Findings revealed two distinct images; the first image connected to self-fulfillment--preservice teachers viewed the action research experience as either an assignment to be completed or as an opportunity for professional growth. The second image addressed action research space, which had two attributes--a "friendly" action research space or an "unfriendly" action research space. Preservice teachers who experienced a friendly space felt their cooperating teachers supported the action research process; preservice teachers in an

unfriendly space received limited or no support from the cooperating teachers for the action research process. Support from all constituents must be present; hence, the collaborative nature of a professional development school, with support from administration, university faculty, and mentor teachers, would be an ideal environment for investigations of practice (action research).

The new middle school PDS is one of many schools that have adopted one-to-one computing initiatives that seek to provide personal devices and Internet access to students for use at home and school. One published meta-analysis and one currently under review provide a comprehensive overview of the one-to-one initiative. Recently published in the *Review of Educational Research*, Zheng, Warschauer, Lin, and Chang (2016) identified 96 studies to include in their literature review; 10 of which were included in their meta-analysis as a result of meeting more rigorous criteria. All of the studies in the meta-analysis included middle school students (grades 6-8). The, as yet unpublished, review completed by Bethel and Bernard (2016), identified more than 1,300 K-12 one-to-one laptop studies; 88 of which met the more rigorous criteria for inclusion in the meta-analysis. Both of these meta-analyses conclude that such initiatives have a positive impact on student learning. Likewise, one-to-one initiatives and other intensive technology integration strategies, as reported in a recent Johns Hopkins review (Morrison, Morrison, & Ross, 2016), "increased student-centered instruction. Teachers had additional tools and time they could devote to individualized instruction to meet the needs of specific learners." A flipped classroom instructional approach is one such student-centered strategy.

As more school districts adopt one-to-one initiatives, more teachers are experimenting with flipped classrooms. As reported at the American Association of School Administrators' national conference, "for the third consecutive year, 4,326 building and district administrators from 2,600 school districts are seeing a significant increase in teachers flipping their classrooms" (Project Tomorrow, 2015). The Speakup 2014 National Research Project Findings indicate that the number of administrators and teachers who had never heard of the concept of flipped classrooms has dropped to 12% and 7% respectively (Project Tomorrow, 2015).

Flipped classrooms reverse traditional learning environments by delivering content outside the classroom. A flipped classroom requires students to watch recorded video presentations using Internet media services prior to class. During class, students complete activities designed to support or assess their understandings of the concept previously presented. When using a flipped classroom approach, rather than presenting the concept in class, teachers allow students to investigate the concept that was introduced during the video presentation outside of class (Lage, Platt, & Treglia, 2000).

These areas: teacher effectiveness, action research, PDS work, and flipped learning inspired the collaborative investigations, which were two of many such investigations on the PDS campus. These studies illustrate the nature of PDS work and action research. Working together, the various members of the PDS community shared a commitment to collaborative teacher-led investigations, in a supportive environment, where questions about classroom practice could be raised, data collected, results analyzed and practice adjusted accordingly.

Context of the Study

To avoid the negative perceptions identified by Subramaniam (2010), where preservice teachers might perceive action research as just another assignment to complete, the School of Education and its PDS partner campuses encouraged all teacher mentors to engage in deliberate

investigations with their interns. As a means of supporting mentor teachers in this initiative, the partnership conducted a day-long professional development session focused on action research, essentially following the model articulated by Dana and Yendol-Hoppey (2009). The first phase created an understanding of action research and why it is critical for teachers to engage in the process and examine classroom practice. The second phase helped mentor teachers form researchable questions (wonderings). During the third phase, participants brainstormed what data was needed to answer their questions, how that data might be collected, and how the collected data would be analyzed. The day ended with a discussion of ways the partners could share research findings both within and outside of the PDS campuses.

Many of the mentor teachers and the campus principal from the newly identified middle school PDS participated in the one-day action research professional development. Teachers who attended the professional development did not yet know if they would mentor a preservice teacher during the upcoming year; therefore, their level of commitment to a collaborative action research project could not be determined at that time. That same summer, the middle school PDS was to embark upon its first academic year as a one-to-one campus, where every middle school student would be issued an iPad. All middle school teachers received iPads the semester before in order to prepare for the student distribution.

In August 2014, mentor teachers at the middle school PDS were introduced to their preservice teachers (interns). One mentor, an eighth -grade mathematics teacher who had attended the summer professional development on action research, quickly shared his wondering with his intern to determine if they might collaborate on an inquiry. The mentor teacher had heard about and read extensively about flipped classrooms. With the distribution of an iPad to every student, he wanted to implement a flipped classroom and investigate how students responded to this instructional approach. The intern excitedly agreed to collaborate on the inquiry.

Prior to beginning the investigation, the mentor teacher and intern had to establish the flipped classroom approach. During the implementation, the flipped classroom consisted of the following:

- determine the content and practice problems;
- record the video in several short segments using iMovie on the iPad;
- transfer the video to the computer;
- upload the video to YouTube; and
- log student homework submitted electronically.

Each video lesson usually included direct teaching of the identified content, from which students were to take notes; several examples of the problems being taught (worked out in detail); and 2-4 practice problems students completed without assistance and submitted electronically to the teacher before the next class meeting. Class time the following day consisted of five minutes checking the practice problems, five minutes answering questions from the video, and the remaining class time extended the mathematics experience through activities, games, projects, and applications. After establishing the flipped classroom approach, the mentor and intern began their investigation. During academic year 2014-2015 (AY15), the following questions guided the initial inquiry:

1. What are eighth grade mathematics students' perceptions of a flipped classroom instructional approach?
2. What impact does a flipped mathematics classroom have on eighth grade mathematics student homework submission?

These guiding questions were collaboratively established based on the wonderings of the mentor teacher and the intern, demonstrating the PDS commitment to shared inquiry at the local level. In academic year 2015-2016 (AY16), the second year of the one-to-one initiative at the middle school PDS, the same eighth grade mathematics teacher again served as a mentor and shared with his newly assigned intern the action research from the previous year and his desire to continue researching student perceptions of the flipped classroom approach. The second intern agreed to collaborate on the action research, yet also moved in a more independent direction (consistent with the principle that action research is led by the individual teacher). The second intern wanted to examine student engagement during class time at school. As a result, the second year (AY16) of this inquiry added a third guiding question:

3. What impact does a flipped mathematics classroom have on eighth grade mathematics student engagement during class?

Methodology

Participants

The study was conducted in a large suburban middle school with a typical annual enrollment of approximately 1,200 students; the ethnic breakdown of the school is generally 56% Caucasian, 23% Hispanic, 14% African American, 5% Asian, and 2% Other. Low socioeconomic status applies to approximately 33% of the population.

Participants in the first year of the study (AY15) consisted of 151 eighth graders enrolled in algebra or eighth grade pre-AP mathematics. Participants for the second year (AY16) consisted of 148 eighth graders enrolled in algebra, eighth grade pre-AP mathematics, or regular eighth grade mathematics. In total, 299 eighth grade students participated in the study.

Participants in this study experienced two different instructional approaches in their daily 45-minute mathematics class. During the first month of the study, the mentor teacher and interns used a traditional approach to teaching mathematics--students were introduced to concepts, engaged in activities, and applied their understandings while in their assigned class periods. After the first month of the study, the teacher and interns "flipped" the classroom--students were introduced to concepts by watching a teacher-created video lesson at home on their school district-provided iPads. After watching the lesson at home, students engaged in activities and applied their understandings of the topics while in their assigned class periods. Prior to initiating data gathering for each year of the study, the instructor and interns conducted several lessons using the flipped classroom approach to introduce the eighth-grade mathematics students to the concept. The teacher candidates participated fully in the alternating instructional processes. Candidates created instructional videos and planned classroom experiences following the model established by the mentor teacher. Candidates were also encouraged to try their unique approaches to the process, consistent with a PDS environment seeking to maximize impact on student learning.

Data Sources

Over the course of the two years, a number of methods were used to gather data to address the guiding questions. Within the PDS environment, these methods were brainstormed, discussed, and selected collaboratively by those members of the PDS community that would be implementing

the study: teacher candidates, mentor teacher, university liaison, and campus administrators. Participants in AY15 completed an electronic survey at three points during the process (after initiating the flipped classroom approach; at the midpoint point of the flipped classroom approach; and at the conclusion of the study). All data reported in this study was gathered on the final survey.

The electronic survey consisted of three questions. The first question focused on students' overall perceptions of the flipped classroom approach. Answer choices included "really like," "like," "don't have an opinion," "don't like," and "really don't like." The second question focused on the specific component of watching the video lesson at home and students' perceived impact on homework. Answer choices were framed for particular circumstances: "I love watching the videos and taking notes at home. It helps me get my work done in class and I have less math homework than I did last year;" "I love watching the videos and taking notes at home, but I still have about the same amount of homework as I did last year;" "Watching the videos and taking notes at home is OK. I don't love it, but I don't hate it either;" and "I'm not a big fan of watching the videos and taking notes at home. I'd rather take notes in class and do the work at home." The third question allowed students to select from among ten statements that described various aspects of the flipped classroom approach. Multiple statements could be selected by an individual student. The statements addressed such aspects as classroom arrangement, personal responsibility, and interaction with the instructor. These data were used to ascertain student perceptions of the flipped classroom approach.

During both years, a record of completed homework submitted on time provided data for the second guiding question. Homework during the flipped classroom approach was not the typical paper-and-pencil assignment. Homework in the flipped setting was limited to making sure the students watched the video, took notes, and completed the assigned practice problems. At the conclusion of the first year's study, the mentor teacher conducted class-wide interviews with the student participants and recorded anecdotal data that would serve as the basis for a new data gathering strategy in the second year of the study. This would serve as a reflective piece for the inquiry practices of the mentor teacher.

During the second year of the study (AY16), instead of completing the three electronic surveys, students completed open-ended questionnaires (modified by the input of the new intern and based on the mentor teacher's anecdotal data from the previous year's class-wide interviews) at the conclusion of the study. The prompts on the questionnaire asked students to identify: their preferences (with rationale) for either the traditional or flipped classroom; differences in their participation levels between settings; benefits from watching the video lessons prior to class; and the characteristics of both approaches that they liked and disliked. These data provided greater detail and insight regarding the students' perceptions of the flipped classroom approach.

To address the added guiding question related to student engagement during class time, the specific wondering of the second teacher candidate, the researchers trained five observers (members of the PDS campus community) to complete 10-minute samples throughout the course of the study. The training included all levels of the PDS structure (candidates, mentor, campus administrators, site coordinator, and university faculty). This shared training helped establish consistent rater interpretation (inter-rater reliability) of observed behaviors. Likewise, the discussion surrounding the selection, modification, and adoption of the recording instrument increased the potential that observers would collect similar data—increasing the validity of the data.

Each sample required the observer to randomly select six students to observe during a 10-minute timeframe. At 30 second intervals, observers recorded whether each of the six students was on-task (appropriately attending to the current activity) or off-task (not attending to the current activity). On-task behavior was subdivided into five categories to enable the researchers to differentiate the types of student engagement that might potentially appear in the different settings. Off-task behavior had only two subdivisions—general off-task behavior and talking about anything other than content (identified by the mentor as a potential problem with the flipped classroom approach).

Observers completed 31 samples in the traditional setting (310 minutes; 186 randomly selected students observed), and 36 samples in the flipped classroom setting (360 minutes; 216 randomly selected students observed). The form used to record these samples appears as Appendix A the end of the article. These data were used to extrapolate student engagement over the course of the study.

The electronic survey (AY15 only) provided data for the study's questions related to student perceptions of the flipped classroom approach and the impact on homework submissions. The homework tallies (AY15 and AY16) provided data on the homework submissions question. The 10-minute engagement samples (AY16 only) were the data source for the student engagement question; and the open-ended questionnaire (AY16 only) gathered qualitative data related to all of the study questions.

Data Analysis

All student responses from the electronic surveys (AY15 only), the homework submission tallies (AY15 and AY16), and the 10-minute engagement samples (AY16 only) were analyzed using descriptive statistics. Quantitative data from the 10-minute engagement instrument was analyzed for the percent of time on-task and the percent of time off-task. Percentages were also calculated for each subdivision of on-task and off-task behavior.

All responses to the open-ended questionnaire (AY16 only) were independently read and verified by two members of the PDS community that coded data based on an inductive analysis--where themes, categories, and patterns emerged ''out of the data, through the analyst's interactions with the data'' (Patton, 2002). Researchers independently coded the data sources, then compared, discussed, and verified their coding to assure validity and accuracy of the findings. Had a discrepancy occurred, a third researcher would have been consulted; however, no third person review was necessary.

Results

Data were analyzed to answer the three guiding questions:

1. What are eighth grade mathematics students' perceptions of a flipped classroom instructional approach?
2. What impact does a flipped mathematics classroom have on eighth grade mathematics student homework submission?
3. What impact does a flipped mathematics classroom have on eighth grade mathematics student engagement during class?

Student Perceptions

Analyses of responses to the post-study electronic survey in AY15 reveal that 60% of eighth grade mathematics students participating in the study had a positive reaction to the flipped classroom instructional approach; these students responded, "really like" or "like" to the first survey prompt. While a different strategy was used to gather data in AY16, 95% of eighth grade mathematics students participating in the study indicated that they "preferred" the flipped classroom approach over the traditional approach on the open-ended questionnaire. A qualitative analysis of the written rationales included by participants (on the AY 16 open-ended questionnaire) arrived at three primary reasons for preferring a flipped classroom approach:

a) students enjoyed going at one's own pace; not waiting on classmates;
b) students perceived having more class time to address concepts being taught; and
c) students perceived content was easier to grasp because they could watch the video lesson as many times as needed to understand the concept.

These statements, derived from the qualitative data in AY16, are consistent with quantitative data gathered through the electronic survey in AY15. When asked to select all statements that described how they felt from a list of statements about the flipped classroom approach, more than 70% of the students selected the same three statements and all three of the statements were in the top four most popular responses:

a) "I like the opportunity to review the lesson as many times as I need to" (70%).
b) "I have more time in class to finish my work" (73%).
c) "I have more time in class to ask the teachers a question if I don't understand something" (74%).

Homework Submissions

The structure of the flipped classroom approach, where the initial exposure to content is presented outside of class time, creates an extensive demand on work completed at home. In the present studies, students were required to watch a video lesson and complete practice problems at home. The results were to be emailed to the teacher prior to the next class meeting. Tracking the number of times students submitted the required assignments on time was intended to gauge the impact the flipped classroom had on homework submissions. The graph in *Figure 1* shows the percentage of homework submission completed on time by academic year and class. The homework tally is the only data that was consistently gathered across both AY15 and AY16.

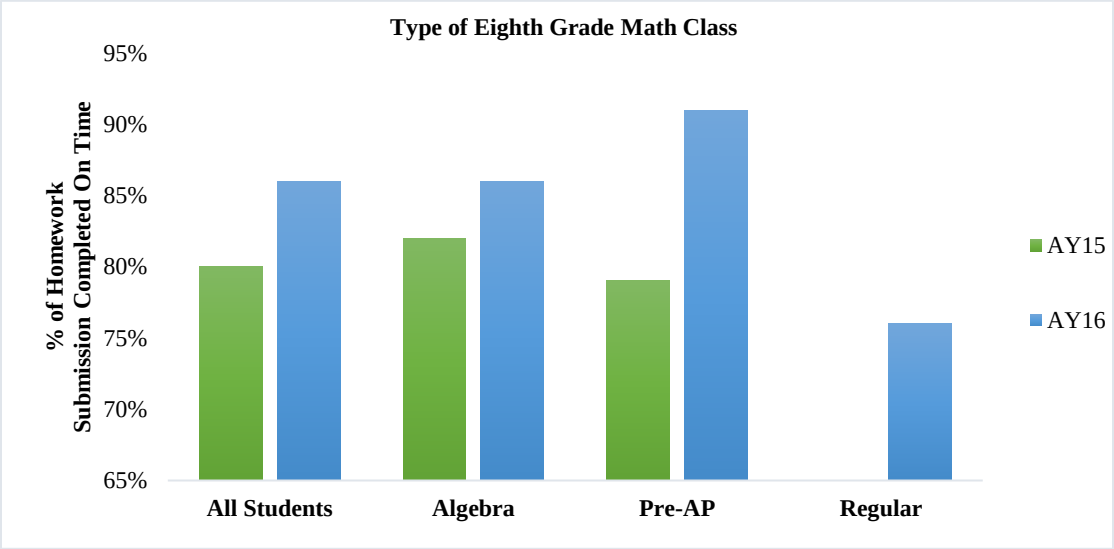

Figure 1. Percent of homework submissions completed on time by year and class. *Note.* Calculated as the number of homework assignments submitted on time divided by the total number of homework assignments. Data were disaggregated by type of eighth grade math class.

As illustrated in *Figure 1*, homework submissions were approximately 80% for all eighth-grade mathematics students participating in the study in AY15. Homework submissions were at 86% in AY16. Eighth grade students in the pre-AP class in AY16 reported the highest percentage of completed on time homework assignments (91%). The lowest percentage of on time completed homework assignments were completed by students in regular eighth grade mathematics classes in AY16. The study did not include regular math classes in AY15; therefore, no data appears in the graph. Homework submissions were not tracked during the traditional classroom segments of the studies.

Student Engagement

Student engagement became the focus of the second study in AY16. A grand total of 670 minutes of class time were sampled to provide data about student engagement (310 minutes in the traditional setting and 360 minutes in the flipped classroom setting). These time samples represent about 12% of the total time eighth grade students spent in the three classes (algebra, eighth grade pre-AP, and eighth grade math) included in the study (670 minutes/5400 minutes—approximated at 45 minutes per class period for five days for eight weeks for three classes). Table 1 summarizes the percent of time sampled students were on- and off-task in each of the class settings.

Table 1. Percent of Time Sampled Students Were On-Task or Off-Task by Setting

Status	Traditional Setting	Flipped Classroom Setting
On-Task	84.1%	92.4%
Off-Task	15.9%	7.6%

Data indicate that sampled students were off-task 15.9% of the time; extrapolated to an entire 45-minute class period, that represents 6 minutes and 45 seconds. Over the course of a week, that might represent a loss of more than 32 minutes (almost an entire class period) of instructional time. The flipped classroom setting reduces that amount by almost half. Sampled students in the flipped classroom were off task only 7.6% of the time; extrapolated to an entire 45-minute class period, that represents 3 minutes and 42 seconds. Over the course of a week, that might represent a loss of only 17 minutes of instructional time.

On-task behavior in both settings was examined more closely. Five subdivisions were established for on-task behavior: taking notes, working, listening, collaborating, and asking questions. When the 10-minute samples were analyzed for specific tasks, major differences appeared and are documented in Table 2. Three subdivisions showed dramatic differences between the settings. Note taking, peer to peer collaboration, and working showed differences of more than fourteen percentage points each. In the traditional setting, sampled students were taking notes 42.6% of the time, while sampled students in the flipped classroom setting were taking notes only 3.3% of the time; a difference of 39.3 percentage points. This difference represents a savings of more than seventeen minutes of class time. The second most significant difference between the settings, 29.6 percentage points, appeared in the subtask of working on mathematical concepts. Sampled students were working on mathematical tasks 1.3% of the time (equivalent to just over five minutes) in the traditional setting. Sampled students in the flipped environment worked on mathematical tasks 35.1% of the time (equivalent to more than fifteen minutes or three times more than in the traditional setting). The third subtask that showed a noteworthy difference was collaborating with peers. Sampled students in the flipped classroom setting collaborated with peers almost seven minutes of the period (15.5% of the time). This was 14.2 percentage points higher than sampled students in the traditional setting who collaborated with peers only 1.3% of the time (less than a minute).

Table 2. Percent of Time On-Task by Subtasks

Status	Subtasks	% of Time Traditional Setting	% of Time Flipped Setting
On-Task	Taking Notes	42.6%	3.3%
	Working	5.5%	35.1%
	Listening	32%	36.3%
	Collaborating	1.3%	15.5%
	Asking Questions	2.6%	2.2%

The quantitative data from the 10-minute engagement samples indicate that sampled students spent more time on mathematical tasks in the flipped classroom setting when compared to the traditional classroom setting. Significant differences were identified in how sampled students spent their on-task time in the two settings. Sampled students in the flipped classroom spent more time working on mathematical tasks and collaborating with peers; they also spent less time taking notes than sampled students in the traditional setting. Overall, the data reflects more and different types of engagement in the flipped classroom setting.

Qualitative excerpts from student comments completed on the open-ended survey (AY16 only) provide insight about student engagement. According to one student, “I participate more in the flipped classroom because I already understand the topic and can be more engaged in the

discussions." Another student explained, "I feel more intrigued by the lesson because I've had a chance the night before to get used to the concept." Overall, engagement during class time moved from students taking notes most of the period to applying and discussing the mathematics they learned. One student summarized this impact by stating, "I can go into class and know what people are talking about. Then I can expand on the topic."

Discussion

While these paired studies provide an interesting view into the perceptions, homework practices and classroom engagement of eighth grade students in mathematics, the studies are also limited by a number of factors. Action research is an acceptable form of teacher inquiry; however, the scope of its focus (a single classroom, a single teacher, a single approach) all serve to minimize the generalizability of the studies' conclusions. The present studies are further limited by confounding data collection schemes that changed from year-to-year. The teacher-constructed instruments (survey questions, open-ended questions, and observation form) were constructed in a collaborative manner in an attempt to increase reliability and decrease bias, but have not been subjected to intense validation protocols. The limitations of self-report data are well documented and the self-reports of eighth grade students engaged in an alternative instructional format should serve to moderate the studies' implications. Finally, using only descriptive statistics, rather than more elaborate statistical analysis, may serve to mask more accurate interpretations of the data.

At the most basic level, this mentor teacher/teacher candidates shared action research serves as an exemplary case of PDS work. The University's teacher preparation program's desire for all senior-level teacher candidates to conduct action research in their own classrooms was embraced by the PDS campus. Shared professional development established a common foundation and common language for all participants. University and campus support created a fertile environment for the examination of classroom practice. While this article reports on this singular case, similar experiences were and continue to occur in multiple classrooms on the PDS campus.

At the heart of practitioner inquiry is the impact on learners (Dana & Yendol-Hoppey, 2009). The present studies documented positive student impact in multiple areas identified by the guiding questions: students preferred the flipped classroom over the traditional classroom and identified specific positive characteristics of the flipped environment; average on-time homework submissions were high in the flipped environment; and student engagement was higher and distinctive in the flipped environment. These results are consistent with the Johns Hopkins' Center for Research and Reform in Education (CREE) report, which concluded that "higher engagement" and "increased interactions with peers" were two of six benefits of technology in the classroom (Morrison, Morrison, & Ross, 2016).

Anecdotally, these studies have been linked to gains on state administered tests. The mentor teacher and others believe the flipped classroom approach helped 12 of 14 participants, who had failed the state mathematics assessment in spring 2015 (as seventh graders), pass the state mathematics assessment as eighth graders in spring 2016. Five of those students had failed the state mathematics assessment in multiple prior years. The belief is that completing homework in a timely manner, participating in class discussions that expanded on their knowledge, and engaging in activities to apply their conceptual understandings, helped students perform better on the exam. These positive results have generated a great deal of enthusiasm for continued action research on the PDS campus.

The data have also revealed an area of concern for the campus. The on-time homework submissions for eighth grade students in regular mathematics class was substantially lower (76%) than the on-time homework submissions for eighth grade students in pre-AP and algebra (91% and 86% respectively). This one discrepancy, essentially hidden by the descriptive statistic (average on-time submissions for all students = 86%), has generated intense questioning on the campus. What should be done when roughly one-quarter of a class arrives unprepared for the day's instruction (students who have not completed the flipped assignment at home)? Unfortunately, there is little data to support any conclusions. Eighth grade regular mathematics students were not included in the first year of the study (AY15), so there is no comparative data to identify increases or decreases. Likewise, homework submission data was not collected during the traditional classroom experience, which prevents comparison to prior behaviors.

Possible interpretations for this difference in homework submissions range widely. Some attribute the difference to intrinsic motivational differences between students who are enrolled in pre-AP and algebra classes and those enrolled in regular eighth grade mathematics. Others perceive the difference as a flaw in the flipped classroom methodology, which would require modification by the instructor. Still others perceive it as students not meeting homework expectations, which would require action from the campus administration. The lingering questions provide a catalyst for on-going inquiry.

This shared action research project also had an impact on the individuals that participated in the studies. The mentor teacher concluded, "This was definitely an experiment I'm glad I tried. I am now a firm believer in flipped learning, and will never go back to a traditional way of teaching again." The intern who participated in the AY15 study indicated he would not continue with the flipped classroom methodology. His primary concern was that it did not appear to be effective for all students. The AY16 intern who expanded the investigation to include student engagement data had a very positive reaction to the process and continues to use the flipped approach in his own classroom as a first-year teacher. The university faculty member serving as University Liaison to the PDS campus is in the midst of the discussions related to the outcomes of the studies. She is enthusiastic about the dialogue occurring around classroom practice and teacher-led investigations. The principal of the middle school made the following observation about these consecutive studies, which has "led to the 'flipping' of all four of our eighth-grade math classes for this current 2016-2017 school year…action research has impacted the entire eighth grade, or approximately half of all of the students who attend our school. It can be said that the results of these action research studies have directly impacted the type of instruction delivered by our teachers, and practiced on a daily basis by our students." As a result of the growing interest in action research, a spring faculty meeting is dedicated to sharing all of the action research projects being conducted by teachers and interns on the PDS campus. These projects are also shared with a community-wide action research symposium including all of the teacher preparation program's senior-level candidates hosted by the University.

The impact of these studies is not limited to the local students, local campus, or even the local university. These studies are consistent with national research related to flipped classrooms. The Flipped Learning Network (2014) identifies four pillars of flipped learning: "flexible environment," "learning culture," "intentional content," and "professional educator." These paired studies maintain a high degree of fidelity to indicators provided by the Network. The experiment met at least one indicator in each of the four pillars. To accommodate the increased class time activity, the teacher had requested that the traditional desks be replaced by tables and chairs. This

change is evidence of the flexible environment pillar and was well received; more than 70% of the students in AY15 indicated that they "like the way the classroom is set up (with tables and chairs instead of desks)." Likewise, one of the indicators of learning culture is "in-class time is dedicated to exploring topics in greater depth and creating rich learning opportunities…students are actively involved." These studies indicated that more students were involved and that more time was spent working on and talking about mathematics during class time in the flipped setting. The third pillar, intentional content—educators "determine what they need to teach and what materials students should explore on their own," was clearly evident in the design of the flipped learning portions of the two studies. Finally, the fourth pillar—professional educator, calls for the professional to be "reflective in their practice" and to "connect with each other to improve their instruction." Both studies were conducted by a mentor teacher collaborating with teacher candidates (supported by campus administration and university faculty) to study and improve their classroom practice.

Conclusion

The twin initiatives of PDS work and action research drove this deliberate investigation of a flipped classroom approach. These collaborative studies, conducted by a mentor teacher and successive teacher candidates exemplify the work that pervaded the PDS campus. The mentor teacher embraced the teacher preparation program's challenge to model studying one's own practice. The preparation program provided requisite professional development and on-going support as both candidates and mentors embarked on self-identified investigations of their local classroom practices. The university faculty member who served as the liaison to the PDS campus also served as a key presenter in the action research training, which provided an extraordinarily supportive environment for the PDS campus.

Within this PDS structure, the mentor teacher and candidates were empowered by adoption of an action research agenda to examine the implementation of a flipped classroom environment as the campus implemented a district-wide one-to-one iPad initiative. The study examined the perceptions of eighth grade mathematics students and the on-time homework submissions as the teachers implemented a flipped classroom environment. In the second year of the study, an examination of student engagement during class time was added. Overall the results were positive, though expanding the flipped environment to a larger population of students in the second year has revealed that all students do not respond equally well to the approach. The PDS community now must address differing interpretations of and the limited amounts of data collected as it also addresses how it will respond to the questions raised by the data and its interpretations. However, this is as it should be in a professional development school—intense discussions about data, practice, and student impact.

References

Auger, W., & Wideman, R. (2000). Using action research to open the door to life-long professional learning. *Education, 121*(1), 120-127.

Bethel, E., & Bernard, R. M. (2016). A meta-analysis of one-to-one access to laptop computing in K-12 classrooms. Manuscript submitted for publication.

Brindley, R., Field, B., & Lessen, E. (2008). *What it means to be a professional development school.* National Association for Professional Development Schools.

Capobianco, B. M., & Ríordáin, M. N. (2015). Navigating layers of teacher uncertainty among preservice science and mathematics teachers engaged in action research. *Educational Action Research*, *23*(4), 581-598. doi: 10.1080/09650792.2015.1045537

Castle, K. & Aichele, D.B. (1994). Professional development and teacher autonomy. In D.B. Aichele & A.F. Cox (Eds.), *Professional Development for Teachers of Mathematics: 1994 Yearbook* (pp. 1—8). Reston, VA: National Council of Teachers of Mathematics.

Chant, R. H., Heafner, T. L., & Bennett, K. R. (2004). Connecting personal theorizing and action research in preservice teacher development. *Teacher Education Quarterly*, *31*(3), 25-32.

Dana, N. F., & Yendol-Hoppey, D. (2008). *The reflective educator's guide to professional development: Coaching inquiry-oriented learning communities.* Thousand Oaks, CA: Corwin Press.

Dana, N. F., & Yendol-Hoppey, D. (2009). *The reflective educator's guide to classroom research: Learning to teach and teaching to learn through practitioner inquiry* (2nd ed.). Thousand Oaks, CA: Corwin Press.

Dana, N.F., & Yendol-Silva, D. (2003). *The reflective educator's guide to classroom research: Learning to teach and teaching to learn through practitioner inquiry.* Thousand Oaks, CA: Corwin Press, Inc.

Flipped Learning Network (FLN). (2014). The four pillars of F-L-I-P™. Reproducible PDF can be found at www.flippedlearning.org/definition.

Guskey, T. R. (2000). *Evaluating professional development.* Thousand Oaks, CA: Corwin Press.

Henson, R. K. (2002). From adolescent angst to adulthood: Substantive implications and measurement dilemmas in the development of teacher efficacy research. *Educational Psychologist*, *37*(3), 137-150.

Hendricks, C. (2006). *Improving schools through action research: A comprehensive guide for educators*. Boston, MA: Pearson Education, Inc.

Holly, M.L,, Arhar, J.M., & Kasten, W.C. (2005). *Action research for teachers: Traveling the yellow brick road.* Columbus, OH: Pearson Education, Inc.

Jones, G. A., Lubinski, C. A., Swafford, J. O., & Thornton, C. A. (1994). A framework for the professional development of K-12 mathematics teachers. In D.B. Aichele & A.F. Cox (Eds.), *Professional Development for Teachers of Mathematics: 1994 Yearbook* (pp. 1—8). Reston, VA: National Council of Teachers of Mathematics.

Lage, M. J., Platt, G. J., & Treglia, M. (2000). Inverting the classroom: A gateway to creating an inclusive learning environment. *Journal of Economic Education*, 30-43.

Loucks-Hoursley, S., Love, N., Stiles, K., Mundry, S., & Hewson, P. (2003). *Designing Professional Development for Teachers of Science and Mathematics.* Thousand Oaks, CA: Corwin Press.

McNiff, J., & Whitehead, J. (2006). *All you need to know about action research*. Thousand Oaks, CA: Sage Publications, Inc.

Merther, C.A. (2006). *Action research: Teachers as researchers in the classroom.* Thousand Oaks, CA: Sage Publications.

Moran, M. J. (2007). Collaborative action research and project work: Promising practices for developing collaborative inquiry among early childhood preservice teachers. *Teaching and Teacher Education*, *23*, 418-431.

Morrison, G. R., Morrison, J. R., & Ross, S. M. (2016). A review of the research literature on the infusion of technology into the school curriculum. Center for Research and Reform in Education (CRRE), Johns Hopkins University.

Patton, M. Q. (2002). *Qualitative research and evaluation methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Project Tomorrow. (2015). Speak up 2014 national research project findings: Flipped learning continues to trend for third year. Retrieved from http://www.tomorrow.org/speakup/2015_FlippedLearningReport.html

Schacter, J., & Thum, Y.M. (2005). Tapping into high quality teachers: Preliminary results from the teacher advancement program comprehensive school reform. *School Effectiveness and School Improvement, 16*(3), 327—353.

Subramaniam, K. (2010). Images in action: Preservice teachers' action researcher images. *The Qualitative Report, 15*(3), 535-546.

Thomas, R.M. (2005). *Teachers doing research: An introductory guidebook.* New York: Pearson Education, Inc.

Tomal, D.R. (2003). *Action research for educators*. Lanham, MD: Scarecrow Press, Inc.

Yendol-Hoppey, D. & Franco, Y. (2014). In search of signature pedagogy for PDS teacher education: A review of articles published in school-university partnerships. *School-University Partnerships, 7*(1), 17-34.

Zheng, B., Warschauer, M., Lin, C., & Chang, C. (2016). Learning in one-to-one laptop environments: A meta-analysis and research synthesis. *Review of Educational Research*. doi:10.3102/0034654316628645

Rachelle Meyer Rogers,Ed.D., is a Clinical Assistant Professor in the Department of Curriculum and Instruction at Baylor University. Research interests include clinical experiences through web-based scenarios and action research.

Doug Rogers,Ed.D., is an Associate Professor in the Department of Curriculum and Instruction at Baylor University. His area of expertise is the application of technology to the teaching/learning process.

John Choins,M.S.Ed., is an eighth grade mathematics teacher at Robinson Junior High in Robinson, Texas. He is a mentor teacher who has been flipping his classroom for three years.

Herb Cox,Ed.D., is the Principal of Midway Middle School in Hewitt, Texas. He served as the leading advocate to have his campus become a professional development school.

Appendix

Student Engagement Observation Form
(adapted from a form used in the School of Education)

Observer _____ Date _____
Campus _____ Time _____

	Setting S, G, I	Student 1	Student 2	Student 3	Student 4	Student 5	Student 6
:30							
1:00							
1:30							
2:00							
2:30							
3:00							
3:30							
4:00							
4:30							
5:00							
5:30							
6:00							
6:30							
7:00							
7:30							
8:00							
8:30							
9:00							
9:30							
10:00							

Every 30 seconds, observe each of six randomly selected students.
Observe each student for 5seconds during the minute.

Codes:

%_____+ = On Task--following directions, looking at teacher
%_____– = Off Task--not engaged
%_____N = Taking notes
%_____W = Working on assignment
%_____L = Listening
%_____C = Collaborating
%_____Q = Asking questions
%_____O = Off-task
%_____T = Talking (not about lesson)

Student # 1: _____% on task _____% off task
Student # 2: _____% on task _____% off task
Student # 3: _____% on task _____% off task
Student # 4: _____% on task _____% off task
Student # 5: _____% on task _____% off task
Student # 6: _____% on task _____% off task
Total #1-#6: _____% on task _____%off task