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The Effects of Professional Development and Formative Assessment Quality on Students' Self-Regulation in Primary School Mathematics

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Walden University
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Abstract

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MSEd, Brooklyn College, 2006

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Student self-regulation is associated with mathematics achievement in Nigerian primary schools, and formative assessment holds promise for increasing self-regulation. However, to date no research has explored teacher professional development (PD) for formative assessment and its effects on students' self-regulation in Nigerian primary schools. This quasi-experimental nonequivalent control group design used Desimone's teacher professional development conceptual framework, Popham's model for practicing formative assessment, and Zimmerman's concept of self-regulated learning. Research questions concerned whether differences existed in teachers' practice and students' self-regulation between two groups of Nigerian primary school mathematics teachers who received variations of professional development. The sample was 13 volunteer mathematics teachers (7 in a workshop plus follow-up group and 6 in a workshop-only group) and 183 students from 7 primary schools. Teacher formative assessment quality (FAQ) data was collected from 3 classroom observations and student end-of-project self-regulation was measured via a questionnaire. Descriptive analysis at the teacher level showed that teachers in the workshop-plus group had a higher level of FAQ than workshop-only teachers. A *t* test showed students with workshop-plus teachers had significantly higher self-regulation scores on average than students with workshop-only teachers, although FAQ did not correlate with students' self-regulation scores, possibly due to a small sample size. This study contributes to social change by providing supporting evidence for school administrators to provide workshop plus follow-up coaching PD to teachers to increase the quality of formative assessment, which may have implications for improving mathematics achievement among primary students in Nigeria.

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Dedication

I dedicate this dissertation to my family. To my husband for believing in and supporting me all these years. To my children for their constant prayers, enduring patience, and understanding of my constant busy moments. To my siblings for not doubting for a moment that I could complete this. To my parents for their endless prayers and faith that indeed this journey would be completed to God's glory.

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Chapter 1

Many Nigerian primary school students perform poorly on customized standards-based tests in mathematics (Fajemidagba, Salman, & Ayinla, 2012). Although there is a dearth of studies in this area, the few studies that have been carried out over the years show that there is a deficiency in numeracy and literacy learning outcomes of Nigerian students in primary school–kindergarten through Grade 5 (Johnson & Gabrscek, 2008)–and secondary schools–Grade 6 through 11. Many factors have been blamed for students' underachievement and phobia for mathematics (Okafor & Anaduaka, 2013). Since teaching in the Nigerian context is based mostly on direct instruction without room for students to participate in their learning (Fajemidagba et al., 2012), one of the factors that cause underachievement and phobia for mathematics may be students' lack of autonomy or control over their own learning (Gbolagade, Waheed, & Sangoniyi, 2013).

Students in many schools that exclusively use the Nigerian curriculum rarely receive feedback other than a term grade; the students' progress is not tracked to make adjustments during ongoing learning, which compromises student achievement, alienates students, and reduces their level of ownership over their learning (Okafor & Anaduaka, 2013). This reliance on direct instruction itself may be the result of a culture of teacher strictness, overcrowding in math classrooms, infrequent professional development (PD) opportunities, poor salaries, and frequent teacher strikes (Gbolagade et al., 2013).

It may be that more responsive instruction centered on formative assessment would help students activate and develop their self-regulatory abilities (Zimmerman, 1990; Panadero & Alonso-Tapia, 2013). Educational self-regulation is a learning strategy

that students can use to improve their understanding (Panadero & Alonso-Tapia, 2013). Researchers have found that self-regulation is a key indicator of student achievement (Cheng, Liang, & Tsai, 2013; Khalkhali, Sharifi, & Nikyar, 2013; McClelland, Ponitz, Messersmith, & Tominey, 2010).

By instructing teachers on how to adopt formative assessment practices, which entail providing feedback to students and inviting students into the instructional process, PD programs could lead to improved student self-regulatory skills and, ultimately, increase mathematics achievement in Nigerian schools. The purpose of this quantitative study was to assess the effects of two variations of teacher PD on formative assessment practices of teachers and, subsequently, students' self-regulation in primary school mathematics. The absence of research in this area showed the potential of the study to contribute to social change. Mathematics is an important subject and includes numeracy skills that students must master to be productive members of modern society. Nigeria is the most populous nation in Africa (World Population Review, 2016) and its government has set the goal of becoming an industrialized nation by 2020 (Agbodike & Ajah, 2014). For industrialization to succeed, mathematics education must be taken seriously and improved upon (Gbolagade et al., 2013).

This chapter will first present the background for the study. Following that, I describe the problem statement, purpose, research questions, hypothesis, theoretical concepts, nature of the study, definitions, scope and delimitations, limitations, and significance of the study.

Background

Self-regulation is a key self-assessing learning strategy that students have in varying degrees. Although some researchers believe that the level of self-regulation of a person may change across the lifespan depending on environmental or other factors (McClelland et al., 2010), self-regulation entails exerting control over actions, emotions, and motivations in a cyclic process (Zimmerman, 1990). There are a variety of definitions of self-regulation based on cognition, affect, and behavior (McClelland et al., 2010).

Cognition-wise, self-regulation is metacognitive in nature in that it entails thinking about how one thinks and acts in response to stimuli or in the integration of learning processes. It entails the planning and adoption of behaviors that support the achievement of desirable goals (McClelland et al., 2010; Santosh, Roy, & Kundu, 2015). Affect-wise, self-regulation is the ability to manage emotions in a socially tolerable manner that demonstrates controlled responses to stimuli (McClelland et al., 2010). Behavior-wise, self-regulation is defined as the process of persons purposefully modulating, modifying, or inhibiting their actions and reactions to achieve a better or more positive outcome (McClelland et al., 2010).

From an education standpoint, self-regulation entails all the above. Educational self-regulation is defined as a learning strategy that includes metacognition, planning, and adopting behaviors that support the achievement of desirable academic goals, managing emotions such as frustration and gratification in the classroom, and purposefully

modulating, modifying, or inhibiting actions and reactions in and out of the classroom to achieve a better academic outcome (Zimmerman, 1990).

Formative Assessment

Formative assessment is the adjustment of instructional or learning tactics during ongoing teaching and learning (Popham, 2008). It enables students to self-assess to improve learning (Panadero & Alonso-Tapia, 2013). This student self-assessment process entails a teacher-guided plan-practice-evaluate process and teacher-guided learning and reflecting process (Popham, 2008; Panadero & Alonso-Tapia, 2013). This continuous learning and reflecting process could eventually become automatic for students, at which point it then becomes student-guided self-assessment (self-regulation; Zimmerman, 1990).

Quite a few researchers have found that formative assessment—the practice of providing students with ongoing feedback during the learning process—can help students understand content being taught and improve their learning outcomes (Black & Wiliam, 1998; Popham, 2008; Stull, Varnum, Ducette, & Schiller, 2011). Stull et al. (2011) found that, based on students' assessment outcomes, formative assessment that involved university lecturers and students adjusting teaching and learning tactics improved student achievement. Phelan, Choi, Vendlinski, Baker, & Herman (2011) found that formative assessment supported by PD and instructional resources (short assessments to check for student understanding and teacher handbooks, etc.) significantly improved high performing middle school students' scores in mathematics. Doige (2012) focused on formative assessment in a voluntary online environment and found that students who

frequently participated in a low-risk formative assessment program were more likely to achieve higher scores on tests and exams than their peers who did not participate in the program.

Self-regulation (student-guided self-assessment) and formative assessment (teacher-guided self-assessment) are two different constructs; however, they are both forms of self-assessment (Panadero & Alonso-Tapia, 2013). Formative assessment entails reflection on work done, decision making with regards to improving upon learning tactics (in the case of students) while self-regulation is the exertion of control over behavior to achieve a desired outcome (Zimmerman, 1990). Specifically, transformative assessment entails four levels of implementation. Level one is teachers' instructional adjustments: teachers build learning progressions for target curricular aims and use learning progressions and assessments—letter card responses, selected response items, constructed response items, whiteboard responses, and so forth—to identify when to adjust instruction. Level two is students' learning tactic adjustments: students are presented with the curricular aims in understandable language, students see rubrics/scoring guide and samples of extreme responses—one excellent and one deficient—and students see the building blocks of the learning progression and how assessment evidence will be collected. Students use the aforementioned and teacher-identified potential assessments, teacher-identified adjustment triggers, and, finally, teacher-proposed learning tactic adjustments in order to decide on the adjustments to make (Popham, 2008). Level three is classroom climate adjustment (teacher distributes classroom climate guidelines, seeks trust and nurtures it seriously, models and reinforces appropriate conduct, solicits

students' advice on classroom climate, assesses students' relevant affective status). Level four is school-wide implementation (implementation of levels one to three via a PD program or a teacher learning community in which teachers learn from each other and share best practices) in schools, districts, and beyond.

Although it is unclear whether training teachers to adjust their instructional tactics and aid students on their journey towards adjusting their learning tactics will affect students' self-regulation, the self-assessing property of formative assessment lends itself to the exploration of how this pedagogic process (a process that students can learn) relates to and impacts self-regulation (a learning strategy that is somewhat innate) (Panadero & Alonso-Tapia, 2013).

Professional Development

PD is a tool used to impact teacher quality and can be both formal and informal. It is also the key to life-long learning (accumulations of new skills and knowledge) in a teacher's career. According to Akiba (2012), teachers participate in various learning activities, which can be classified under formal and informal PD activities. In addition to formal and informal PD activities, there are also different types of PD models, teacher learning communities, online learning communities, professional learning communities, one-off PD sessions/workshops, college courses, coaching, mentoring, and so forth (Akiba, 2012).

The impact of PD programs on teaching quality vary (Akiba, 2012; Desimone, 2009). Essentially, the value of a PD model or program is not in whether it is formal or informal or in the type of program but in the components that form the model or program

(Desimone, 2009). Desimone (2009) conducted a review of the PD literature spanning 10 years and found five key components common to successful PD programs. The elements include: content focus, active learning, coherence, duration, and collective participation. Quite a few researchers have conducted studies where they assessed the impact of various PD programs on teaching quality and student achievement. On average, they found that the active learning, content focus, coherence, and collective participation helped new learning transfer to consistent teaching practice (Bifuh-Ambe, 2013; Brendefur, Strother, Thiede, Lane, & Surges-Prokop, 2012; Heller, Daehler, Wong, Shinohara, & Miratrix, 2012; Mukeredzi, 2013). In contrast, some researchers who conducted studies that did not include collective participation or coherence did not find great gains in the improvement of teaching quality or student achievement (Arens et al., 2012). Well-structured PD programs with most of the components in Desimone's framework provide the best opportunities for impacting teacher and student outcomes. This study could add to the literature on PD and self-regulation as self-regulation has the potential to impact student achievement (Popham, 2008) and, ultimately, aid the production of well-functioning members of society.

Problem Statement

A solution is needed for the high failure rate of students on the West African Senior School Certificate Examination l, taken in May/June of each year by students in the last grade (Senior Secondary Three, SS3) of secondary school. To increase the number of students who get five credits on the West African Senior School Certificate Examination l from 21% to a higher number and decrease the number of students who

have a phobia for mathematics, the Federal Ministry of Education (FME) will have to look at more than just improving infrastructure in schools (FME, 2014). Teaching and learning must improve, and transformative assessment holds promise for improving instruction and learning in the classroom, as well as student achievement and self-regulatory skills (Popham, 2008; Popham, 2011).

Although there is a dearth of research on formative assessment's effects on self-regulation, current research shows that formative assessment practices are useful in the classroom and can help improve teacher and student outcomes (Vingsle, 2014), provided factors such as classroom climate and classroom climate among others are accounted for and well managed (Yin, et al., 2008).

The transformative assessment model, which may provide the FME, State Universal Board for Basic Education, Nigerian Educational Research and Development Council, and private school owners with a model for implementing formative assessment in schools, has not been studied and thus this study may begin to form the evidence base for this framework.

Purpose of the Study

The purpose of this quantitative study was to assess the effects of two variations of teacher PD on teachers' formative assessment quality (FAQ) and, subsequently, students' self-regulation in primary school mathematics. Type of PD was an independent variable while FAQ (as measured by an observation protocol) was both an independent and dependent variable. Students' self-regulation end-of-project scores on the Academic Self-Regulation Questionnaire (SRQ-A) assessment was the dependent variable.

Research Questions and Hypotheses

The following research questions guided inquiry in this study.

RQ1: How does FAQ, as measured by an observation protocol, vary depending on the type of PD teachers receive (workshop only vs. workshop plus follow-up)?

RQ2: What is the relationship between FAQ and students' self-regulation scores as measured by the end-of-project SRQ-A?

$H_0$2: There is no relationship between FAQ and students' self-regulation scores.

H_a2: There is a positive relationship between FAQ and students' self-regulation scores.

RQ3: Is there a difference in student self-regulation scores as measured by the end-of-project SRQ-A between students whose teachers received workshop-only PD versus students whose teachers received workshop-plus-follow-up PD?

$H_0$3: There is no difference between the self-regulation scores of the groups of students whose teachers received workshop-only PD versus students whose teachers received workshop-plus-follow-up PD.

H_a3: The self-regulation scores of students whose teachers received workshop-plus-follow-up PD are higher than the scores of students whose teachers received workshop-only PD.

RQ1 was descriptive due to the small sample size (n = 13) of teachers. However, the working hypothesis for RQ1 was that teachers who participated in both the workshop and

the follow-up discussion sessions would have exhibited a higher quality of formative assessment practice compared to teachers who participated in the workshop only.

Conceptual Framework

Figure 1 depicts the conceptual framework for this study. Conducting workshops and following up with ongoing PD is expected to improve teachers' FAQ because ongoing PD presents teachers with an opportunity to discuss implementation issues, share best practices, and learn more about formative assessment and how it applies to their practice (Desimone, 2009; Edwards-Grove, 2013).

FAQ could affect the ability of students to self-regulate because teachers who adjust their teaching tactics and guide their students to adjust their learning tactics (latent variable) teach them to use assessment for learning. These students learned to manage their own learning experience. Making plans to learn, practicing skills and concepts, and evaluating their own learning were all parts of the self-regulation process (Zimmerman, 1990).

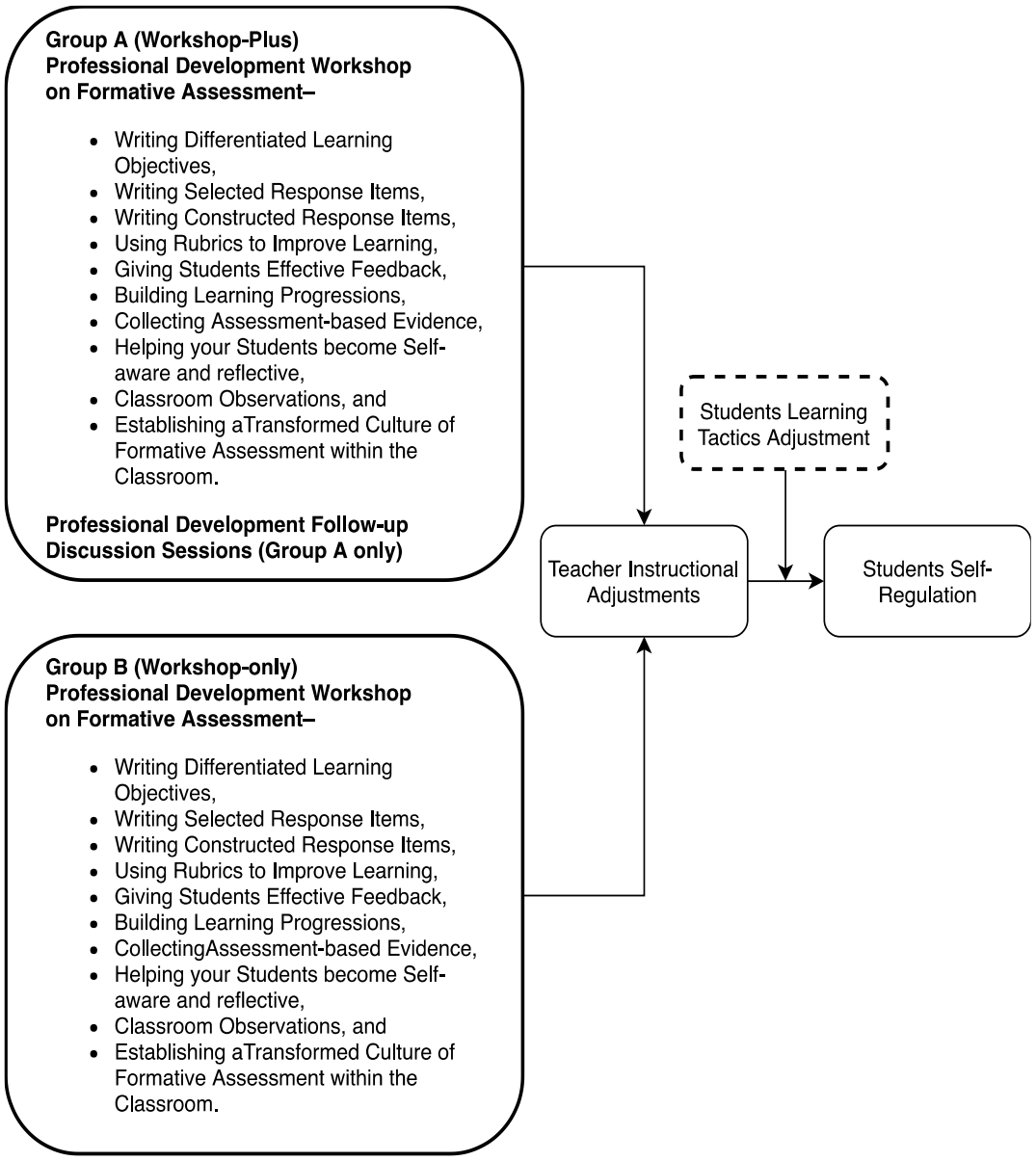

Figure 1. Researcher-developed conceptual framework. The Bethesda Education Project (BEP) delivered the PD based on transformative assessment practices (Popham, 2008). A classroom observation protocol was used to assess formative assessment quality (independent variable) and the Academic Self-Regulation Questionnaire (SRQ-A) was used to assess student self-regulation (dependent variable).

The hypothetical proposition that PD can affect teacher instructional practices in specific ways that influence student self-regulation rests on a theoretical framework

derived from a combination of Desimone's (2009) teacher professional development framework, Popham's influential prescription for implementing formative assessment practices detailed in his book for practitioners, *Transformative Assessment* (2008), and Zimmerman's concept of self-regulated learning (1990). These concepts are discussed in detail in Chapter 2.

Nature of the Study

This quantitative study involved the use of a quasi-experimental nonequivalent control group design. The purpose of this quantitative study was to assess the effects of two variations of teacher PD on formative assessment practices of teachers and, subsequently, students' self-regulation in primary school mathematics. I used a quasi-experimental nonequivalent control group design in this study because participants constituted a convenience sample, as schools and teachers volunteered (there was no random assignment of participants into groups) to participate in a project/intervention.

The Bethesda Education Project (BEP) offered nonprofit schools a PD opportunity aimed at transforming their teaching and learning environments in their schools. Thirteen teachers registered for the project and these teachers had an associated 183 students (in primary 3, 4, and 5, ages 8 to 10, which is equivalent to Grades 2, 3, and 4 in schools in the United States). The teachers attended workshops on building learning progressions, adjusting instructional tactics, teaching and supporting students on assessment literacy and adjustment of learning tactics, classroom climate implementation, and self-regulation strategies that were conducted for teachers in both groups. After the workshops, some teachers opted to continue PD (Group A) while others opted not to continue PD (Group

B). Teachers in Groups A and B were expected to adjust instructional practices and their associated students (n = 183) were expected to adjust their learning tactics. Teachers were also expected to create and promote an appropriate classroom climate. As mentioned earlier, teachers in Group A underwent continuing PD throughout the course of the project, whereas teachers in Group B attended the initial workshops, but received no additional support or training. During the project, teacher participation was tracked. To gather data on teachers' formative assessment practices, a classroom observation protocol was used. To test for student self-regulation at the end of the project, the SRQ-A was used. Data on teachers and students was collected and archived by the Bethesda Child Support Agency (BCSA).

Under the nonequivalent group design, Group A (workshop + follow-up) was considered a quasitreatment group and Group B (workshop only) was considered a quasicontrol group. Descriptive statistics are presented to answer RQ1. For RQ2, an analysis entailing the running of a Pearson product-moment correlation is presented. A *t* test was used to analyze RQ3.

Definitions

Professional development (PD): The specialized training given to participating teachers to help them increase their knowledge and competence on how to practice formative assessment practices and transform their classes into environments where students and teachers undergo ongoing assessments for learning.

Formative assessment: The adjustment of instructional or learning tactics during ongoing teaching and learning. Formative assessment is an instructional process and

pedagogic strategy that enables teachers and students to reflect on their ongoing work and improve upon it in real time (Black & Wiliam, 1998; Popham, 2008).

Formative assessment quality (FAQ): The observable quality of ongoing assessment for learning (teacher's instructional adjustments, student's learning tactics, classroom culture, classroom and behavioural management and feedback) in the classroom (Popham, 2008) as measured on a classroom observation protocol.

Assessment for learning: An instructional process and pedagogic strategy that enables teachers and students to reflect on their ongoing work and improve upon it in real time (Black & Wiliam, 1998; Popham, 2008).

Adjustment occasions: The time at which an instructional adjustment should be made (Popham, 2008).

Self-regulation: When persons purposefully modulate, modify, or inhibit their actions and reactions to achieve a better or more positive outcome (McClelland et al., 2010).

Content focus: The subject matter of mathematics teachers in the BEP being concentrated on solving mathematical problems.

Active learning: Teachers participating in meaningful work that can inform their practices. This work could include reviewing student work, observing expert teachers or being observed and having consequent sessions that are interactive and fueled by reflections and feedback from previously held observations (Desimone, 2009).

Coherence: The consistency of what teacher are learning relative to their current beliefs and knowledge and/or to reforms or policies within their schools, group of schools, or educational districts (Desimone, 2009).

Duration: The length of time (spread–contact hours, and span–number of semesters or terms) required for an intervention to achieve expected change.

Collective participation: The way teachers participate in PD activities by school, grade or department.

Summative assessment: The evaluation of student progress via a test or exam at the end of a course of study that is usually high stakes (for promotion or to be compared to a benchmark; Black & Wiliam, 1998; Popham, 2008).

Continuous assessment: The tracking of the progress of a child through continuous testing at specific times throughout the course of study of that child (Popham, 2008).

Instructional adjustments: The process of teachers adjusting their teaching in response to the implementation of a formative assessment technique that shows a deficiency in students' ongoing learning (Popham, 2008).

Learning tactic adjustment: The process of students adjusting their learning tactics in response to a deficiency in their ongoing learning (Popham, 2008).

Learning progressions: Guides for teaching and learning. They are curriculum gaps that include target curricular aims, building blocks, and enabling bodies of knowledge. They guide the teacher on what students need to know to achieve the target curricular aim (Alonzo, 2011; Elmesky, 2012; Popham, 2008).

Classroom climate: An affective construct that refers to the way people feel as part of the classroom community (Popham, 2008).

Underprivileged student populations: Students whose parents can only afford to send them to a low cost or free school.

Assumptions

The assumption made in this study was that students would accurately report their abilities on the SRQ-A. Additionally, I assumed that the supervisor and consultant would observe and score each teacher fairly and accurately. These assumptions were necessary as the instruments used to measure the outcomes (FAQ and self-regulation) were subjective (observations and self-reports).

Scope and Delimitations

This study involved the analysis of data collected as part of the BEP. The BEP took place with a group of primary school students and teachers in private nonprofit schools in Lagos State, Nigeria. Public schools and private for-profit schools were excluded. Public schools were excluded because of class size issues (class sizes in public schools can be as large as 70 students per teacher). For-profit private schools were excluded because they typically encourage student autonomy more than the nonprofit schools.

Understanding and improving poor student achievement in mathematics is a multi-dimensional problem. Training teachers to include formative assessment as part of their instructional practice may be part of the solution and this study evaluated how PD could change this practice and improve student ability to self-regulate. I chose to focus on

self-regulation because students who self-regulate well early in life have been shown to perform better than their peers later in life (De Naeghel, Van Keer, Vansteenkiste, & Rosseel, 2012; Khalkhali et al., 2013).

Due to the characteristics of the sample available for this study, results may not be generalizable beyond the specific population from which the sample was drawn. This limitation is true of all studies that are not randomized control trials. Evaluations are limited to the participants, the time and the place where the research took place. To mitigate the lack of random assignment, detailed information about the teachers and students were provided for assessing whether these groups represented teachers and students in general in Nigerian nonprofit elementary schools.

Limitations

Limitations of the study included sampling method, sample size, self-reporting, and potential biases in teacher observations. In terms of sampling method, a convenience sample was used to select teachers who participated in the BEP. In other words, teachers volunteered to participate in the program. This caused generalizability issues as it is difficult to tell if the results of the study would hold true for other populations of teachers and their students. To further compound issues, there was also a sample size limitation. The sample size for teachers was 13, which was too small for inferential analysis. To mitigate these sampling issues, I carried out a descriptive analysis of how FAQ varied between PD groups. Additionally, I did not generalize results to the larger population and made recommendations for further research with bigger teacher samples. Response bias also may have been a limitation as students had to report their perceptions about their

own self-regulatory abilities. To mitigate this, only students were in the room when the forms were being completed. Lastly, to mitigate observer bias, observers were well trained on how to use the observation protocol, two people rated each teacher at every observation point and the average score was reported as the FAQ score, and teachers were observed three times throughout the course of the project. The complementary data helped highlight the level of variation present.

Significance

The student-level effects of formative assessment practices have not been studied in Nigerian curriculum schools. Nigerian teachers typically collect assessment evidence for summative purposes and there is no evidence of studies that would provide evidence to support the usage of assessments to track students' progress and adjust instructional or learning tactics. The results of this study could help educators understand how assessment evidence may be collected to track students' understanding and adjust instructional or learning tactics. It could also provide the FME and other educational entities with a model for implementing formative assessment in schools. The FME could use this information to change policy and change the teaching and learning environments in Nigerian schools, especially public and low-funded private schools which cater to most of the underprivileged children in Nigeria.

Understanding how formative assessment impacts teaching and learning in the classroom can be beneficial to all schools, especially underprivileged schools because the gap between privileged and underprivileged students is vast. Improving the teaching and learning for underprivileged students could help them grow up to be well-functioning

members of society. Formative assessment practices may bring about social change by improving the quality of education and achievement levels of underprivileged and privileged students. It may also change the dynamics of the classroom environment thus moving the Nigerian classroom into the 21st century.

Summary

Chapter 1 introduced the research problem that is the focus of the study in addition to stating the research purpose and the research questions. The conceptual framework, nature of the study, scope and delimitations, and significance of the study were also explained. The next section will give an in-depth coverage of the literature, including the search strategy, the theoretical foundation, and a discussion of what research has found regarding PD and how it affects teacher practices and FAQ. Additionally, in chapter 2 the literature on formative assessment and academic self-regulation will be reviewed.

Chapter 2

Although many educationists agree that there is a need to improve instruction and learning in Nigerian public schools, to date no research has been conducted on whether PD can prepare teachers to practice quality formative assessment or whether formative assessment can improve the way the Nigerian student thinks, learns, or self-regulates. The purpose of this quantitative study was to assess the effects of two variations of teacher PD on formative assessment practices of teachers and, subsequently, students' self-regulation in primary school mathematics.

Current studies show that students are underachieving in mathematics (Fajemidagba et al., 2012; Johnson & Gabrscek, 2008), a subject necessary for national development (Charles-Ogan, 2015). A lack of good infrastructure (FME, 2014), teacher-centered instruction, lack of feedback, phobia (Okafor & Anaduaka, 2013), and lack of student autonomy are some of the reasons researchers have found for students' poor performance. Instruction and learning under the Nigerian curriculum are based on direct instruction without room for students to participate in their learning. This reliance on direct instruction itself may be the result of a culture of teacher strictness, overcrowding in math classrooms, infrequent PD opportunities, poor salaries, and frequent teacher strikes (Gbolagade et al., 2013).

Self-regulation can play a role in student achievement; researchers have found that children who self-regulate can achieve better than their peers (De Naeghel et al., 2012; Khalkhali et al., 2013). It is therefore necessary to determine whether PD can prepare teachers to practice quality formative assessment/transformative assessment

(pedagogic self-assessments) that may lead to self-regulation or whether formative assessment can improve the way the Nigerian student thinks, learns, and self-regulates (Popham, 2008; Zimmerman, 1990), which will help them gain the requisite numeracy skills that will form the foundation of future knowledge, increasing their productivity and the advancement of the nation (Charles-Ogan, 2015).

In this chapter, I present the literature search strategy, which entailed the entering of various search terms into ERIC and other online library databases, yielding an outcome of over 200 articles. Next, I discuss the theoretical foundation, which was based on a PD framework by Desimone (2009) and transformative assessment model by Popham (2008). Finally, I explain key concepts (self-regulation, formative assessment, PD, and transformative assessment).

Literature Search Strategy

I reviewed over 200 articles on formative assessment, learning progressions, self-regulation, and professional development. I entered keyword search terms such as *formative assessment, assessment, continuous assessment, summative assessment, feedback, learning tactics, instructional adjustments, learning progressions, professional development, professional learning communities,* and *teacher learning communities* into EBSCO Host, Google Scholar, ERIC, and Educational Research Complete. Additionally, I reviewed the National Bureau of Statistics and FME websites for information on the current state of education and student achievement figures in Nigeria. Lastly, included in the review are the seminal works of Zimmerman (1990), and Deci and Ryan (2000) in the related areas of self-determination theory and self-regulated learning. These theories

relate to student autonomy, which is conceptually linked to level 2 (student learning adjustments) of Popham's (2008) transformative assessment. All the searches were restricted in terms of publication year (2008 to 2016) and topic to search for relevant articles. Nevertheless, some information from older articles and seminal works were included in the discussion; there were no time restrictions on year of publication for seminal articles.

Theoretical Foundation

This study of the effects of two variations of PD on formative assessment practices of teachers and, subsequently, students' self-regulation in primary school mathematics rested on research that PD affects teacher practices and that formative assessment has the potential to affect student self-regulation. Further, though not examined explicitly, this study, research, and theory support the conjecture that self-regulation should improve student achievement in mathematics.

Teacher Professional Development Framework

Researchers have consistently found that PD affects teacher practice (Brendefur et al., 2012; Heller et al., 2012; Bifuh-Ambe, 2013; Mukeredzi, 2013). However, the value of a PD framework or program depends on its components (Desimone, 2009). Desimone (2009) conducted a review of PD literature spanning 10 years and found five key components common to successful PD programs. The components included: content focus, active learning, coherence, duration, and collective participation.

Content focus refers to activities based on the subject matter under study. For this study, the pedagogical content focus was mathematics. In the PD, teachers were taught

the pedagogical practices and skills necessary for their students to function in a transformative assessment mathematics classroom; students learned to adjust their learning tactics in mathematics.

Active learning involves teachers participating in meaningful work that can inform their practices. Meaningful work could include reviewing student work, observing expert teachers, or being observed and having subsequent sessions that are interactive and fueled by reflections and feedback from previously held observations (Desimone, 2009). The project under study included teacher observations whereby the teachers underwent pre and post observations; student work was also reviewed during PD sessions.

Coherence refers to whether what a teacher is learning is aligned to the teacher's current beliefs and knowledge and/or to reforms or policies within the teacher's school, group of schools, or educational district (Desimone, 2009). Schools and teachers volunteered to participate in the BEP; therefore, coherence may have been achieved.

Duration refers to the length of time (spread–contact hours, and span–number of semesters or terms) required for an intervention to achieve expected change. It has been found that at least 20 PD hours and one semester are required to be accompanied by appropriate PD activities (Desimone, 2009). All teachers in the BEP participated in at least 20 hours of PD. Some teachers then opted to continue participating in PD over the span of two semesters/terms.

Collective participation refers to the way teachers participate by school, grade, or department. It has been found that when teachers participate in a cohort style, there are gains in teacher learning (Desimone, 2009). Teachers in the BEP were recruited by

school and subject, so there were groups of elementary school teachers who taught math and collective participation was encouraged inside and outside of their PD sessions.

This PD framework entails ensuring that content focus, active learning, coherence, duration, and collective participation are key factors in PD. These factors have been shown to increase teachers' knowledge and skills, as well as change teachers' attitudes and beliefs. They have also been shown to change instruction and improve student learning as quite a few researchers have conducted studies where they assessed the impact of various PD programs on teaching quality and student achievement. On average, they found that the active learning, content focus, coherence and collective participation helped new learning transfer to consistent teaching practice (Bifuh-Ambe, 2013; Brendefur et al., 2012; Heller et al., 2012; Mukeredzi, 2013). Well-structured PD programs with most of the components in Desimone's framework provide the best opportunities for impacting teacher and student outcomes. The BEP included most of the components from Desimone's framework and could shed light on how PD impacts teachers' formative practice.

Transformative Assessment

Transformative assessment (Popham, 2008) is the model that informed the PD project that is the object of this study. In transformative assessment, the theory of change is that instructional adjustments on the part of teachers and learning tactics adjustments on the part of students improve learning and student performance (Popham, 2008). Transformative assessment or formative assessment, from Popham's (2008) perspective, is a planned process in which teachers or students use assessment-based evidence to

adjust what they do. There are four implementation levels: teachers' instructional adjustments, students learning tactics adjustments, classroom climate, and PD.

Teachers' instructional adjustments entail teachers combining the use of learning progressions and select assessments (e.g. letter card responses, selected response items, etc.) to identify when to adjust instruction. Students' learning tactic adjustments entail students, with guidance from their teachers, using curricular aims, rubrics, learning progressions, assessments, and adjustment triggers to adjust the way they are learning (Popham, 2008). Classroom climate involves the use of classroom climate guidelines, modeling and reinforcement of appropriate conduct to ensure that there is trust within the classroom and that it is conducive for learning. Lastly, school-wide application entails the implementation of levels one to three via a PD program or a teacher learning community; this is aimed at improving teachers' practice (Akiba, 2012) and, ultimately, student performance.

Self-Regulated Learning

Zimmerman's self-regulated learning model, which teaches students to use a cyclic process of planning, practicing, and evaluating to regulate their learning and improve achievement (Zimmerman, 1990) is related to level two (students' adjustment of learning tactics) of the transformative assessment process (Popham, 2008). The self-regulated learning model is important because self-assessment has two paths, self-regulation and formative assessment (Panadero & Alonso-Tapia, 2013). The formative assessment path is a pedagogic process that entails the student reflecting upon work done, whereas self-regulated learning is a learning strategy that students can activate due to

motivation or control over their actions, or emotions (Panadero & Alonso-Tapia, 2013). Ultimately, self-assessment as a pedagogic process or instructional resource and as an internal process or learning strategy must be to influence student learning and encourage student autonomy over their learning.

Key Concepts

After a thorough search of the literature, no studies were found on Popham's transformative assessment or the effects of formative assessment practices on students' autonomy or self-regulation. This lack of research shows that few researchers have studied connections between formative assessment and self-regulation. Additionally, although a second book showing how teachers are using transformative assessment (Popham, 2008) has been written, there is a dearth of literature on how these practices affect student outcomes. Educators appear to be interested in practicing transformative assessment despite the lack of evidence to support it. Additionally, few studies were found on PD's effects on interventions within the classroom and even fewer within the mathematics classroom.

Self-Regulation

There are a variety of definitions of self-regulation. Some of these definitions are based on cognition, behavior, and affects (McClelland et al., 2010). Behavior-wise, self-regulation is the process of a person purposefully modulating, modifying, or inhibiting their actions and reactions to achieve a better outcome (McClelland et al., 2010). From an education standpoint, but still behaviorally inclined, self-regulation is a learning strategy that students can activate to improve current outcomes (Panadero & Alonso-Tapia, 2013).

To compound issues further, motivation is a construct that is closely related to self-regulation; it is the process of using and sustaining goal directed behaviour and is either extrinsic or intrinsic.

Self-regulation and formative assessment (students' adjustment of learning tactics) are two different constructs; however, they are both forms of self-assessment. Formative assessment entails reflection on work done, decision making with regards to improving upon learning tactics (in the case of students) while self-regulation is the exertion of control over behavior to achieve a desired outcome (Zimmerman, 1990). Although there is a dearth of studies on the self-regulation and formative assessment some researchers have studied self-regulation in relation to other student outcomes. Specifically, some researchers have found that motivation/self-regulation can impact student achievement (De Naeghel et al., 2012; Khalkhali et al., 2013). De Naeghel et al. (2012) conducted a study to examine the dimensions of reading motivation in fifth grade reading. The authors studied 1260 fifth grade Flemish students and 67 teachers. The authors found that recreational autonomous reading contributed to reading behaviour and performance (De Naeghel et al. 2012). Researchers have also studied the effects of self-regulation/motivation on other student outcomes. Khalkhali et al. (2013) conducted a study to assess how behavioural regulation impacted students' persistence to staying in school or dropping out of high school in autonomy-supportive classrooms. The authors studied 318 Iranian students in Grade 9. The authors found that the behaviour regulation predicted the intention of students to persist in high school (Khalkhali et al., 2013). Some researchers have found that children who self-regulate well early in life stand a better

chance of achieving highly in the future (Vanthournout, Gijbels, Coertjens, Donche, & Van Petegem, 2012) while others believe that the level of self-regulation of a person may change across the lifespan depending on environmental or other factors (McClelland et al., 2010). Cheng et al. (2013) studied the effects of internet-specific epistemic beliefs and self-regulation on students' online academic help seeking. The authors chose 319 high school students across Taiwan for their study. They found that self-regulation mediated the effects of internet-specific epistemic beliefs on online academic help seeking.

Conversely, some researchers have found that motivation or self-regulation does not impact some student outcomes (Ünlü & Dettweiler, 2015; Soric, 2009). Ünlü and Dettweiler (2015) conducted a study to assess how students internalized motivation. The authors compared 84 German students in two science programs (science teaching in a classical school vs. science teaching in an expeditionary outdoor program) and found that the students who were taught using the expeditionary teaching format did not have an advantage over the students who were taught using the classical teaching format when it came to *identified regulation* (one of the four expressions of self-regulation that entails an individual accepting an activity as personally important).

Soric (2009) examined the connection between regulatory styles and academic achievement in 127 Croatian seventh grade elementary school students. Students, according to their regulatory styles, gave causal attributions of their academic achievement (Soric, 2009). The author found that students who were intrinsically motivated attributed their success to internal and controllable measures but was unable to

gain clarity in students' perceptions of failure and success and the measures that control them in extrinsically motivated students (Soric, 2009).

Formative Assessment

Assessment can be broadly classified into formative assessment and summative assessment. Formative assessment is assessment for learning and entails adjustment of instructional or learning tactics during ongoing teaching and learning. Formative assessment is an instructional process and pedagogic strategy that enables teachers and students reflect on their ongoing work and improve upon it in real time (Popham, 2008; Black & Wiliam, 1998). There is a lot of confusion over the definition of formative assessment and what it entails (Black & Wiliam, 1998). Some educational stakeholders believe formative assessment is continuous assessment (which is progress tracking via tests or other forms of assessment instruments), while others think it is assessment for learning—progress tracking and revision of teaching or learning procedures to achieve a better teaching or learning outcome (Black & Wiliam, 1998). On the other hand, summative assessment is assessment for a score at the end of an instructional period (midterm, end of term, etc.) for reporting purposes; summative assessment does not include adjusting ongoing teaching or learning.

Formative assessments could play a major role in helping students self-regulate and gain autonomy over their own learning. Valuable formative assessment practices include feedback, reflection, and improvement on work done (Zi, 2014). Some people take formative assessment to mean a collection of assessments that are administered, and scores recorded (Bennett, 2011). While others define it as an assessment process that

impacts ongoing teaching and learning. Panadero and Alonso-Tapia (2013) described formative assessment as students' self-assessment and a part of a pedagogic process through which teachers seek for students to reflect on their work. This suggests that, ultimately, formative assessment should involve the teacher and student. It is important to clarify that for the intent of this study, continuous assessment is a form of summative assessment (assessment for a score) and is not the same as formative assessment which is assessment for learning (Black & Wiliam, 1998; Popham, 2008; Black, Wilson, & Yao, 2011).

Formative assessment practices are very useful in the classroom and can help improve teacher and student outcomes. While there is a dearth of research on the impact of formative assessment practices on students' self-regulation skills. There are a few on its impact on student achievement and motivation. Vingsle (2014) studied the effects of a PD program on a teacher's formative assessment practices. The case-study was conducted over the course of two and a half months. The author found that formative assessment practices were difficult and demanding for the teacher to implement.

Additionally, Yin et al. (2008) studied the effects of formative assessment on student motivation and conceptual change in science. They studied 12 teachers and their students in middle school over the course of 63 to 249 days. They found varying levels of implementation and that the impact of formative assessment on student motivation and conceptual change was not statistically significant. They conjectured that classroom management and varying levels of implementation may have been the factors that affected the insignificant effect that was observed.

Formative assessment enables students to self-assess to improve learning (Panadero & Alonso-Tapia, 2013). The self-assessing property of formative assessment lends itself to the exploration of how this pedagogic process relates to self-regulation which is self-assessment as a learning strategy that students can activate (Panadero & Alonso-Tapia, 2013).

Feedback

Feedback is a key component of formative assessment (Black & Wiliam, 1998; Hattie & Timperley, 2007). It is information provided by a person towards another's performance on a task or similar (Hattie & Timperley, 2007). An important component of feedback is that in its best case it is formative and informs ongoing learning if it arrives just in time as learning is ongoing (Hattie& Timperley, 2012; Havnes, Smith, Dysthe, & Ludvigsen, 2012). Shute (2008) described formative feedback as information passed on to the learner in order to influence their thinking and actions in order to, ultimately, improve their learning. In the formative case, feedback enhances learning in an intentional manner by providing opportunities for students to engage actively in their own learning. Hattie and Timperley (2007) decompartmentalized feedback into various levels: feedback at the task (feedback on performance e.g. wrong or correct answer), process (e.g. student using error detection to assess learning), self-regulation (student self-assessing performance), and self (e.g. teacher giving student feedback based on personality) levels as being key to learner engagement and goal attainment. Some of these feedback types are stronger than others (e.g. feedback on process is stronger than task feedback) in terms of their effects on achievement (Hattie & Timperley, 2012).

Harks, Rakoczy, Hattie, Besser, and Klieme (2013) studied the effects of two types of written feedback on mathematics achievement, interests, and self-evaluation. 146 ninth graders participated in the study and were placed into two treatment groups. The treatment groups were a process-oriented group or a grade-oriented group. Students were given feedback on mathematics tests and completed a survey about their perception of the feedback process used in their group. After a path analysis, the researchers found that students showed more appreciation for process-oriented feedback. They, also, found that process-oriented feedback had a significant effect on mathematics achievement and interests; there was no effect on self-evaluation (Harks et al., 2013).

Additionally, Hattie and Timperley (2007) posited that although feedback could be very usual and formative in nature the way it was delivered was very important as this affected its level of effectiveness. Subsequently, Havnes et al. (2012) studied feedback practices across three subjects and vocational training during a two-year project involving five upper secondary schools in Norway. 192 teachers and 391 first year students participated in the study. Questions were framed around assessment and feedback. The researchers looked at four key areas: student involvement, quality of feedback, use of feedback, and peer assessment. They found that the nature of a subject impacted upon the feedback practices used during the teaching of that subject (e.g. there is a stress on process and mistake correction in mathematics in order to achieve correct answers). They, also, found that there was a need for systematic and ongoing feedback dialogue which would enhance teachers and students' ability to explore instructional conditions and enhance learning and problem solving (Havnes et al., 2012). They suggested that

feedback literacy was key to improving performance but that an assessment for learning (formative assessment) culture had to be established first.

Havnes et al. (2012) found that student involvement, as well as quality and use of feedback were important aspects of feedback. Specifically, they found that in addition to written feedback, personal (verbal) communication between student and teacher was key and made students buy into the assessment for learning process in a better and more beneficial way. Issues of student and teacher perceptions on feedback and its use where easily mitigated via personal communication (Havnes et al., 2012). The researchers found that a system of feedback that connects ongoing to future learning was key to enhancing student learning (Hattie & Timperley, 2007; Havnes et al., 2012).

Conversely, Khanlarzadeh and Nemati (2016) conducted a study to assess the effectiveness of written feedback on grammatical accuracy in an elementary school in Iran. Thirty-three students participated in the study and produced 8 pieces of writing during the study. The researchers used an experimental and control group and observed grammatical accuracy in both groups. Although they found that the treatment group performed better than the control group on revision tasks, students in the treatment group did not outperform the control group students on new tasks.

Additionally, Mendez & Tirado (2016) studied a formative assessment strategy that relied on continuous feedback for promoting historical reasoning in Grade 8 students in a Mexican secondary school. The strategy included a feedback rubric which formed the basis for ongoing feedback. Four teams of three students (grouped according to their knowledge of history) and their teacher participated in the study. They used graded

rubrics to manage the continuous feedback system based on six historical elements – substantive concepts, metaconcepts, asking historical questions, argumentation, contextualization, and using sources. The authors found that students reacted to the rubrics in different ways and suggested that further studies were needed to determine the impact feedback had on students' new learning.

Professional Development

PD is the learning that occurs which specifically adds to a person's learning and improves their professional knowledge; it ranges from formal education or courses to specialized training or informal day to day educational opportunities (Hidden Curriculum, 2014).

PD is key to lifelong learning and supports the accumulation of skills and knowledge (Akiba, 2012). Akiba (2012) surveyed 577 middle school mathematics teachers in Missouri, US. Using qualifications and contextual characteristics as delineators, the author aimed to discover the types of professional learning activities teachers participated in and how much time they dedicated to these activities. The author found that most of the teachers spent their time in PD programs, teacher collaboration, and individual learning activities while teachers with mathematics certification and mathematics education degrees spent a lot of time formally developing themselves (Akiba, 2012). The author stressed the importance of policy makers' support for teachers' active participation professional learning activities as it was key to improving their practice. Bifuh-Ambe (2013) also stressed the importance of impacting teachers' practices through PD activities. As teacher quality has been linked to student

achievement, it is key to ensure that the activities provide teachers with the opportunity to contextualize their learning to transfer it to their classrooms and impact student outcomes. Bifuh-Ambe (2013) suggested that teachers should be a part of the content development process to ensure proper contextualization of interventions.

Although there are various types of PD models (courses, online courses, teacher learning communities, professional learning communities, one-off workshops, ongoing workshops, etc.), each one, aims to impact teacher outcomes with a direct or indirect impact on student outcomes, as well. Therefore, in addition to PD being key to ensuring that teachers remain updated in their professions, it is also key to the implementation of interventions aimed at improving student outcomes. The level of confidence, content knowledge, skills, and in many cases, support that a teacher possesses can affect the level of success they achieve when implementing an intervention targeted at improving student outcomes. Heller et al. (2012) found that interventions where teachers were immersed into situations where they practiced, within workshops, specific teaching cases or looking at student work had significant impact on student outcomes (test scores). As opposed to situations where teachers were asked to reflect alone; reflective situations did not provide a significant effect on student scores. Similarly, Bifuh-Ambe (2013) conducted a mixed methods study on the effects of PD on teachers' attitudes and students' attitudes and abilities towards writing in four elementary schools in need of improvement in Massachusetts. This study supports Heller et al.'s (2012) and Desimone's (2009) framework component of active learning as a key part of PD. The training workshop held over the course of 10 weeks for teachers in kindergarten through Grade 4. Teachers

completed preworkshop and postworkshop surveys and classroom observations were conducted; student portfolios were also examined. Overall, the researcher found that there was a positive shift in teachers' general attitude towards writing. However, teachers showed negative shifts in teachers' perceptions of their ability to revise students work, give students feedback, generate ideas, ability to motivate students, and so forth. Teachers complained about not receiving tips or strategies on how to improve their students' writing (Bifuh-Ambe, 2013). Evidently, the workshop was not immersive enough to give the teachers an active learning experience relevant to their work in their classrooms.

On the other hand, Arens et al. (2012) studied the effects of curriculum (On Our Way to English – OWE—for Grades K-5) and PD (response Instruction for Success in English – RISE) on the language proficiency of English language learners (ELL). The researchers predicated their study on the fact that 28% of the 41% ELL teachers in the United States reported not receiving PD in specific ELL strategies to meet the needs of their students (Arens et al., 2012). Their confirmatory research question was: Does implementation of OWE in conjunction with the use of RISE have a significant impact on the acquisition of English language skills for ELL students as measured by the IPT composite score (based on subsection scores for listening comprehension, reading/vocabulary comprehension, and writing). The study was a randomized controlled study conducted over the course of two years in randomly selected schools in Colorado, Nebraska, and Kansas (Arens et al., 2012). Teachers were trained over the course of a year and received resource materials. After which, they implemented the intervention in

the second year. The researchers used descriptive statistics (mean difference between treatment and control groups) to analyze the data. They found that there was no statistical difference between student achievement (listening, reading, and writing on the IPT testing system) of students in the control and treatment groups.

A one-size-fits-all approach to PD, like Arens et al.'s PD approach, or no PD at all are two most common preintervention paths practiced in Nigeria, even though the literature supports positive impacts for immersive/active learning-based initiatives as this is necessary for teachers to contextualize their learning and apply it to their practice (Desimone, 2009). After teachers complained about insufficient practice-changing content in a PD program, the author concluded that teachers should be a part of the content development process to ensure proper contextualization of interventions (Bifuh-Ambe, 2013). Mukeredzi (2013) explored the impact of PD (whole school meetings, cluster meetings, and in school support) on teachers' instructional practices in rural South Africa and Zimbabwe. Twelve teachers (six in each country) in alternative certification programs participated in the study. After analyzing the data from interviews, the author found that cluster meetings were more relevant to teachers' practice and in school support was key to teachers collaborating and socializing to improve their practice (Mukeredzi, 2013).

Similarly, Brendefur et al. (2012) studied the effects of PD and mathematics activities (numbers, spatial reasoning, interpreting relationships, and measurement), given to early childhood educators, on four-year-olds' knowledge of mathematics in head start programs. The study was conducted over the course of 6 months and head start centers

were randomly selected for participation in the program. Six head start centers participated in the study, two in the control group (8 teachers and 33 students) and four in the treatment group (16 teachers and 111 students). Students were tested before and after the intervention via the Pre-kindergarten-Primary Screener for Mathematics (Brendefur et al., 2012). The researchers found that PD (content knowledge of educators – mathematical and how students learn conceptually and procedurally, active learning – engagements in tasks that explore various learning trajectories and learning progression, and coherence) and the activities used in the treatment classrooms significantly affected students' knowledge of mathematics.

De Kramer, Masters, O'Dwyer, Dash, and Russell (2012), also, recorded positive and significant gains in student and teacher outcomes in a teacher learning community approach to PD that included extensive PD opportunities (three 7-week workshops conducted over the course of three terms for 4-6 hours per week, and independent and classroom activities). They studied the effects of a learning community model of an online PD (a section of the e-Learning for Educators Initiative) on teachers' content knowledge, instructional practices and students' content knowledge and practices in seventh grade English language. The researchers conducted a randomized controlled trial in multiple states in the United States over the course of three semesters. Eighty teachers (35 in the treatment group and 45 in the control group) and their 2056 students participated in the study. Teachers took a precontent and postcontent knowledge and instructional practice-based survey. Workshops were conducted over the course of 7 weeks with a total participation requirement of 28 to 42 hours per semester (De Kramer

et al., 2012). Students took a presurvey and postsurvey that measured content knowledge and student practices affected by teachers' changing practice (De Kramer et al., 2012). Students test scores from national standardized tests were also reviewed. The researchers used descriptive statistics and an analysis of covariance (ANCOVA) to analyze the data. Overall, they found that there was a significant difference in the scores of the teachers in the treatment group over the teachers in the control group after adjusting for their presurvey scores. They, also, found that the average change in student scores from pre to post was higher for students whose teachers were in the treatment group (De Kramer et al., 2012).

Additionally, Dix and Cawkwell (2011) explored the effects of sustained—ongoing—PD (writing workshops) on teachers' professional identities, self-efficacy, and their students' learning. The case study was based on a two-year project in New Zealand. The author found that the learning of the teacher, upon which the case study was based, evolved and transformed as she became self-confident and experienced higher levels of self-efficacy which she then used to improve her practice and positively impact her students' in her writing class (Dix & Cawkwell, 2011).

Similarly, Edwards-Grove (2013) studied the role of dialogue (discussion groups) in and its impact on the PD of a group of university educators (Teacher Talk Group) in Australia. The group comprised of 13 educators in an Australian university. The author conducted a two-year empirical case study on a group of teachers. The members of this group met regularly (once every six weeks for two years) to discuss issues concerning their practice in their local context and how politics and administrative practices affected

their practices (Edwards-Groves, 2013). They wrote reflective pieces or conducted scholarly research based on the product of their meetings. The meetings were transcribed and used for reflection, analytical discussions, and empirical research into teachers' practices. After content analysis and the identification of emergent themes, triangulation occurred via member checking and interviews (Edwards-Groves, 2013). The author found that giving teachers the opportunity to discuss their practice enhanced PD of the teachers in the Teacher Talk Group (Edwards-Groves, 2013).

As much as the right PD model is important to the implementation of interventions in classrooms or schools, coherence (the consistency or relevance of what the teacher is learning to their knowledge and beliefs and/or the consistency of school policies or reforms to the content of the PD program) is a big factor which must be considered. Doherty (2011) assessed the impact of PD on teaching practice. The author conducted a mixed-methods longitudinal study (three years) in Auckland on 21 teachers who were also academics/lecturers at the University of Auckland. The author used preworkshop and postworkshop surveys to assess participants' level of participation in the workshops (Doherty, 2011); questions were on a 5-point Likert scale. The author conducted follow-up interviews and used descriptive statistics to describe their results. The author found that on average, about five of the participants transferred acquired skills to their practice as evidenced through teachers' explanations of what they had done (Doherty, 2011). Overall, it was observed that workshop participants gave positive evaluations for the workshops they attended (in terms of skills acquisition and achievement of workshop-based learning outcomes). However, after interviewing them,

the author found that few of them implemented the learning outcomes achieved during the workshops. The author found a gap in teachers' motivation to integrate acquired skills into practice (Doherty, 2011).

Conversely, Nishimura (2014) conducted a quasi-experimental study to examine the impact of PD (peer coaching and support) on teachers' self-efficacy. The author used a pre-post comparison group design. 121 elementary school teachers (121 in the comparison group and 8 in the intervention group – eight-week intensive PD program), in southern California, participated in the study and were given presurveys- and postsurveys (demographic and the Scale of Teacher Attitudes towards Inclusive Classrooms). After analyzing the data using Cohen d's effect size and reliable change index analysis, the author found that there was only a moderate effect on participants' perceptions of their ability to practice in an inclusive classroom (Nishimura, 2014).

Past research shows that collective participation can also improve the successful implementation of educational interventions (Desimone, 2009). Fitzgerald and Theilheimer (2012) conducted a qualitative case study of three Head Start Centers in New York. They used stratified sampling to select the centers and 67 teachers participated in the study. They studied educators' perceptions of how PD could impact their practice. The researchers used surveys and interviews to collect data. Teachers participated in PD activities and reported that they felt valued when their opinions were sought and used to improve upon their PD (Fitzgerald & Theilheimer, 2012). They highlighted team work, communication, clear organization, and supportive leaders as key elements for collaboration between teachers.

Edwards-Grove (2013) studied the role of dialogue (discussion groups) in and its impact on the PD of a group of university educators (Teacher Talk Group) in Australia. The group comprised of 13 educators in an Australian university. The author conducted a two-year empirical case study on a group of teachers. The members of this group met regularly (once every six weeks for two years) to discuss issues concerning their practice in their local context and how politics and administrative practices affected their practices (Edwards-Groves, 2013). They wrote reflective pieces or conducted scholarly research based on the product of their meetings. The meetings were transcribed and used for reflection, analytical discussions and empirical research into teachers' practices. After content analysis and the identification of emergent themes, triangulation occurred via member checking and interviews (Edwards-Groves, 2013). The author found that giving teachers the opportunity to discuss their practice enhanced PD of the teachers in the Teacher Talk Group (Edwards-Groves, 2013).

As important as collaboration is to the success of PD programs and the implementation of educational interventions, the content of the PD is also important (Bifuh-Ambe, 2013; Desimone, 2009; Heller et al., 2012). Bifuh-Ambe stressed the importance of ensuring that the content of PD programs include activities that focus on relevant subject matter that will suit the objectives the creators of the program intended for learners to achieve.

Heller et al. (2012) conducted a quantitative study to examine the effects of three teacher interventions (Teaching Cases, Looking at Student Work, and Metacognitive Analysis) on teacher and student outcomes in science in six American states (270

elementary school teachers and 7000 students). The interventions were variations of the same intervention, whereas teachers in Teaching Cases went through science content investigations, discussions, readings, pedagogical content (students' perspective), and teaching, teachers in looking at student cases went through the courses excluding science investigations for teachers and readings, while the Metacognitive Analysis teachers only went through discussions and pedagogical content (teacher's perspective). They found that student scores on tests improved significantly in all the interventions. However, they found that teachers and students in the Teaching Cases and Looking at Student Work interventions showed higher achievement and understanding of content than Metacognitive Analysis of Teachers' Learning. Additionally, the Metacognitive Analysis of Teachers' Learning intervention did not show a significant effect on student achievement (Heller et al., 2012). They, also, stated that the findings suggested that PD programs that included content learning with analysis of student learning and teaching rather than teachers' metacognitive analysis alone were more beneficial (Heller et al., 2012).

Similarly, the researcher found that there was a positive shift in teachers' general attitude towards writing. However, teachers showed negative shifts in teachers' perceptions of their ability to revise students work, give students feedback, generate ideas, ability to motivate students, and so forth. Teachers complained about not receiving tips or strategies on how to improve their own writing as the workshops were targeted at improving their own writing. The researcher concluded that teachers should be a part of the content development process to ensure proper contextualization of interventions.

Additionally, the researcher stated that workshops should have extended beyond ten weeks to afford teachers the opportunity to perfect their skills (Bifuh-Ambe, 2013). In terms of the duration of PD programs, Desimone (2009) found that PD programs which ran for at least 20 hours and over the span of a semester tended to be more successful than those that ran for less time (this agrees with Bifuh-Ambe's findings).

Content focus, active learning, coherence, duration, and collective participation are key elements of successful PD programs (Desimone, 2009). Most of the researchers in this review included some or all the components in order to achieve successful teacher and student outcomes. A researcher in Portugal also did the same. da Ponte (2012) investigated a PD program implemented in Portugal and its effect on teachers' practice. The workshops concentrated on orientation, student learning, collaboration, practitioner research, and change of professional culture. The workshop format was 25 hours face to face PD and 25 hours self-directed/autonomous learning (teachers reviewed real student work, reflected upon them and came up with solutions) (da Ponte, 2012). Data was collected via self-reports from teachers and teacher educators. The author found that professional voice, collaborative planning, reflection, focus on student learning, and contextual factors (e.g. support of the ministry of education and PD workshops organized by authors of the curriculum).

Transformative Assessment

Transformative assessment is a planned process in which teachers or students use assessment-based evidence to improve instruction, learning, and student performance (Popham, 2008). There are four implementation levels of transformative assessment.

Level one is teachers' instructional adjustments whereby teachers build learning progressions for target curricular aims and use learning progressions and select assessments (letter card responses, selected response items, constructed response items, whiteboard responses, etc.) to identify when to adjust instruction. Level two is students' learning tactic adjustments whereby students are presented with the curricular aims in understandable language, students see rubrics/scoring guide and samples of extreme responses — one excellent and one deficient —, and students see the building blocks — learning progression and how assessment evidence will be collected. Students use the aforementioned teacher-identified potential assessments, teacher-identified adjustment triggers, and, finally, teacher-proposed learning tactic adjustments in order to decide on the adjustments to make (Popham, 2008). Level three is classroom climate whereby the teacher distributes classroom climate guidelines, seeks trust and nurtures it seriously, models and reinforces appropriate conduct, solicits students' advice on classroom climate, and assesses students' relevant affective status. Lastly, the fourth level is school-wide implementation (implementation of levels one to three via a PD program or a teacher learning community -- teachers learn from each and share best practices) -- schools, districts, and beyond (Popham, 2008).

Summary and Conclusions

In summary, although many students perform poorly in mathematics in Nigeria, formative assessment may help teachers and students connect teaching and learning to learning goals and assessments (Popham, 2008). The research presented in this section showed that PD and formative assessment practices could positively impact teaching and

learning outcomes. Student autonomy is very important in improving student achievement and although articles were not found directly linking or studying formative assessment and self-regulation/motivation, the research does show that students who self-regulate early on in life perform well later in life (McClelland et al., 2000). Therefore, the tracking of instruction and learning bolstered by PD (that pays attention to pedagogical content, active learning, coherence, duration, and collective participation) are essential to improving teaching and learning outcomes, as well as the use of assessment within the classroom. The next section will delve into details of the intervention, research design, data collection and analysis, and a discussion on the threats to validity and ethical procedures of the study.

Chapter 3

The purpose of this quantitative study was to assess the effects of two variations of teacher PD on teachers' FAQ and, subsequently, students' self-regulation in primary school mathematics. The intent of the PD was to develop teachers' skills in practicing formative assessment and to enhance the quality of formative assessment. The outcome of interest was primary school students' self-regulation. This chapter provides first a review of the intervention, then a description of the research design, data collection and analysis, as well as a discussion of the threats to validity and the limitations of the study.

The Intervention

The BEP was conducted in seven nonprofit schools in Lagos, Nigeria. The initiative's objective was to train teachers to use formative assessment following Popham's (2008) transformative assessment model. The intent was to encourage and prepare teachers to alter their teaching practices to support students' self-regulatory skills and help them become autonomous, independent learners, which, it was hoped, could lead to improved academic achievement.

Seven schools volunteered for the project and, in total, sent 13 teachers to the training sessions, which occurred over a 2-day period in January, 2016, and was conducted in Freedom Foundation's (BCSA's parent organization) conference room. The PD curriculum was based on Popham's (2008) transformative assessment guide, which describes how instructional or learning tactics adjustments improve instruction, learning, and student performance. This curriculum was designed by a group of representatives from BCSA and education consultants.

Course participants underwent training that included the following topics, derived from chapters in *Transformative Assessment* (Popham, 2008):

- formative assessment,
- writing differentiated learning objectives,
- writing selected response items,
- writing constructed response items,
- using rubrics to improve learning,
- giving students effective feedback,
- building learning progressions,
- collecting assessment-based evidence,
- helping your students become self-aware and reflective,
- classroom observations, and
- establishing a transformed culture of formative assessment within the classroom.

Each session ran for approximately 90 min.

The training was provided by a content specialist (the head of the mathematics department from an elementary school in Nigeria that practices 21st century best practices and provides ongoing PD for its teachers), head teachers from nonprofit schools, and an educational consultant. The head of mathematics had participated in continuing PD in his school before and after being selected to the head of mathematics position. He had, also, conducted various training sessions at the school's consulting arm. The education

consultant briefed him and found that he already practiced formative assessment in his classroom, thus making him a good candidate for training the participants.

The training was supplemented by continuing PD for a group of seven teachers that continued until July, 2016. There were seven sessions in total (spread over six months), and they entailed face to face and instant messaging (via a WhatsApp group) interactions facilitated by the training facilitators. The sessions also entailed considering how transformative assessment translated to teachers' practice in the classroom. Each session featured discussions around a topic (e.g. adjusting instruction in the classroom), and teachers shared their experiences, learned from one another's practices, and got advice (from the book and experience) from facilitators.

Research Design and Rationale

The purpose of this quantitative study was to assess the effects of two variations of teacher PD on formative assessment practices of teachers and, subsequently, students' self-regulation in primary school mathematics. It included an analysis of 183 primary school students (in primary levels 3, 4, and 5 -- ages 8 to 10), which is equivalent to Grades 2, 3, and 4 in schools in the United States) taught by 13 math teachers in nonprofit primary schools in Lagos State, Nigeria. These teachers were participants in the BEP. A quasi-experimental nonequivalent control group design was used in this study. A nonequivalent control group design is a design whereby two or more intact and similar groups (without random assignment of participants to each group) are compared pre and postintervention or treatment (Frankfort-Nachmias & Nachmias, 2008). In this study, the students of two groups of teachers—Group A (7 teachers and 82 students) and Group B

(6 teachers and 101 students) —who were exposed to different PD variations were compared. Teachers in Group A attended a 2-day transformative assessment workshop. Following this workshop, the Group A teachers also participated in a follow-up program, which entailed consistent PD and discussions throughout the 6-months course. Teachers in Group B also attended the 2-day PD workshop but did not undergo consistent PD follow-up.

A nonequivalent control group design was appropriate for this study because it allowed for the study of the variation between the two groups in terms of the independent variable (teacher's FAQ) and dependent variable (students' self-regulation scores). The training team (consultant and head-teachers/supervisors) created a classroom observation protocol for measuring the 13 teachers' FAQ (according to the guiding principles of *Transformative Assessment*), which was the independent variable. The observation protocol measured teachers' FAQ in the following areas: teacher's instructional adjustments, student's learning tactics, classroom culture, classroom and behavioural management, and feedback (see Appendix B). The SRQ-A was used for the end-of-project test of student self-regulation, which was the dependent variable (see Appendix A).

Because this study depended on archived data (data that had been stored for over a year), other research designs could not be implemented. However, several designs may have been appropriate approaches to study the research problem. The ideal approach would have been an extended time experimental design (Frankfort-Nachmias & Nachmias, 2008) that would have entailed randomly selecting and assigning teachers to

treatment and control conditions, conducting multiple observations of teachers, and having teachers administer repeated posttests to students over an extended period of testing and retesting.

However, participants in this study constituted a convenience sample, a sampling technique whereby participants are selected based on their accessibility to a researcher (Frankfort-Nachmias & Nachmias, 2008), because schools and teachers volunteered for the BEP. Because there was no random assignment of participants into groups, this study followed a nonequivalent group design, which considered Group A (workshop + follow-up) to be a quasitreatment group and Group B (workshop only) to be a quasicontrol group. Internal validity was an issue with this design because the lack of random assignment of teachers and students made it impossible to show that the treatment alone caused an effect. This design is typical of designs in education and the social sciences, whereby due to social interactions and the need to have intact groups, optimal experimental conditions cannot be observed (Frankfort-Nachmias & Nachmias, 2008).

Methodology

This section contains details about the population, the sampling method and procedures, data collection, instrumentation and the operationalization of the variables, and the intervention and the data analysis plan.

Population

The general population for the study was primary school students (ages 8 to 10) in nonprofit primary schools in Lagos, Nigeria. The 2011 Lagos Private School census

estimated the number of private schools at 12,098 (Harma, 2011). At least half of these schools are nonprofit schools.

Sampling and Sampling Procedures

The sampling frame consisted of 183 students (associated with 13 math teachers) from seven primary schools around Lagos that participated in the BEP. The students were in primary 3, 4, and 5, which is equivalent to Grades 2, 3, and 4 in schools in the United States. The project relied on schools volunteering their teachers to participate in the project. Schools chose to participate based on their interest in the unique content (transformative assessment) of the project. No incentives were given. School leaders who did not believe in PD or this type of PD chose not to participate in the project. For data analysis, teachers were grouped according to which of the two PD variations (workshop + follow-up vs. workshop only) they enrolled.

Table 1

Professional Development Variations

Professional development variation	Grade	Number of math teachers	Numbers of students
Group A: Workshop + Follow-up	3	3	51
	4	3	50
Group B: Workshop only	2	1	14
	3	3	40
	4	3	28

Note. Grade 2 = Primary 3; Grade 3 = Primary 4; Grade 4 = Primary 5

To determine the minimum sample size that can be used to detect statistically significant effects, I conducted an a priori statistical power analysis. Statistical power refers to the probability that a statistical test will lead to the rejection of a false null hypothesis (Field, 2009). Since statistical power analysis is a function of the relationships between sample size (*N*), significance criterion or Alpha level (α), population effect size (ES), and statistical power, to determine *N*, I first set the other values (Alpha level, power, significance). Several factors needed to be considered to determine the correct values to set.

Standard power settings for a priori analyses range from 0.80 to 0.95, meaning that the analysis would have an 80% to 95% probability of correctly rejecting the null if the null is false (Field, 2009). The chance of rejecting a true null (α) was set at .05. According to Lipsey and Wilson (1993), who did a meta-analytic review of the efficacy of educational treatments (interventions), the effect size for in-service training should be 0.80 (all outcomes) and .47 (effect on teachers and students), while the effect size for psychological and affective interventions for underprepared learners is .36, and instructional cues/student participation/corrective feedback effects on learning is .97. Due to this wide range of effect sizes, it is reasonable to use a moderate effect size to determine needed sample size in the G*Power program (Faul, Erdfelder, Lang, & Buchner, 2007), a statistical analysis tool.

To determine the type of power analysis to use, I considered the different analyses required for the different research questions. As described below in the data analysis section, the means (from the observation protocol) for teachers in Group A and Group B

were compared to answer RQ1, I conducted a product-moment correlation (exact test–correlation: bivariate normal model) to answer RQ2, and I conducted a *t* test (*t* test–means: difference between two independent means, two groups) to answer RQ3. Minimum sample size varied for each of these tests but fell between the range of 29 and 130, which this study met with 183.

For the Pearson correlation, with a medium correlation ($\rho\ H_a$) ± 0.50, α of .05, and power (1-β) of .80, the needed number of corresponding FAQ scores and self-regulation scores was $n = 29$. For the *t* test (two-tailed), with a medium ES of 0.5, α of .05, power (1-β) of .80, and an allocation ratio (N2/N1) of 1.23170, the needed sample for Group A was 58 and the needed sample for Group B was 72.

Procedures for Recruitment and Participation

The nonprofit educational organization that ran the BEP recruited nonprofit schools in Lagos State to participate in the project. The organization advertised the education project to nonprofit or low-cost schools (schools that have no school fees or very low school fees). The advertisement was distributed via letters, emails, and phone calls to over thirty contacts of the nonprofit educational organization. Approximately 16 schools responded and seven signed up for the project. Teachers from the seven schools were interviewed and eligible candidates were later informed of their acceptance into the project. Teachers then completed forms that stated that they agreed to participate in the project.

The organization ran a two-day face-to-face workshop for all participating teachers over the course of two weeks, after which teachers were given the option of

undergoing continuing PD or not. Seven of the thirteen teachers opted to undergo continuing PD. These volunteer teachers became the members of the treatment group (Group A). Thus, selection into the overall project was on a volunteer basis and assignment to either of the two variations was also voluntary. Due to the voluntary nature of the selection and assignment process, the sampling method was nonprobability sampling.

Procedures for Data Collection

To measure teacher FAQ, an observer from the organization and a supervisor of each teacher observed participants three times after participation in the two-day workshop, over the course of the project. For each observation, each observer gave each teacher a score and these two scores were averaged to create a single score per teacher-participant per observation. To measure self-regulation, students completed the SRQ-A (see Appendix A) before their teachers participated in the PD workshop in January and again at the end of the term in July.

Data Storage

The classroom observation forms from all three instances of classroom observations and other data were housed at the organization's headquarters in Lagos. Soft (digital) and hard copies of the data were housed at the main office of the organization. Accessing data entailed writing an e-mail to the organization for permission to use data (copies of their teacher observation data and students' end-of-project SRQ-A data) from the BEP. Upon receipt of the email containing the permission form, the program director of BCSA printed, signed and sent the data use agreement (see Appendix D) to the

researcher. After that, the data was sent to the researcher in hard and soft copy formats. Information gathered from the organization was placed into an SPSS database.

Operationalization of Constructs and Instrumentation

Three primary constructs were examined in this study: teacher participation in one of two variations of PD, teacher FAQ, and students' self-regulation scores. These variables are itemized in Table 2 and discussed in the following three subsections.

Teacher Professional Development Variation

Teacher PD variation refers to two variations of PD divided into Groups A and B. Workshops were conducted for all teachers. Group A received continuing PD throughout the project and Group B attended the two-day workshop only. Group membership was accessed from participation records and indicated with a two-level group indicator variable.

Teacher's Formative Assessment Quality

FAQ refers to the observable quality of ongoing assessment for learning in the classroom. A classroom observation protocol (see Appendix B) was created for measuring FAQ in teachers' practices. Teachers were given a score of 1 (Needs Improvement) to 4 (Advanced) on 20 formative assessment related items, divided into six domains. A score of 4 meant the teacher demonstrated the behavior described at the highest level, while a score of 1 meant the teacher demonstrated the behavior with 3 or more deficiencies. The items ranged from classroom elements like lesson planning and learning progressions to classroom culture and student autonomy (adjustment of learning tactics). For example, under the lesson delivery domain, assessors were asked to score

and comment on teachers' adjustment of instructional tactics. Scores from all domains were summed to produce a composite FAQ score that ranged for each teacher from a minimum of 20 to a maximum of 80 points. Each teacher was rated by two raters each on three separate occasions. For each of the three observations, each teacher was assigned the average of the two rater scores. Thus, each teacher received three composite average FAQ scores that ranged from 20 to 80.

Classroom observations are conducted in schools all around the world and observation forms or protocols are standard tools for assessing teaching quality and classroom practice in the classroom (Bell et al., 2012). The classroom observation protocol for this intervention was designed by the education consultant in collaboration with head-teachers from four schools. The content of the protocol was customized based on transformative assessment implementation principles (Popham, 2008). Thus, construct validity was established by matching (Trochim, 2006) the content of the classroom observation form to key elements outlined in *Transformative Assessment* (Popham, 2008), consisting of a teacher's instructional adjustments, students' learning tactics, classroom culture, classroom and behavioural management, and feedback. The four school leaders reviewed the observation protocol and adjusted it to make it more practical and useful. In addition, an educational consultant who worked extensively with *Transformative Assessment* (Popham, 2008) and implemented programs based on the book reviewed the protocol for face and content validity.

During the construction of the observation form, sampling validity was carefully checked to ensure that teaching quality and classroom practice before, during, and after

the intervention would be measured appropriately (Frankfort-Nachmias & Nachmias, 2008).

Self-Regulation

Self-regulation is when a person purposefully modulates, modifies, or inhibits their actions and reactions to achieve a better or more positive outcome (McClelland et al., 2010). The SRQ-A was used for the end-of-project test of student self-regulation. Permission was granted for the use of the SRQ-A via a limited use agreement at the point of registration on the self-determination theory website.

To assess certain regulatory behaviours, the 32 items on the SRQ-A centre on why children do their class work. These behaviours form four subscales: external regulation, introjected regulation, identified regulation, and intrinsic motivation (Ryan & Connell, 1989). The responses for each item are on a four-point scale, very true (4), sort of true (3), not very true (2), and not at all true (1). To calculate students' self-regulation scores, each subscale was computed separately so that students had a score for each self-regulatory behaviour, then the Relative Autonomy Index (RAI) was computed by weighting the subscale scores and combining them (RAI = 2 X Intrinsic + Identified - Introjected - 2 X External). The RAI was the overall self-regulation score and regularly runs from -9 (least autonomous) to +9 (most autonomous).

The SRQ-A was developed by Richard Ryan and James Connell in 1989. Instructions direct students to respond to each question by considering why they behaved a certain way in their classrooms under each circumstance. The questionnaire was developed for late elementary and middle school children (Grades 4 to 8) or children

from ages 8 and up. Thus, the SRQ-A was appropriate as the students were in primary 3 to 5 (Grades 2 to 4 in the United States). Students answered 32 questions on a four-point scale because this had been found to be appropriate for children as young as eight (Ryan & Connell, 1989).

Table 2

Operationalization of Variables

Variable	Levels/Values	Level of measurement	Source
Teacher PD	0=Workshop only, 1=Workshop + follow up	Nominal/Categorical (dummy coded)	Participation records
Teacher's formative assessment quality (20 items, max. score = 80 and min. score = 40)	4= no deficiencies 3= 1 or less deficiencies 2= 2 or less deficiencies 1= 3 or more deficiencies	Interval-Ratio	Observation protocol
Student's self-regulation score (end-of-project) (calculation on 32 items, max. score = 10, min. score = -9)	4 = Very True 3 = Sort of True 2 = Very True 1 = Not at All True	Interval-Ratio	Academic Self-Regulation Questionnaire

Ryan and Connell (1989) stated that the SRQ-A's alpha coefficient/reliability was .62 to .82 for three studies they conducted in suburban, rural, and urban communities in the United States of America. Vanthournout, Gijbels, Coertjens, Donche, and Van Petegem (2012) combined the SRQ-A and Amotivation Scale (AMS) into the learning and motivational questionnaire and reported a reliability score of .80 to .85. Ünlu and Dettweiler (2015) used the German version of the SRQ-A and reported a reliability score of .80 to .81. Khalkhali et al., (2013) used an extended form of the SRQ-A and reported a reliability score of .73 to .85.

Various researchers have used the SRQ-A to study students' ability to self-regulate and it has been accepted and, in fact, has served as the basis for the development of many other questionnaires (Pehlic & Spahic-Jaserevic, 2012; Ünlü & Dettweiler, 2015). The construct validity of this instrument is well established. Finally, permission for use of the SRQ-A was granted to me upon registration on the SDT website (Self-Determination Theory, 2016). At registration, I checked a box agreeing to the limited use (use for nonprofit research) of the SRQ-A.

Sufficiency of Instrumentation to Answer Research Questions

The first research question aimed to assess how FAQ, as measured by an observation protocol, varied depending on the type of PD teachers received. The multi-rated observation protocol provided a sufficient means of ensuring that classroom FAQ was assessed fairly and subjectivity reduced. The second research question assessed the relationship between FAQ and students' self-regulation scores as measured by the end-of-project SRQ-A. The third research question asked if there was a difference in student self-regulation scores as measured by the end-of-project SRQ-A between students whose teachers received workshop-only versus students whose teachers received workshop-plus PD.

Table 3

Research Questions, Variables and Methods

Research question	Variables	Methods
How does the quality of teachers' formative assessment practice, as measured by an observation protocol, vary depending on the type of PD the teachers receive (workshop only vs. workshop plus follow-up)	IV: PD Variation DV: Formative Assessment Quality	Descriptive Comparison (Means of both groups of teachers will be compared)
What is the relationship between the formative assessment quality students experience and their end-of-project self-regulation scores as measured by the SRQ-A?	IV: Formative Assessment Quality DV: Self-regulation Scores	Pearson Product Moment Correlation
Is there a difference in student end-of-project self-regulation scores as measured by the SRQ-A between students whose teachers received workshop only versus students whose teachers received workshop plus follow-up PD?	IV: PD Variation DV: Self-regulation Scores	*t* test

Note. IV = independent variable; DV = dependent variable

Data Analysis Plan

The statistical package for the social sciences (SPSS) was used for data analysis while G*Power 3 analysis program was used for statistical power analysis. I planned to clean the data by standardizing test scores and running frequencies to check for outliers and missing data. However, if there were quite a few outliers then I would have modified them by trimming or winsorizing. Trimming refers to the removal of a certain percentage

of outliers from a data set so that the resultant distribution is not skewed (Field, 2009). Winsorizing is the process of reducing the power of outliers in data by assigning lower weights or changing the value of the outliers so that it is closer to other values in the data set. The number is then checked to ensure that they do not surpass 5% of the data (5% or less missing data should not significantly impact results, (National Institute of Standards and Technology, 2003; Laureate Education, n.d.). Additionally, I will generate histograms to assess the values of skewness and kurtosis to check for nonnormality of the test scores. Once I clean the data and test the assumptions of statistical procedures, I will analyze by testing the hypotheses associated with the research questions.

The first research question was how does teachers' FAQ, as measured by an observation protocol, vary depending on the type of PD the teachers receive (workshop only vs. workshop plus follow-up)? Since the sample size of teachers (n = 13) was too small to provide statistical power, the analysis was purely descriptive. Teachers were divided into two groups based on whether they received follow-up support and then the mean scores from the observation protocol (ranging from 20 to 80) were compared between groups. Further descriptive analysis of performance differences between groups in each of the six domains measured on the classroom observation protocol may be warranted.

The second research question was what is the relationship between the FAQ students experience and their self-regulation scores as measured by the end-of-project SRQ-A? For this question, the alternative hypothesis was: There is a positive relationship between FAQ and students' self-regulation scores. A Pearson product-moment

correlation was conducted to test this hypothesis. This helped determine if there was a linear relationship between a teacher's degree of FAQ and each student's self-regulation score. Each student record included an associated teacher's FAQ score and this score was crossed with the student's self-regulation score to determine the correlation coefficient *r*.

The third research question asked whether there was a difference in student self-regulation scores as measured by the end-of-project SRQ-A between students whose teachers received workshop only versus students whose teachers received workshop plus follow-up PD? The alternative hypothesis for this question was: there is a significant difference between the self-regulation scores of the groups of students whose teachers received either of the two variations of PD. To test this hypothesis, a *t* test was used to assess whether students' self-regulation scores varied by PD type of their teachers. A *t* test will help compare the means of students whose teachers received workshop only with those who received workshop plus follow-up (Field, 2009; Green & Salkind, 2011).

Threats to Validity

According to the G*Power calculations to achieve 80% power, the sample size needed for this study was 130, which means that it would not be possible to make statistical inferences for the effects of PD variation on teacher FAQ, but it was possible to assess whether students of participating teachers had different levels of self-regulation. The ability to generalize to the bigger nonprofit school teacher population was limited. Representativeness of sample was an issue because schools volunteered to participate in the intervention (Frankfort-Nachmias & Nachmias, 2008). Additionally, because schools

volunteered to participate in the study, the sample may have been unrepresentative of the general nonprofit school population in Nigeria.

As stated above, there were external validity issues that affected generalizability. Specifically, selection bias arose due to the use of a convenience sample and nonrandom selection of participants. This means that aside from the fact that the sample of teachers was small, because teachers opted in to the project, these schools may not have fully represented the underprivileged community. This was addressed by ensuring that only schools that paid minimal or no school fees were contacted for participation in the project.

In terms of internal validity, short-term maturation arose as the students who had to take the SRQ-A were underprivileged students who may have had a myriad of issues (tiredness, hunger, etc.) affecting them. This was mitigated by ensuring that the tests were administered in the mornings after short break (snack time). Long-term maturation issues such as students growing older during the project and thus possibly feeling better in control of their learning and answering questions on the SRQ-A with more confidence was not an issue as the project duration was short.

Ethical Procedures

Ethical consideration entailed ensuring that participant and school privacy were respected by guarding sensitive information (Creswell, 2009). Research plans were approved by the Institutional Review Board (IRB; approval number 10-02-17-0298125) at Walden University before the commencement of the study. The program director for BCSA, which ran the education project, signed a data use agreement (see Appendix D)

before releasing data. The data was de-identified to ensure that the privacy of the students and their teachers were kept and did not include students' names. Soft copies of de-identified data were sent to the researcher with hard copies in a sealed envelope. Prior to that hard copies of the data were kept in a locked cabinet at BCSA's offices. The data was moved from Excel files to an SPSS database on the researcher's personal laptop (password protected) while the hard copies were kept in a locked drawer in the researcher's study. All data will be destroyed in five years' time after completion of the study.

Summary

The purpose of this study was to assess the effects of two variations of teacher PD on FAQ of teachers and, subsequently, students' self-regulation in primary school mathematics. Thirteen math teachers (seven in Group A (workshop and follow-up) and six in Group B (workshop only)) and their students (183 primary school students) participated in the BEP. A quasi-experimental nonequivalent group design was used to evaluate the effect of PD variations on students' self-regulation scores. The three research questions were targeted at describing PD variations, determining the relationship between FAQ and students' self-regulation scores, and comparing students' self-regulation scores based by PD variation. Descriptive analysis, Pearson Product Moment Correlation and a *t* test were used to analyze the data. After the consideration of several factors during an a priori statistical power analysis, the researcher found that the minimum sample size for each test fell between 29 and 130; however, there were only 13 participants who elected to participate in the project. As a result, threats to validity included significant limitations

in the ability to generalize findings to the general nonprofit population. Ethical considerations entailed the BCSA completing and signing a letter of cooperation, as well as the protection of participants' privacy. The next chapter will discuss the results of the study: how the methodology and data were able to address the hypotheses.

Chapter 4

The purpose of this quantitative study was to assess the effects of two variations of teacher PD on teachers' FAQ and, subsequently, students' self-regulation in primary school mathematics. I aimed for the first research question to assess the relationship between type of PD and FAQ. The multirated observation protocol provided a sufficient means of ensuring that classroom FAQ was assessed fairly, and subjectivity reduced. The second research question asked about the relationship between the FAQ and students' self-regulation, as measured by the end-of-project SRQ-A. The third research question asked if there was a difference in student self-regulation scores as measured by the end-of-project SRQ-A between students whose teachers received workshop-only versus students whose teachers received workshop-plus PD. Guided by these questions, this chapter provides the results of a comparison of the means of teachers' classroom observation scores based on the PD variation to which they were exposed. It also provides the results of a Pearson product-moment correlation used to determine the relationship between the teacher FAQ as observed by independent raters and experienced by students and these students' self-regulation scores on the SRQ-A. Lastly, it presents the results of a *t* test intended to test whether the difference in self-regulation scores between students whose teachers received workshop-only and students whose teachers received workshop-plus follow-up (workshop-plus) PD was statistically significant.

Data Collection

Data was collected over 7 months (January to July, 2016) and stored on a secure computer at the BCSA. BCSA's program director and BCSA's education consultant had

access to the stored data. Walden University's IRB (10-02-17-0298125) approved the study on October 2, 2017. Data was sent from BCSA to me upon IRB approval, and I downloaded and cleaned the Excel file after which the data was transferred to an SPSS database. Descriptive statistics, a Pearson product-moment correlation and a *t* test were run to analyze the data for RQ1 through RQ3.

Table 4 presents the variables collected in the study. For RQ1, the independent variable was PD variation (workshop-only vs. workshop-plus) and the dependent variable was teacher average FAQ over three measurements. For RQ2, the independent variable was teacher FAQ assigned at the student level, and the dependent variable was students' self-regulation scores. For RQ3, the independent variable was PD variation assigned at the student level and the dependent variable was students' self-regulation scores.

Table 4

Operationalization of Variables with Range of Scores

Variable	Values	Range of scores	Level of measurement	Source
Teacher PD	0=Workshop-only, 1=Workshop-plus	0 to 1	Nominal/Categorical (dummy coded)	Participation records
Teacher's formative assessment quality (20 items, max. score = 80 and min. score = 20)	4= no deficiencies 3= 1 or less deficiencies 2= 2 or less deficiencies 1= 3 or more deficiencies	20 to 80	Ordinal	Observation protocol
Student's self-regulation score (end-of-project) (calculation on 32 items, max. score = 9, min. score = -9)	4 = Very True 3 = Sort of True 2 = Very True 1 = Not at All True	-9 to 9	Interval-Ratio	Academic Self-Regulation Questionnaire

In terms of recruitment rates, seven out of 30 schools contacted signed up for the project. Teachers from the seven schools were interviewed and 13 teachers from these schools were accepted as participants in the project. Response rates for the end-of-project SRQ-A were very good, with all students (183) completing their surveys. All 13 teachers were observed three times during the project and thus had three observation scores.

The following describes the final analytic sample for this study.

- Thirteen mathematics teachers—seven teachers (five women and two men) in the workshop-plus group and six teachers (four men and two women) in the workshop-only group—participated in the BEP.

- Of the seven teachers in the workshop-plus group, five (71%) had their bachelor's degrees and two had only a National Certificate in Education, which is a basic teaching qualification similar to an associate's degree in the United States. In the workshop-only group, four of six (66%) had bachelor's degrees, while the other two had basic teaching qualifications (National Certificate in Education or similar). These teachers earned a minimum of 60,000 Naira and a maximum of 120,000 Naira.
- All of the teachers in the workshop-only group were from Southeastern Nigeria while six of the seven teachers in the workshop-plus group were from Southwestern Nigeria.
- These teachers taught 183 students.
    - One hundred eighty-three students took the end-of-project SRQ-A.
    - Students were from various tribes from Southeastern and Southwestern Nigeria.
    - There were 92 boys (49 in the workshop-plus and 43 in the workshop-only categories) and 91 girls (33 in the workshop-plus and 58 in the workshop-only categories).
- Each of the 13 teachers had three observation scores (taken at the beginning, middle, and end of the BEP).

Teachers and students in the BEP were from seven nonprofit (fee-paying and free) schools in Lagos State. Free schools served severely disadvantaged populations (lower socioeconomic class) whose parents could not afford their tuition while fee-paying

schools served disadvantaged students whose parents could afford to pay a token towards their tuition. Although a convenience sample was used, it was somewhat representative of the larger pool of underprivileged schools in Lagos State because there were different types of underprivileged schools (free to fee-paying but low-cost) represented in the sample.

Treatment

Teachers from both groups attended the face-to-face PD sessions, which occurred over a 2-day period in January 2016. The PD curriculum was based on Popham's (2008) transformative assessment guide, which describes how instructional or learning tactics adjustments improve instruction, learning, and student performance.

Course participants attended training sessions that included the following topics, derived from chapters in *Transformative Assessment* (Popham, 2008):

- formative assessment,
- writing differentiated learning objectives,
- writing selected response items,
- writing constructed response items,
- using rubrics to improve learning,
- giving students effective feedback,
- building learning progressions,
- collecting assessment-based evidence,
- helping your students become self-aware and reflective,
- classroom observations, and

- establishing a transformed culture of formative assessment within the classroom.

Each session ran for approximately 90 minutes, and full attendance was a requirement for participation in the project. Teachers were asked by the group of representatives from BCSA and education consultants to write and share summaries at the end of each workshop and their levels of FAQ were assessed within their individual classrooms.

The workshop was supplemented by continuing PD for a group of seven teachers who continued until July 2016 (referred to here as *workshop-plus*). For this group, there were seven sessions in total (spread over 6 months) and they entailed face to face and instant messaging (via a WhatsApp group) interactions facilitated by the training facilitators. The sessions also entailed considering how transformative assessment translated to teachers' practice in the classroom. Each session featured discussions around a topic (e.g. adjusting instruction in the classroom) and teachers shared their experiences with each other. They also learned from one another's practices and got advice from facilitators. Teachers' formative assessment was measured three times by each teacher's supervisor and an education consultant via a teacher observation form while students' self-regulation scores were measured via the SRQ-A.

Results

Results and brief discussion of analyses for the three research questions are presented next. The first research question was purely descriptive. The other research

questions (RQ2 and RQ3) pertained to variations in FAQ and student self-regulation between the two groups.

I cleaned the data by manually checking the hard copy data against the soft copy data, ensuring the subject/participant (teachers and students) identification codes were sequential, matching student codes to teacher codes. I also used Excel functions to check numbers not within the range of achievable scores on the FAQ or SRQ-A. Next, I exported the data from Excel spreadsheets and to an SPSS database, after which I ran frequencies to check for outliers and missing data.

There were no outliers in the teacher sample. Teachers in the workshop-plus group had average scores of 52, 57, 57.16, 57.6, 63, 70, and 72.83, while teachers in the in the workshop-only group had average scores of 46.83, 48, 61.66, 61.83, 62, and 62.

One hundred percent (54% in the workshop-plus group and 46% in the workshop-only group) of the teachers were observed at three points during the project and thus had complete FAQ scores. One hundred percent of the students completed the end-of-project SRQ-A. The average FAQ scores were 64.64 for the workshop-plus group and 59.67 for the workshop-only group of teachers. Standard deviation for the FAQ scores were 8.29 for the workshop-only group and 6.23 for the workshop-only group of teachers. The range of the FAQ scores for the workshop-plus group was 24, while that of the workshop-only group was 13. For the students, the average self-regulation end-of-project score for the workshop-plus group was 0.21, while that of the workshop-only group was 0.31.

Research Question One

I used the first research question to assess how FAQ, as measured by an observation protocol, varied depending on the type of PD teachers received. This research question was descriptive due to the small sample size (n = 13) of teachers. As shown in Table 6, descriptive statistics of teachers' FAQ, as measured using an observation protocol, showed that means for FAQ were relatively similar for teachers in the workshop-only group and the workshop-plus group at the first set of observations (they differed by about three points), with the workshop-only teachers scoring about 52 and the workshop-plus teachers scoring about 55. However, workshop-plus teachers' FAQ jumped 10 points at the second set of observations, on average. By comparison, the mean FAQ for the teachers in the workshop-only group also increased at the second observation, but only by seven points. For the third observation, both groups' scores remained steady.

Table 6

Formative Assessment Quality by PD Variation

	Workshop-Plus				Workshop-Only			
	Beginning	Middle	End	Mean FAQ Change	Beginning	Middle	End	Mean FAQ Change
N	7	7	7		6	6	6	
M	54.7	65	64.64	9.94	52.25	59.25	59.67	7.42
SD	7.24	8.84	8.29		10.95	5.56	6.23	
Range	19.5	22.5	24		24.5	13	13	

Note. FAQ = formative assessment quality; *M* = mean of each group's formative assessment quality score; *N* = number of teachers; Mean FAQ Change = difference between each group's beginning and end FAQ score.

Research Question Two

I used RQ2 to assess the relationship between FAQ and students' self-regulation scores as measured by the end-of-project SRQ-A. I ran a Pearson product-moment correlation to evaluate the hypothesis that there is a positive relationship between FAQ and students' self-regulation scores.

I computed a correlation coefficient between average FAQ (average observation scores on three measurements) and students' self-regulation scores. The correlation between FAQ and self-regulation scores was not significant, $r(183) = .06$, $p = .43$, thus the alternative hypothesis was rejected. This finding shows that the correlation between average teacher observation scores (FAQ) and students' self-regulation scores was not statistically significant in this sample. Thus, there is no evidence of a positive relationship between the two variables.

Research Question Three

With RQ3 I asked if there was a difference in student self-regulation scores as measured by the end-of-project SRQ-A between students whose teachers received workshop-only versus students whose teachers received workshop-plus PD. I conducted an independent sample *t* test to test the null hypothesis in order to determine if there was no difference between the self-regulation scores of the groups of students whose teachers received workshop-only versus students whose teachers received workshop-plus-follow-up PD. Students whose teachers underwent the workshop-plus treatment had higher self-regulation scores on average ($M = .21$, $SD = 1.26$) than students whose teachers underwent the workshop-only ($M = -.38$, $SD = 1.00$) treatment. Therefore, the test was

significant, $t(181) = .23$, $p < .001$, and led to the rejection of the null hypothesis. Furthermore, Cohen's effect size value ($d = .52$) suggested a moderate practical significance. These results suggest that students of teachers in the workshop-plus group self-regulated better during the mathematics lessons than students of teachers in the workshop-only group.

Summary

The results from the study showed that teachers who underwent continuous PD (workshop-plus) had a higher level of FAQ than teachers who did not (workshop-only); however, this study did not assess a large enough teacher sample to determine whether the independent variable (PD variation) may have had an effect on the dependent variable (FAQ) at the teacher level. Examination of outcomes at the student level showed that the average teacher observation scores (FAQ) tended to not correlate with students' self-regulation scores. However, students whose teachers underwent workshop and follow-up on the average had significantly higher self-regulation scores ($M = .21$, $SD = 1.26$) than students whose teachers underwent the workshop-only ($M = -.38$, $SD = 1.00$). Chapter 5 contains an explanation and discussion of the study's findings, the limitations of the study, and recommendations for future studies that could advance the investigation into the relationship among PD, self-regulation, and formative assessment.

Chapter 5

The purpose of this study was to assess the effects of two variations of teacher PD on formative assessment practices of teachers and, subsequently, students' self-regulation in primary school mathematics. Mathematics is crucial to the accomplishment of the industrialization goals set by the Nigerian Government (Agbodike & Ajah, 2014) and to the development of productive members of modern society; thus, mathematics education must be taken seriously and improved (Gbolagade et al., 2013) for industrialization to succeed. I aimed for RQ1 to assess how FAQ, as measured by an observation protocol, varied depending on the type of PD teachers received. I structured RQ2 to assess the relationship between FAQ and students' self-regulation scores as measured by the end-of-project SRQ-A. With RQ3 I asked if there was a difference in student self-regulation scores as measured by the end-of-project SRQ-A between students whose teachers received workshop-only versus students whose teachers received workshop-plus PD. Key findings for RQ1 were that all teachers who participated in the project had higher FAQ scores at the end of the study than they did in the beginning, but teachers in the workshop-plus group had higher mean ending FAQ scores than teachers in the workshop-only group. Additionally, the data for RQ2 yielded results showing no correlation between FAQ and students' self-regulation scores. Lastly, key findings for RQ3 suggested that students whose teachers underwent the workshop-plus variation self-regulated better than students whose teachers attended the workshop-only option.

Interpretation of Findings

This study involved the use of a quasi-experimental nonequivalent control group design to examine the effects of two variations of teacher PD on formative assessment practices of teachers and, subsequently, students' self-regulation in elementary/primary schools (primary 3, 4, and 5/Grades 2, 3, and 4). Firstly, findings from the study included progressively increased levels of FAQ for teachers in both the workshop-plus and workshop-only groups. However, by the third observation, teachers in the workshop plus group had a higher mean FAQ score than their counterparts in the workshop only group. It is important to note, as earlier stated, that the assessment of the effects of PD variation on FAQ was purely on a descriptive basis as the sample size for teachers was too small for inferences to be made. Notable factors that could have affected teachers' FAQ scores included type of PD chosen**,** coherence, collective participation, and active learning. Secondly, FAQ did not correlate with students' self-regulation scores. Lastly, students whose teachers underwent the workshop-plus variation self-regulated better than their counterparts. With regards to the first research question, which was purely descriptive, the data showed that there was a difference in FAQ between teachers who underwent continuous PD (workshop + follow-up) and those that did not (workshop only). FAQ for the group of teachers who experienced the workshop and follow-up was higher than those who did not.

A factor that could have caused the differences in mean FAQ between groups is the *type of PD* (workshop-only or workshop-plus) as it related to ongoing support, collective participation, and active learning, as well as intervention duration. The ongoing

support received by the teachers in the workshop-plus group may have supported their use of formative assessment in their classrooms. Additionally, the workshop-plus intervention may have, by default, increased teachers' ability to work with each other and encouraged collective participation and active learning, which has been shown to encourage powerful discourse and improve teacher learning (Desimone, 2009). In other words, the duration of the project for the teachers in the workshop-plus variation was longer, and duration has been tied to intellectual and pedagogical change. Conversely, teachers in the workshop-only variation could have had lower scores due to a lack of active learning, coherence, and the shorter duration of their PD variation. However, due to the limitations of the study design, there is no way to make definitive conclusions from these data.

FAQ for the group of teachers who experienced the workshop and follow-up was higher than those who did not. These findings (higher FAQ scores achieved by teachers in the workshop-plus group) are in line with Desimone (2009) and other researchers (Bifuh-Ambe, 2013; Brendefur et al., 2012; Heller et al., 2012; Mukeredzi, 2013). Their findings were that PD programs that included active learning, content focus, coherence, and collective participation helped new learning transfer to consistent teaching practice. These PD researchers found that active and ongoing involvement of teachers in PD positively impacted teacher outcomes (Edwards-Grove, 2013; Mukeredzi, 2013). Additionally, quite a few researchers conducted studies where they assessed the impact of various PD programs on teaching quality. On average, they found that active learning, content focus, coherence, and collective participation helped new learning transfer to

consistent teaching practice, thus improving teaching quality (Bifuh-Ambe, 2013; Brendefur, Strother, Thiede, Lane, & Surges-Prokop, 2012; Heller et al., 2012; Mukeredzi, 2013).

With regards to the second research question, the data did not provide evidence that the average teacher observation scores (FAQ) were associated with students' self-regulation scores. Although the sample size for students (n =183) was large enough for the analysis, the sample size for teachers (n = 13) was small, which may have limited the variability of FAQ scores and therefore limited the power of the analysis to show a relationship between FAQ and student self-regulation. Per the power analysis, it would have been ideal for the 183 students to have been drawn from a teacher sample of at least 29. The analysis yielded a low r value close to 0, which showed that FAQ and students' self-regulation scores were not closely related in this study. Put another way, it is quite possible that with a bigger sample of teachers the ratio of positive average student self-regulation score to negative student-self-regulation score, which was 1:6 for the workshop-only students and 1:3.5 for the workshop-plus may have been amplified and ultimately a correlation may have been observed as almost twice the number of teachers in the workshop-only group had students with low self-regulation scores. The lack of evidence of an association between FAQ and students' self-regulation scores confirmed findings in the study by Heller et al. (2012), which entailed a PD program that affected teacher outcomes positively but did not significantly impact student achievement. Arens et al. (2012) assessed the effects of a curriculum and PD program on the language proficiency of ELL and found that there was no statistical difference between student

achievement in the control and treatment groups. However, the studies focused on student performance while this study focused on students' self-regulation. Unfortunately, the sample size for teachers from which the student sample was drawn was too small to make definitive conclusions about the effects of FAQ on students' self-regulation. Therefore, the studies cannot take away from PD researchers who have found significant gains in student achievement due to PD interventions. De Kramer et al. (2012) recorded positive and significant gains in student and teacher outcomes in a teacher learning community approach to PD that included extensive PD opportunities. Additionally, Dix and Cawkwell (2011) explored the effects of sustained, ongoing, PD (writing workshops) on teachers' professional identities, self-efficacy, and their students' learning. They found that the teacher's learning, upon which the case study was based, evolved and transformed as she became self-confident and experienced higher levels of self-efficacy which she then used to improve her practice and positively impact her students' in her writing class (Dix & Cawkwell, 2011).

Lastly, for the third research question, the data showed that students whose teachers were in the workshop-plus group, on average though not significantly, had higher self-regulation scores than students whose teachers underwent the workshop only These results are not definitive as the sample size from which the students were drawn was smaller than recommended by the power analysis. The finding that students whose teachers were in the workshop-plus group had higher self-regulation scores than students whose teachers were in the workshop-only group confirmed the work of other researchers who found that PD programs that engaged teachers in an ongoing manner positively

affected teacher and student outcomes (Brendefur et al., 2012; De Kramer et al., 2012; Dix & Cawkwell, 2011; Heller et al., 2012). These findings also supported the conceptual framework that was grounded in the idea that teachers who engaged in ongoing PD (Popham, 2008), driven by student work/content focus, active learning, collective participation, and coherence tended to have improved teaching outcomes and improved levels of student learning (Desimone, 2009). Essentially, the conceptual framework was predicated on the hypothetical proposition that PD could affect teacher instructional practices in specific ways that could influence student self-regulation and rested on a theoretical framework derived from a combination of Desimone's (2009) teacher PD framework, Popham's influential prescription for implementing formative assessment practices detailed in his book for practitioners, *Transformative Assessment* (2008), and Zimmerman's concept of self-regulated learning. Although, FAQ did not correlate with self-regulation scores and the sample size from which the students were drawn was too small to make definitive conclusions in this study, these findings show that more research with a larger teacher sample size is needed.

Limitations of the Study

The design of this study limited the inferences in several ways. Firstly, the design of this study may have caused internal validity (construct validity) issues. This may have occurred due to the lack of random assignment of teachers and students, which makes it difficult to show that the treatment alone caused an effect. Specifically, construct validity issues may have been evident when comparing the self-regulation scores of students based on their teachers' PD variation (workshop-plus vs. workshop-only) because some

of the teachers were from fee paying schools while others were from free schools. Although all of the schools were low income schools, on a micro level, the type of school may have created construct validity issues as the type of school may have affected the impact of FAQ on students' self-regulation scores.

Secondly, the sample selection method (convenience sampling) threatened external validity. It threatened external validity because participants volunteered to participate in the BEP. Due to the sampling method, results may not be generalizable to the general population of underprivileged schools or children in Lagos State.

Thirdly, the sample size from which students were drawn created limitations for the study. The minimum sample size required for each test fell between the range of 29 and 130, which this study met with 183 students. However, the student sample size was drawn from a very small sample of teachers (n = 13) and thus limited the variance of the data and the power of the analysis to show a relationship between variables. Specifically, the sample size for students (n = 183) was large enough for the analysis, the sample size for teachers (n = 13) was too small, which may have limited the variability of FAQ scores and therefore limited the power of the analysis to show a relationship between FAQ and student self-regulation. Per the power analysis, it would have been ideal for the 183 students to have been drawn from a teacher sample of at least 29.

Recommendations

In this study I attempted to do something uncommon: examine the relationship between teacher FAQ and student self-regulation scores in elementary/primary schools (primary 3, 4, and 5/Grades 2, 3, and 4). Currently, many studies exist that examine the

relationship between formative assessment and student achievement but not self-regulation. Although efforts to link teacher practice with specific domains of student learning are important in order to understand how teacher behavior affects learning, this study was limited in several ways that weaken inferences. Additionally, results did not provide a conclusive answer as to the relationship between teacher FAQ and student self-regulation scores.

This study also contributes to the literature by providing information on the impact of PD variations on teacher outcomes (FAQ) in the Nigerian context, as well as the impact of PD variations on students' self-regulation scores. Further studies with larger samples should provide more insight into the relationship between these variables. De Naeghel et al. (2012) conducted a study to examine the dimensions of reading motivation in fifth grade reading. The authors studied 1,260 fifth grade Flemish students and 67 teachers. The authors found that recreational autonomous reading contributed to reading behaviour and performance (De Naeghel et al., 2012). Variables that should be considered in future studies include autonomous self-regulation, controlled self-regulation, leadership support, access to resources, developmental/psychological/ behavioural factors, and FAQ. PD of teachers and fidelity to the implementation of the program will also need to be strongly considered. The transformative assessment model (Popham, 2008) and PD framework (Desimone, 2009) should be studied further by replicating this study on a larger scale to see how FAQ and student self-regulation scores correlate under such circumstances.

Implications

This study contributes to social change by studying constructs in Nigeria that individually have been shown to improve student achievement in other countries. Studies connecting formative assessment to self-regulation are limited in other countries and almost nonexistent in Nigeria. Implementing the transformative assessment model (Popham, 2008) and PD framework (Desimone, 2009) may provide educational bodies (FME, State Universal Board for Basic Education, Nigerian Educational Research and Development Council, and private school owners) with a framework for improving teaching and learning outcomes in underprivileged schools in Lagos and throughout Nigeria. This in turn could help produce more well-functioning members of society.

More specifically, the PD framework provided a map for the implementation of the PD portion of the BEP. As the study showed, teachers who attended the workshop-plus variation had higher FAQ scores than their colleagues who attended the workshop-only variation. Therefore, governmental educational bodies and the management of low-cost schools in Nigeria could stand to gain from this PD framework as it could help bridge the gap between the PD opportunities for teachers of high-cost and low-cost schools.

Additionally, the transformative assessment model provided a way to study the implementation of teaching practice with regards to formative assessment and student self-regulation and the effects of FAQ on students' self-regulation. Although there were sample size issues, this study provides the basis for further exploration into the area of FAQ and self-regulation as self-regulation has been linked to student achievement. Also,

investigating the correlation of formative assessment on student self-regulation in a larger study could help shed more light on whether or how the two variables correlate. This study contributes to social change by adding to the dearth of literature concerning students' self-regulation in Lagos, Nigeria, and forming an evidence-base from which further studies can be implemented, ultimately, with a goal of increasing the quality of formative assessment and improving self-regulation among mathematics students in Nigeria. Formative assessment practices may bring about social change by improving the quality of education and achievement levels of underprivileged and privileged students. It may also change the dynamics of the classroom environment, thus moving the Nigerian classroom into the 21st century.

Conclusion

In conclusion, this study demonstrated a need for further research into the effects of FAQ on students' self-regulation scores and skills. Efforts should be made to further understand the role that formative assessment has on student learning. Additionally, efforts should be made to sensitize government and policy-makers on the importance of empowering students to own their learning and how formative assessment practices can support that. It is important, therefore, that additional research is done in the Nigerian context, on a larger scale, to determine how the PD framework and transformative assessment model could provide a basis to improve student autonomy.

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Appendix A: Academic Self-Regulation Questionnaire

This questionnaire concerns the reasons why children do their school work (Self Determination Theory, 2016). The scale was developed for students in late elementary and middle school. (The comparable SRQ for adults is referred to as the Learning Self-Regulation Questionnaire.) Consequently, its format is slightly different from the format of the Self-Regulation Questionnaires intended for adults. First, the responses to each item are on a 4-point scale rather than a 7-point scale because we have found that more than 4 possible responses is not optimal for the children who complete the questionnaire who are as young as about 8 years of age. Second, we typically have the children respond right on the questionnaire by circling the correct response rather than using an answer sheet. Again, this is easier, especially when doing a group administration to a class of students.

Of course, it is more work for the researcher to get the information off the questionnaires, but it is worth the trade-off (Self Determination Theory, 2016). Third, there are more items on the SRQs for children than the SRQs for adults in order to ensure good reliability. Fourth, the “very true” response comes first for each item, whereas on the adult questionnaire it comes last. To score the scale: Very True is scored 4; Sort of True is scored 3; Not Very True is scored 2; and Not at All True is scored 1. This way, a higher score will indicate a higher level of endorsement of that regulatory style. The SRQ-A uses four subscales: external regulation, introjected regulation, identified regulation, and intrinsic motivation.

Two versions of the scale. There are two versions of the SRQ-A (Self Determination Theory, 2016). The first version is the one that has used in many studies of school children. It asks four questions about why students do various school related behaviors. Each question is followed by several responses that represent the 4 regulatory styles used in this scale. Validation of this scale is presented in Ryan and Connell (1989). The second versions of the SRQ-A, which is a modification of the first, was created for students with Learning Disabilities. In a study of students with LD (Deci, Hodges, Pierson, & Tomassone, 1992), we found that the standard format was too difficult. So, rather than having one question with several responses, every item is formulated as a separate question. The items still represent the responses to the same 4 questions as in the standard version of the scale, but they are written so the children will understand them more easily. Also, we changed the wording of the four responses to make them easier for the children. In this version, Always is scored 4; Most of the Time is scored 3; Sometimes is scored 2; and Never is scored 1. Scoring information for each version of the scale is after that version. First we present the standard version; then we present the version for students with LD.

The Scale (standard version)

WHY I DO THINGS
Name: _____
Age: _____
Grade: _____
( ) Boy or Girl ( )
Teacher: _____

A. Why do I do my homework?
1. Because I want the teacher to think I'm a good student.

Very true
Sort of true
Not very true
Not at all true

2. Because I'll get in trouble if I don't.
Very true
Sort of true
Not very true
Not at all true
3. Because it's fun.
Very true
Sort of true
Not very true
Not at all true

4. Because I will feel bad about myself if I don't do it.
Very true
Sort of true
Not very true
Not at all true

5. Because I want to understand the subject.
Very true
Sort of true
Not very true
Not at all true

6. Because that's what I'm supposed to do.
Very true
Sort of true
Not very true
Not at all true

7. Because I enjoy doing my homework.
Very true
Sort of true
Not very true
Not at all true

8. Because it's important to me to do my homework.
Very true
Sort of true
Not very true

Not at all true

B. Why do I work on my classwork?

9. So that the teacher won't yell at me.
Very true
Sort of true
Not very true
Not at all true

10. Because I want the teacher to think I'm a good student.
Very true
Sort of true
Not very true
Not at all true

11. Because I want to learn new things.
Very true
Sort of true
Not very true
Not at all true

12. Because I'll be ashamed of myself if it didn't get done.
Very true
Sort of true
Not very true
Not at all true

13. Because it's fun.
Very true
Sort of true
Not very true
Not at all true

14. Because that's the rule.
Very true
Sort of true
Not very true
Not at all true

15. Because I enjoy doing my classwork.
Very true
Sort of true
Not very true

Not at all true

16. Because it's important to me to work on my classwork.
Very true
Sort of true
Not very true
Not at all true

C. Why do I try to answer hard questions in class?

17. Because I want the other students to think I'm smart.
Very true
Sort of true
Not very true
Not at all true

18. Because I feel ashamed of myself when I don't try.
Very true
Sort of true
Not very true
Not at all true

19. Because I enjoy answering hard questions.
Very true
Sort of true
Not very true
Not at all true

20. Because that's what I'm supposed to do.
Very true
Sort of true
Not very true
Not at all true

21. To find out if I'm right or wrong.
Very true
Sort of true
Not very true
Not at all true

22. Because it's fun to answer hard questions.
Very true

Sort of true
Not very true
Not at all true

23. Because it's important to me to try to answer hard questions in class.
Very true
Sort of true
Not very true
Not at all true

24. Because I want the teacher to say nice things about me.
Very true
Sort of true
Not very true
Not at all true

D. Why do I try to do well in school?

25. Because that's what I'm supposed to do.
Very true
Sort of true
Not very true
Not at all true

26. So my teachers will think I'm a good student
Very true
Sort of true
Not very true
Not at all true

27. Because I enjoy doing my school work well.
Very true
Sort of true
Not very true
Not at all true

28. Because I will get in trouble if I don't do well.
Very true
Sort of true
Not very true
Not at all true

29. Because I'll feel really bad about myself if I don't do well.
Very true

Sort of true
Not very true
Not at all true

30. Because it's important to me to try to do well in school.
Very true
Sort of true
Not very true
Not at all true

31. Because I will feel really proud of myself if I do well.
Very true
Sort of true
Not very true
Not at all true

32. Because I might get a reward if I do well.
Very true
Sort of true
Not very true
Not at all true

Scoring the SRQ-A (standard version).

First, you calculate the subscale score for each of the four subscales by averaging the items that make up that subscale. Very true is scored 4; Sort of true is scored 3; Not very true is scored 2; and Not at all true is scored 1. The four subscales are: external regulation, introjected regulation, identified regulation, and intrinsic motivation. Listed below are the item numbers associated with each of the four subscales.

External Regulation:
2, 6, 9, 14, 20, 24, 25, 28, 32
Introjected Regulation:
1, 4, 10, 12, 17, 18, 26, 29, 31
Identified Regulation:
5, 8, 11, 16, 21, 23, 30
Intrinsic Motivation:
3, 7, 13, 15, 19, 22, 27

You can use the individual subscale scores in your analyses, and you can also use the Relative Autonomy Index
(RAI). To form the RAI for this scale, use the following formula to combine the subscale scores:
2 X Intrinsic + Identified - Introjected - 2 X External

Appendix B: Observation Protocol

Name of Assessor: **Name of Teacher:** **Date:** **School:**			
Directions: Assess each component carefully. Check the appropriate column (Yes/No) or indicate not applicable (N/A). Write evidence-based comments about each component. State the location/s where observations are being made. Use the rubric on page 5 to score each component.			
Observation Component	Yes/No	Score (1 to 4)	Comments
Classroom Elements: Set-up, lesson plan, learning objectives, content mastery, teaching aids, differentiation, lesson org, teaching method, learning progressions			
1. Describe classroom set-up (efficiency, conduciveness to learning).			
2. Describe the learning goals and objective/s for the lesson.			
3. Describe the learning goals and objectives of the lesson and the extent to which the lesson plan includes provision for materials, connection to prior knowledge, starter, modeling/mini-lesson/vocabulary, evaluation, space for reflection (continuous improvement), lesson reinforcement, and assignment (if applicable)			
4. Describe the extent to which the lesson plans show evidence of learning progressions, content mastery and how instruction was delivered.			
Observation Component	Yes/No	Score (1 to 4)	Comments

Name of Assessor:	**Name of Teacher:**	**Date:**
School:		

Directions: Assess each component carefully. Check the appropriate column (Yes/No) or indicate not applicable (N/A). Write evidence-based comments about each component. State the location/s where observations are being made. Use the rubric on page 5 to score each component.

Observation Component	Yes/No	Score (1 to 4)	Comments
Lesson and Delivery: Teacher's Instructional Tactics (adjustment occasions, assessments, establish adjustment triggers, make instructional adjustments)			
5. Did the teacher identify adjustment occasions?			
6. Did the teacher use a variety of assessments to gauge student learning?			
7. Did the teacher show evidence of the use of adjustment triggers?			
8. Did the teacher make instructional adjustments?			
Student Autonomy: Learning Tactics Adjustment (assessment awareness and reflection)			
9. Did the students consider adjustment occasions?			
10. Did the students consider a variety (2 or more) of assessments?			
11. Did the students consider adjustment triggers?			

Name of Assessor:	**Name of Teacher:**	**Date:**
School:		

Directions: Assess each component carefully. Check the appropriate column (Yes/No) or indicate not applicable (N/A). Write evidence-based comments about each component. State the location/s where observations are being made. Use the rubric on page 5 to score each component.

Observation Component	Yes/No	Score (1 to 4)	Comments
12. Did students adjust their learning tactics?			

Observation Component	Yes/No	Score (1 to 4)	Comments
Classroom Culture: Climate (Learning Expectations, Responsibility for Learning, Role of Classroom Assessment)			
13. Are classroom climate guidelines evident?			
14. Does the teacher model a nurturing disposition?			
15. Does the teacher model and reinforce suitable (respectfulness, accountability talk) behavior?			
16. Does the teacher insist on accountability talk within the classroom?			
Classroom Culture: Classroom and Behavioral Management			
17. Are routines in place?			

Name of Assessor:	**Name of Teacher:**	**Date:**
School:		

Directions: Assess each component carefully. Check the appropriate column (Yes/No) or indicate not applicable (N/A). Write evidence-based comments about each component. State the location/s where observations are being made. Use the rubric on page 5 to score each component.

Observation Component	Yes/No	Score (1 to 4)	Comments
18. How are students being disciplined?			
Feedback			
19. Did the teacher give students written feedback?			
20. Did the teacher give students verbal feedback?			

Rubric	
Level	
4	Teacher demonstrates described behavior at the highest level without any deficiencies
3	Teacher demonstrates described behavior with less 2 or less instances of deficiencies
2	Teacher demonstrates described behavior with 3 or less instances of deficiencies
1	Teacher demonstrates described behavior with 4 or more deficiencies

Appendix C: License Agreement for Academic Self-Regulation Questionnaire

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