A STUDY ON THE IMPACT OF THE TEACHING CYCLE ELEMENT OF THE KIPP FRAMEWORK FOR EXCELLENT TEACHING ON THE DEVELOPMENT OF THE PEDAGOGICAL CONTENT KNOWLEDGE OF SCIENCE TEACHERS

by

LARRY KEVIN HAMPTON

(Under the Direction of J. Steve Oliver)

ABSTRACT

The goal of this study was to gain a better understanding of how a charter school framework for teaching is related to the development of new science teachers' pedagogical content knowledge (PCK). The Knowledge Is Power Program (KIPP) is one of the fastest growing public charter school systems in the country. It has grown from two teachers with 30 students each to impacting more than 80,000 students and 200 schools in 20 states and the District of Columbia. KIPP has a track record of student success both in performance on high-stakes testing and in getting students to and through college. The foundation of KIPP's teaching success is the KIPP Framework for Excellent Teaching (KFET). The teaching cycle is one of five elements that comprise the KFET.

This study explored the impact of the teaching cycle element of the KFET on the PCK development of science teachers new to KIPP. The study participants were two high school science teachers with previous teaching experience outside of KIPP. They both were in their first year of teaching in the KIPP system. Data was collected from observations, interviews, teacher's written reflections, teacher artifacts, lesson plans, and researcher field notes. The evaluation of the data was accomplished using ATLAS.ti as an aid, the constant comparative method, enumerative approach, and in-depth analysis of PCK.

The results demonstrated the following between the relationship of PCK development and the teaching cycle component of the KFET: 1) New teacher enactment of the four other elements of KFET has a greater impact on specific components of a teacher's PCK development while the teaching cycle impacts the development of all of the components of PCK; 2) The development of the new teacher's understanding of the teaching cycle of the KFET is not focused on by coaches during the first year of employment at KIPP; 3) The number of PCK/teaching cycle of the KFET incidents exhibited by new teachers increased over time; 4) The teachers' developing understanding of KFET impacts the development of their PCK, but the KFET rubric is not sensitive enough to detect these changes; and 5) The observable behaviors of the teaching cycle element of the KFET impact new KIPP science teachers' PCK.

This study also makes suggestions for future research related to the interaction of KIPP, PCK, and the KFET.

INDEX WORDS: Pedagogical Content Knowledge, Knowledge Is Power Program, KIPP Framework for Excellent Teaching, Teaching Cycle

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DEDICATON

To my wife, Vickie G. Hampton, my true north star

To our children, Phillip, Christopher, and Selah, the joys of our life

To my mother, Helen G. Hampton, my inspiration

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INTRODUCTION

Every October, I asked my chemistry students if they had heard who won the Noble Prize in Chemistry. Each year, I told them that it would be my year to win for sure. I even got other teachers near my class involved in asking students if they knew who won that year's prize in chemistry. As students transitioned to classes, some of my colleagues offered me their encouragement—that this is indeed *my* year—to help me boost the students' interest. As each of the Nobel prizes were awarded, we built up anticipation until the chemistry prize was announced. Ultimately, I lamented that I had once again failed to win the prize.

The students sympathized with me. But inevitably, in trying to understand my loss, they asked me what I had done to earn such a prize. *This is when I had them*. I had done absolutely nothing, I told them. Their obvious response: I did not deserve such an illustrious award if I had made no effort to accomplish anything to earn it. We then discussed how my effort in winning the award was similar to some of their efforts to get a certain grade in my class. I indicated that someone "telling" me they want an "A" in the class and then not doing the hard work necessary to earn it, is just as useless as me "telling" The Nobel Prize Committee that I want to win the Nobel Prize in Chemistry, but not putting forth any effort to actually make it happen. I told them that even though I had not won the prize, they still could, and that it was my expectation that they all will become Nobel Prize Laureates in chemistry.

We discussed how the path to winning the Nobel Prize in Chemistry is a tortuous one. For blacks and Hispanics, it has yet to happen since its inception in 1901. We discussed what is necessary to win, including going to graduate school and obtaining a Ph.D. in chemistry, and how really challenging that is. We also talked about how the odds of getting into various professional sport organizations for basketball, football, and soccer—a dream many of the young boys and girls in the class have—are less than those for obtaining a Ph.D. in chemistry. They often do not believe me until I present the data.

NCAA Data

According to data published in 2016 (the latest available), the National Collegiate Athletic Association (NCAA) indicates only 3.5% (Table 1) of male high school basketball players will play competitively on the NCAA level. Of the 60 NBA players drafted, only 46 slots were taken by these NCAA participants. The remaining 14 slots were taken by international players.

Table 1:
Estimated Probability of Competing in Men's College Basketball

High School Participants	NCAA Participants	Overall % HS to NCAA	% HS to NCAA Division I	% HS to NCAA Division II	% HS to NCAA Division III
541,479	18,697	3.50%	1.00%	1.00%	1.40%

Source: http://www.ncaa.org/about/resources/research/probability-competing-beyond-high-school

This indicates only 0.009% of male high school basketball participants—or 1 out of 11,771—are drafted by the National Basketball Association. For the National Football League and Men's Major League Soccer, only 1 out of 4,232 (0.024%) and 1 out of 5,767 (0.017%), respectively, of male high school participants will earn a spot. For female basketball participants only .007%—or 1 out of 13,015—will be drafted by the Women's National Basketball Association (NCAA Research). Not going to college makes the probability of playing on the professional level even lower. Only 1.1% (Table 2) of all NCAA male basketball participants

Table 2:
Estimated Probability of Competing in Men's Professional Basketball

NCAA Participants	Approximate # Draft Eligible	# Draft Slots	# NCAA Drafted	% NCAA to Major Pro
18,697	4,155	60	46	1.10%

***Source:* http://www.ncaa.org/about/resources/research/probability-competing-beyond-high-school**

makes it to the NBA. So, the odds (Table 3) are significantly better for obtaining a Ph.D. in the physical sciences or engineering versus competing in professional sports.

Table 3:
Estimated Probability of Competing in Professional Sports Vs. Obtaining a Ph.D.

Task	% Achieving	Odds
NFL	0.02%	1 out of 4,232
NBA	0.01%	1 out of 11,771
Soccer	0.02%	1 out of 5,767
WNBA	0.01%	1 out of 13,015
Ph.D.*	**7.00%**	**2,567 out of 36,485**

Source:http://www.ncaa.org/about/resources/research/probability-competing-beyond-high-school

Ph.D. Data

However, getting a Ph.D. in science or engineering is still a long shot—especially if you are black or Hispanic. The statistics indicate the dearth of minority candidates completing a Ph.D. in the physical sciences. Since 1994—and thereafter every five years—the National Science Foundation (2016) has tabulated the number of Ph.Ds awarded in the physical sciences and engineering. Of the 36,485 Ph.D.s awarded over this 20-year period, 1,120 (3.1%) have been awarded to blacks. When Hispanics are included, the number rises to 2,567 (7.0%). The number awarded to whites was 26,764 (73.4%). The remaining recipients are classified as Asian and other.

The Challenge

In the text *Blacks, Science, and American Education* (Person and Bechtel, 1989), the introduction by Bechtel describes the challenge of blacks going into science:

> "… The source of the problem is obvious: There are few black scientists because there are few blacks in graduate science programs; there are few blacks in graduate programs because there are few blacks who are encouraged to take the undergraduate courses required for successful scientific careers; there are few black undergraduates who are prepared by their high schools or grade schools to choose such courses." (p. 1)

Bechtel's statement describes a trend of diminishing returns. The challenge of getting students of color to obtain a Ph.D. in the physical sciences actually begins in high school. This challenge is made more onerous by the difficulty associated with students graduating from high school. While data (Figure 1) from the National Center for Education Statistics (NCES) indicates that the drop-out rate is improving for whites, blacks, and Hispanics, the challenge still persists for blacks and Hispanics to graduate from high school.

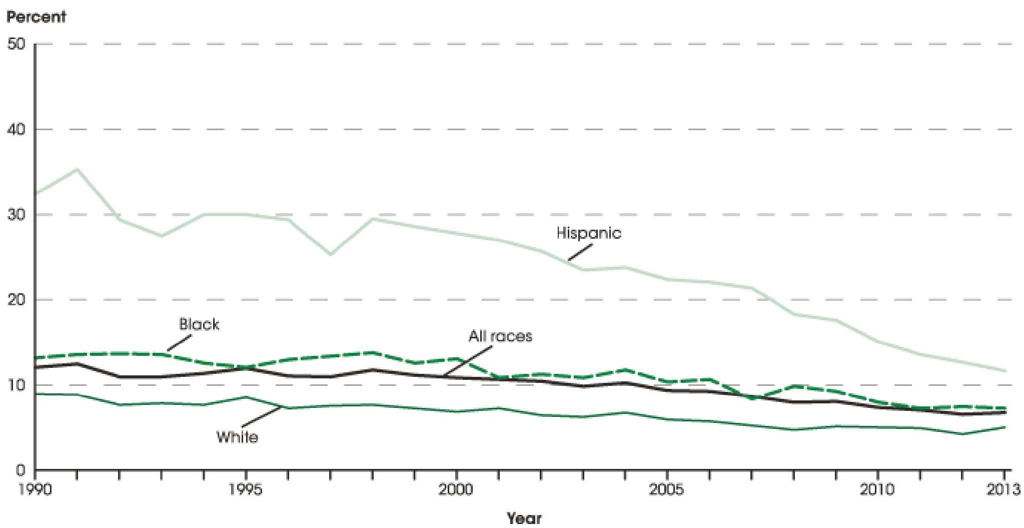

Figure 1: Status Dropout Rates of 16 to 24-Year-Olds, by Race/Ethnicity: 1990-2013

***NOTE*:** The "status dropout rate" represents the percentage of 16- through 24-year-olds who are not enrolled in school and have not earned a high school credential (either a diploma or an equivalency credential such as a General Educational Development [GED] certificate). Data are based on sample surveys of the civilian noninstitutionalized population, which excludes persons in prisons, persons in the military, and other persons not living in households. Data for all races include other racial/ethnic categories not separately shown. Race categories exclude persons of Hispanic ethnicity.

SOURCE: U.S. Department of Education, National Center for Education Statistics. (2015). *The Condition of Education 2015* (NCES 2015-144), Status Dropout Rates. https://nces.ed.gov/programs/coe/indicator_coj.asp

There is a plethora of reasons that can help explain the high school drop-out rates, among them socioeconomic challenges, lack of mentors, lack of self-efficacy, poor academic preparation, and parental educational attainment (Timar and Maxwell-Jolly, 2012). Even those blacks and Hispanics who graduate from high school still face challenges in attending college. Perna and Jones (2013) indicate there are four categories of predictors that determine college enrollment and choice:

1. Financial resources
2. Academic preparation and achievement
3. Support from significant others
4. Knowledge and information about college financial aid

Data from the NCES in Table 4 illustrates the drop in the percentage of black and Hispanic students who graduate from high school and fail to obtain a bachelor's degree four years later. Over this time period, whites made up an average of 65% of the public high school graduates, while blacks made up 14% and Hispanics made up 14.3%. The average change in the number of high school graduates to bachelor's degrees conferred over the same time period increased for whites by 9.8% and decreased for blacks by -4.3% and for Hispanics by -6.8%.

According to the NCES, there were 1,353,206 science, technology, engineering, and mathematics (STEM) bachelor degrees conferred to U.S. citizens and nonresident aliens from 2008 to 2013. Of this number, 96,118 (7.5%) went to blacks, 101,309 (7.8%) went to Hispanics, and 1,353,206 (69.9%) went to whites.

Table 4:

The Change in the Percent Distribution of High School Graduates and Bachelor's Degrees Conferred to White, Black, and Hispanic Students 1998-2012 NCES Table 219.30

	Percentage distribution of graduates						Change in number of High School Graduates to Bachelor's Degrees Conferred		
Year	Public High School Graduates{a}			Bachelor's Degrees Conferred{b}			()= decrease		
	White	Black	Hispanic	White	Black	Hispanic	White	Black	Hispanic
1998-99	**70.4**	**13.1**	**10.9**	**78.1**	**8.8**	**6.0**	**7.8**	**(4.3)**	**(4.9)**
1999-20	**69.6**	**13.2**	**11.3**	**77.5**	**9.0**	**6.3**	**7.9**	**(4.2)**	**(5.1)**
2000-01	**69.1**	**13.2**	**11.7**	**77.0**	**9.2**	**6.5**	**7.9**	**(4.0)**	**(5.3)**
2001-02	**68.5**	**13.3**	**12.1**	**76.7**	**9.3**	**6.6**	**8.1**	**(4.0)**	**(5.5)**
2002-03	**68.3**	**13.2**	**12.5**	**76.2**	**9.5**	**6.8**	**7.9**	**(3.7)**	**(5.7)**
2003-04	**66.4**	**13.9**	**13.6**	**75.7**	**9.7**	**7.0**	**9.3**	**(4.2)**	**(6.6)**
2004-05	**66.3**	**13.8**	**13.7**	**75.3**	**9.8**	**7.3**	**9.0**	**(4.0)**	**(6.5)**
2005-06	**65.3**	**14.2**	**14.1**	**74.7**	**9.9**	**7.5**	**9.4**	**(4.3)**	**(6.6)**
2006-07	**64.6**	**14.5**	**14.6**	**74.4**	**9.9**	**7.8**	**9.8**	**(4.5)**	**(6.8)**
2007-08	**63.3**	**14.3**	**15.0**	**73.9**	**10.0**	**8.1**	**10.7**	**(4.3)**	**(6.9)**
2008-09	**62.0**	**14.9**	**15.9**	**73.6**	**10.1**	**8.3**	**11.6**	**(4.8)**	**(7.5)**
2009-10	**59.8**	**15.1**	**17.4**	**72.9**	**10.3**	**8.8**	**13.0**	**(4.8)**	**(8.7)**
2010-11	**58.4**	**15.0**	**18.6**	**71.1**	**10.4**	**9.3**	**12.7**	**(4.6)**	**(9.3)**
2011-12	**57.4**	**14.8**	**19.2**	**70.0**	**10.7**	**9.8**	**12.6**	**(4.1)**	**(9.4)**
AVG	65.0	14.0	14.3	74.8	9.8	7.6	9.8	-4.3	-6.8

{a}SOURCE: U.S. Department of Education, National Center for Education Statistics, Common Core of Data (CCD), "State Nonfiscal Survey of Public Elementary/Secondary Education," 1981-82 through 2005-06; "State Dropout and Completion Data File," 2005-06 through 2011-12; and National Public High School Graduates by Race/Ethnicity Projections Model, 1995-96 through 2024-25. (This table was prepared August 2015.)

{b}SOURCE: U.S. Department of Education, National Center for Education Statistics, Higher Education General Information Survey (HEGIS), "Degrees and Other Formal Awards Conferred" surveys, 1976-77 and 1980-81; Integrated Postsecondary Education Data System (IPEDS), "Completions Survey" (IPEDS-C:90-99); and IPEDS Fall 2000 through Fall 2012, Completions component. (This table was prepared July 2013).

If we are to increase the number of Ph.Ds from students of color, as Bechtel indicated, we must fix the pipeline starting in high school. A part of that must involve the quality of the teaching these students receive during their educational journey (Darling-Hammond, 2000; Koedel, 2008; Peske and Haycock, Education Trust, W. D., 2006; Wenglinsky, H., & Educational Testing Service, P. C., 2000).

The Knowledge Is Power Program (KIPP), a national charter school network, has as a reason for its existence the goal of providing a quality secondary education that enables students of color to graduate from high school with the ability to succeed in and graduate from college. A major component of this strategy involves a teacher framework titled the KIPP: Framework for Excellent Teaching (KFET, Appendix A), which is designed to serve as a cornerstone in improving the educational outcomes for students who attend KIPP's network of elementary, middle, and high schools.

Research Significance

The purpose of this research study is to exam the impact of the teaching cycle of the KFET on the development of the Pedagogical Content Knowledge (PCK) of new KIPP science teachers. To carry out this study, there are some "practical considerations" that Corbin and Strauss (2008, p. 21) suggest be implemented. The first is choosing a research problem and stating the question. The second is developing sensitivity to what is in the data. Third is use of the literature; and fourth is developing a theoretical framework.

Maxwell (1996, p. 15) suggests the following:

> "There are three different kinds of purposes for doing a study: personal purposes, practical purposes and research purposes. Personal purposes are those that motivate *you* to do this study; they can include such things as a political passion to change some

existing situation, a curiosity about a specific phenomenon or event, a desire to engage in a particular type of research, or simply the need to advance your career. …Practical purposes are focused on *accomplishing* something- meeting some need, changing some situation, or achieving some goal. Research purposes, on the other hand, are focused on *understanding* something, gaining some insight into what is going on and why this is happening."

My purpose in completing this study is both personal – I have taught in the KIPP system and have a daughter who can serve as the poster child for its successes – and for a research purpose – attempting to explain KIPP's success in getting students to and through college. The research problem for this study was understanding the role that the teaching cycle of the KFET plays in the PCK development of new KIPP science teachers. The following questions helped to clarify the research problem and guide the data collection:

1. How does implementing the teaching cycle element of the KFET impact the development of the components of new KIPP science teachers' PCK?
2. How does a teacher's "experience in practice" in a KIPP environment impact the development of their PCK?
3. What role does the KFET teaching cycle have on this "idiosyncratic" aspect of a new science teacher's PCK?

One of the goals of this document is to explain the rationale for studying the teaching cycle of KFET. I will now explain what KIPP is about; the significance of the research problem; the unique contribution the teaching cycle of KFET may add to the understanding of teaching cycles and a science teacher's PCK; and the useful knowledge and practices for educators that may emerge from the study.

Throughout all KIPP schools, teachers, administrators, parents, and students believe in the power of high expectations—not only *can* all students learn, but all students *will* learn. The guiding idea is that, as a KIPP team, everyone will do whatever it takes to ensure that students perform to the best of their ability. The mission and outcomes expected by KIPP stakeholders are represented by a "no excuses" mindset that incorporates a reward/consequence ideal for classroom management and a set of "KIPPisms" that make the KIPP experience unique as an educational experience.

KIPP is a free, open-enrollment public charter school. While KIPP schools are located in areas where other educational options may be bleak, the student and parent make the choice to come to KIPP. This often involves participation in the admissions lottery due to the limited number of classroom seats available. The commitment comes with everyone agreeing to put in the time that is required to succeed at the school. A part of this involves everyone from the students, parents, teacher, and administrator signing a Commitment to Excellence Agreement (KAC, 2016, p. 5). This is an agreement where everyone involved commits to upholding the school values of unity, honor, tenacity, innovation, and humanity. This commitment may take other forms in other KIPP schools, but the idea is the same.

Other aspects of being at KIPP involve components of more time on task and the power to lead. The "More Time" component is recognition that there are no shortcuts. Success requires time on task; therefore, at most KIPP schools, the day starts at 7:30 a.m. and ends at 5 p.m.; there are Saturday sessions; and there are mandatory summer school sessions. The "Power to Lead" component frees the KIPP school leader from the bureaucratic red tape that entangles other public school principals. KIPP school leaders have autonomy over budget and personnel. This enables them to make immediate decisions they feel are in the best interest of the student.

KIPP teachers are monitored with two mandatory observations per year. School directors or their designee can and often do have informal observation sessions. If a classroom is in turmoil (either by student/parent complaints or benchmark performance), informal observations then increase and additional teacher monitoring occurs. School directors have the autonomy (and often use it) to terminate the employment of any teacher with cause. This can range from an obvious unwillingness to implement the KIPPisms that are the hallmark of the system, to poor performance, to inappropriate behavior, to simply not being the right fit for the school. Prior to termination, significant efforts would have been made to rectify the issue.

KIPP is a world where high-stakes testing is a fact of life. There is a “Focus on Results” component that serves as an expectation that students will be prepared to succeed no matter where they go after KIPP.

Teachers also have autonomy in the classroom. As KIPP has grown from a seat-of-your-pants system into a national network serving more than 80,000 students, there had to be both systematic and personal changes in how things got done. If a student in one teacher’s class can exceed the state and county performances on high-stakes, state-mandated testing, how did that happen? And, more importantly, how can those best practices be preserved and passed on to others?

KIPP’s Unique Contribution

According to Tyler (1977): “If students are to enter wholeheartedly into learning, they should perceive just what the behavior is that they are expected to learn and should feel confident that they can carry the learning tasks through successfully (p 63).”

A unique part of the KFET teaching cycle involves “the what.” This component of lesson planning expects the teacher to “establish clear criteria for success and an aligned way to assess daily." This concept is derived from work by Jon Saphier's Research for Better Teaching (Sites.google.com, 2013) and is part of his course on Criteria for Success. The main component involves the 5 P's:

1. Public means there are no secrets: students know exactly what will be the basis for evaluating the work
2. Precise means naming the qualities or characteristics that need to be present for the work to meet the standard
3. Prior means sharing this information with the class at the beginning of the task so that students can work toward creating a successful product or performance
4. Printed means that the criteria are written down for students to refer to as they complete the task
5. Presented in models of exemplary work means that students see concrete models that exemplify the criteria for success - these pieces of work are often called exemplars

Incorporating these concepts into a teacher's curriculum design will "show the learners clearly what they are expected to learn, and will employ learning tasks that are within their present abilities to carry through" (Tyler, 1977, p. 63)

Another unique aspect that KIPP has implemented with the KFET teaching cycle is the same thing that makes a KIPP teacher's experience what it is: there is no one way of accomplishing it. It is not a static, one-size-fits-all type of system, but instead incorporates a blend of what are considered best practices. The teacher—who is at the center of everything—decides what should and should not be a part of his or her class.

There is an expectation that KIPP teachers develop a 1/12th mindset. This is a KIPP ideal that maximizes every minute of class time for the student. It implies that there is a laser focus by the teacher on the tiniest details, which the KFET teaching cycle suggests can dramatically impact student mastery. The implication is that incremental changes in the way a teacher does what they do best can result in significant positive improvements in how KIPP students learn. By doing something as simple as reducing the amount of time to hand out or collect papers, or getting the students into the room, or making sure that the last five minutes of class is independent practice—any effort at improving the efficiency and urgency of class routines and systems incorporates the 1/12th mindset.

Another major expectation at KIPP is accountability. There is a rubric (see Appendix A) that accompanies the KFET that can be used to measure the teacher's fidelity to the implementation of the KFET elements.

This rubric used for establishing accountability also serves as a teacher evaluation component. The goal, however, is not to establish a system of evaluation that is punitive, but to provide a level of feedback that would improve the teacher's performance in the classroom. It has been designed to distinguish the accomplishments of a new teacher from a veteran teacher. Finally, the KFET encourages teachers to seek feedback and use it. This is viewed as part of the continuous growth that is expected of all teachers.

When entering a KIPP classroom, the teacher has an understanding of content, as well as PCK. The development of PCK in a KIPP environment represents a modification of what a teacher already has gained as both content knowledge and as the method of transforming that knowledge to students. This has been developed either through the teacher's participation in a college teacher preparation program or by having taught in another classroom. Within KIPP, a large part of the teacher transforming knowledge is based on the KFET. This document underscores that, at KIPP, "excellent teaching means students learn, grow, and achieve transformative life outcomes” (Ali et al., 2012). In summary, the KFET has as its core this ideal of student growth and achievement, and incorporates notions of beliefs and character, self and others, classroom culture, the teaching cycle, and knowledge. Each of these notions carries with them well-outlined tenets that not so much as instructs a teacher in how to accomplish these tasks, but describes what a successful classroom would look like after implementing them. One of the reasons for KIPP implementing the framework is its hope that every teacher has the belief that they can “become a great teacher and will never truly get to the end of this path because there’s so much to learn and so much to do in the act of teaching and learning” (Ali et al., 2012).

Useful Knowledge and Practices

Previously, we have described the teaching cycle as one of five elements of the KFET. Unique to the KFET teaching cycle are the following practices:

- A consistency across an educational network, yet the independence to run a classroom as the teacher sees fit. The online KIPP: Share network, which is unique to KIPP, is a platform that enables this consistency
- A transparency others can use both within and outside of system. KIPP readily shares best practices with other educational systems
- A level of accountability outside of test results. KIPP is using the KFET as an evaluation tool that looks beyond performance related to high-stakes testing
- A different approach to the induction process for new teachers. The cornerstone of the induction process for new KIPP science teachers is the KFET

At KIPP, there is an effort to provide information in an electronic database called KIPP: Share (share.kipp.org). It serves as a repository for lesson plans, projects that worked, projects that bombed, and notes related to content. The KFET teaching cycle encourages teachers to use this as a resource and share their resources with others. Teachers get out of this system as much or as little as they see fit.

KIPP recognizes that it does not have the answer for all that ails the urban educational system in America. The KFET teaching cycle provides a structured format that fosters a conversation about what works inside the KIPP world. These competencies and observable behaviors are not a secret. They can serve as a starting point for individuals both within and outside KIPP to look at a system and try to understand what (from a KIPP perspective) are the traits of excellent teaching that can be "observed" in a KIPP classroom. KIPP acknowledges that it is a living document. By looking at the best practices from other systems, it has built a framework that enables students of a disadvantaged socioeconomic environment to succeed.

What impact does the teacher evaluation system that is a part of the KFET teaching cycle really have on the teacher in the KIPP classroom? Is the rubric (Appendix A) used to evaluate the success of the teaching cycle effective? Accountability is ingrained in the KIPP system. It must do what it professes to accomplish: prepare underserved students for getting to and through college; otherwise, the wave of support that KFET receives will surely dissipate. My research will examine the validity of this component.

Research Rational

KIPP is currently providing on a daily basis educational opportunities to more than 80,000 students across 20 states and the District of Columbia. It is the vanguard of charter school reform. While it has its share of critics, it is frequently heralded as a model for improving the educational outcomes for students of color (Tuttle, Gleason, Knechtel, Nichols-Barrer, Booker, Chojnacki, Coen, Gogle & Mathematica Policy Research, Inc., 2015; Gleason, Tuttle, Gill, Nichols-Barrer, & Teh, 2014)) and demonstrating that socioeconomic status should not be a determinant of educational and career success.

When I started my KIPP career, I was given a textbook and a room and told to do the best I could. KIPP has progressed from this seat-of-your-pants type system to one that has a clearly defined teacher induction program designed to support both new and experienced teachers in their acclimation to the system. The teacher induction process involves new teachers to KIPP meeting prior to the arrival of veteran KIPP teachers, getting a boot-camp introduction to the KFET concept, consistently interacting with administrators and a mentor teacher, and attending workshops that assist the new teacher in implementing the KFET teaching cycle.

The KFET serves as the cornerstone for the induction process in the KIPP system and is the focus of teacher professional development and evaluation. To date, there has been no study to determine the impact of the KFET on KIPP's success. The focus of my research will look at one component that helps explain KIPP's success. My research will focus on determining what impact the teaching cycle component of the KFET may have on changing the pedagogical content knowledge of new KIPP science teachers. This is important because 80,000 students across America depend on KIPP each day to provide an educational opportunity. The KIPP teacher plays a critical role in this process. It is critical to gain an understanding of how the cornerstone of KIPP's classroom expectations through the teaching cycle of the KFET impact that process.

CHAPTER 2

LITERATURE REVIEW

With his seminal work in identifying PCK in 1986, Shulman set off a torrent of debate and inspired extensive research on exactly what is PCK, how is it evaluated, and what impacts or retards its growth. He described PCK as knowledge "which goes beyond knowledge of subject matter per se to the dimension of subject matter knowledge for teaching." This "knowledge" has three forms, including strategic knowledge, which is defined as "a process of analysis, of comparing and contrasting principles, cases and their implications for practice"; case knowledge, which is "knowledge of specific, well-documented and richly described events"; and propositional knowledge, which Shulman feels is what is most often taught to teachers. He divided propositional knowledge into "three major sources of knowledge about teaching: disciplined empirical or philosophical inquiry, practical experience, and moral or ethical reasoning" (pp. 11-12).

In 1987, Shulman redefined his notion of PCK from three tenets to seven that include the following:

- Content knowledge
- General pedagogical knowledge, with special reference to those broad principles and strategies of classroom management and organization that appear to transcend subject matter
- Curriculum knowledge, with particular grasp of the materials and programs that serve as "tools of the trade" for teachers

- Pedagogical content knowledge, that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding
- Knowledge of learners and their characteristics
- Knowledge of educational contexts, ranging from the workings of the group or classroom, the governance and financing of school districts, to the character of communities and cultures
- Knowledge of educational ends, purposes, and values, and their philosophical and historical grounds (p. 8)

The impact of this expansion added to the discourse concerning PCK, as researchers have proposed their own adaptation to this effort. This ontological approach can be found in works by van Driel, Verloop, & de Vos (1998); Daehler and Shinohara (2001); and Sperandeo-Mineo, Fazio, & Tarantino, (2006). In addition, authors such as van Driel et al. (1998) defined PCK as something that refers to teachers' interpretations and transformations of subject-matter knowledge in the context of facilitating student learning.

There also are notions of transformative and integrative ideals of PCK. Sperandeo-Mineo et al. (2006) looked at physics teachers and proposed the notion that PCK is separate from subject matter knowledge (SMK) and is therefore transformative. There is a "transformation" of subject matter, pedagogical, and contextual knowledge required in order to teach students. Magnusson, Krajchik, and Borko (1999) described pedagogical content knowledge as the transformation of several types of knowledge for teaching (including subject matter knowledge), and that, as such, it represents a unique domain of teacher knowledge.

The integrative model suggests that SMK and PCK are part of the same body of knowledge. It recognizes pedagogy, SMK, and context as one unit of knowledge (Daehler and Shinohara, 2001). This differs slightly form Shulman's initial model in that "transforming" subject knowledge is no longer a viable part of the PCK. Other authors looking at PCK have used different terms to describe what Shulman referred to as "transformation." Dewey (1902/1983) referred to it as "psychologizing"; Ball, Thames, & Phelps (2008) referred to it as "representation"; Bullough (2001) called it "professionalizing"; and Veal and Makinster (1999) labeled it "translation."

Components of PCK

In completing this study, I began by being more specific about the components that I am defining as PCK. The components of PCK that will be used in the completion of this study have been described elsewhere (Magnusson et al., 1999; Park & Oliver, 2008). Magnusson (1999, p. 99) first described them as the components of pedagogical content knowledge for science teaching, as depicted in Figure 2.

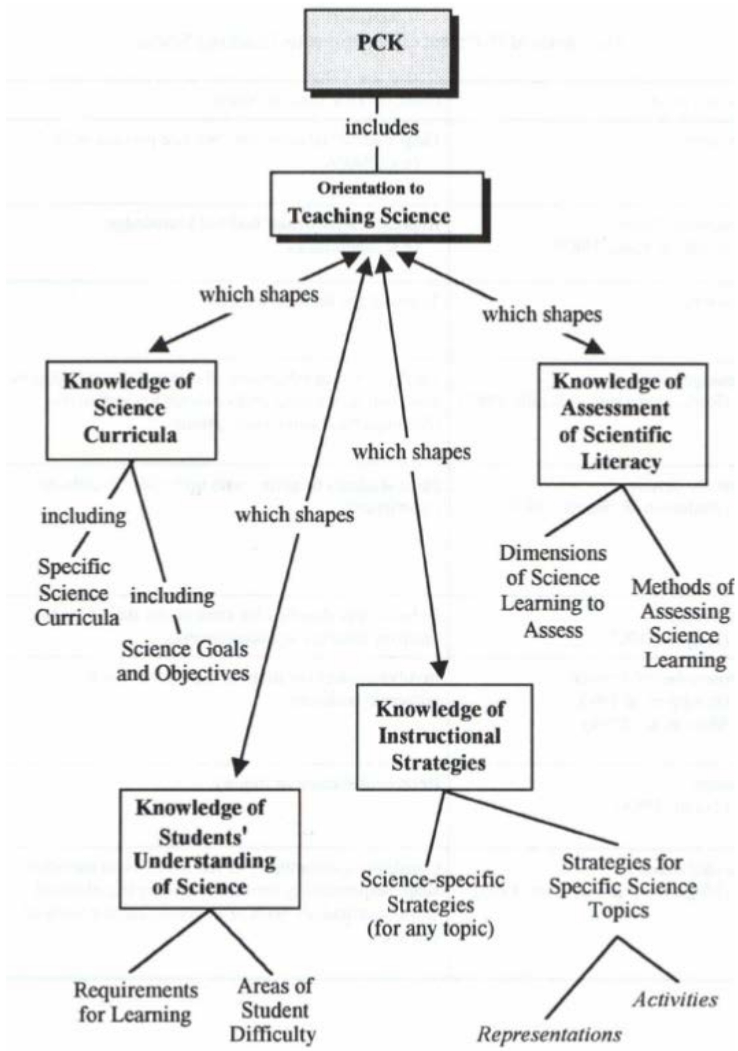

Figure 2: Components of PCK for Science Teaching

A more detailed description of each component was provided by Park & Oliver (2008). The following is a brief description for the five components that will be used for this study:

- Knowledge of Orientations to teaching science - refers to teachers' beliefs about the purposes and goals for teaching science at different grade levels
- Knowledge of students' understanding in science - refers to knowledge of students' conceptions of particular topics, learning difficulties, motivation and diversity in ability, learning style, interest, developmental level, and need

- Knowledge of science curriculum - refers to teachers' knowledge about curriculum materials available for teaching a particular subject matter, as well as about both the horizontal and vertical curricula for a subject
- Knowledge of instructional strategies and representations for teaching science - comprised of two categories: subject-specific strategies and topic-specific strategies. Subject-specific strategies are general approaches to instruction that are consistent with the goals of science teaching in teachers' minds, such as learning cycles, conceptual change strategies, and inquiry-oriented instruction. Topic-specific strategies refer to the strategies that apply to teaching particular topics within a domain of science
- Knowledge of assessment of science learning - comprised of knowledge of the dimensions of science learning important to assess, and knowledge of the methods by which that learning can be assessed (p. 6)

Previous Approaches to Evaluating PCK

There are a number of different approaches in evaluating a teacher's PCK. In an extensive review of studies related to PCK, van Driel, Berry, and Meirink (2015) summarized the approach from the following perspectives: conceptualization or model of science teacher knowledge; research design or approach; and findings regarding the content or structure of science teacher knowledge and its relationship to teaching practice.

In looking at studies that evaluated a teacher's PCK, I focused on those that examined the use of prompts, how PCK was developed in a teaching/learning environment, the use of rubrics, and how knowledge of student learning and instructional strategies were evaluated. Each of these components played a role in helping me understand how to structure my research.

Using Prompts to Evaluate PCK. Kind (2009) looked at PCK both *in situ* and through the use of "prompts." *In situ* work involves looking at how science teachers actually teach in their classrooms or laboratory settings. This data is collected over an extended period of time rather than a one-shot, instant evaluation. This process may involve pre- and post-lesson interviews and the use of rubrics. Prompt studies involve the use of "video excerpts or descriptive prompts as instruments for investigating PCK." They may also involve examining PCK "following or during an intervention, such as attendance at a workshop or training course." Prompts can be used in a variety of settings and allow the comparison of PCK across different environments.

One disadvantage of prompts, according to Kind, is that they allow only data that "relates primarily to PCK perceived in the probe material. The full range or quality of PCK a teacher possesses may not be exposed by this technique; its success relies on the nature of the probe itself." Another criticism, according to Kind, is that prompts allow only a snapshot of PCK.

Kind also discussed the need for questionnaires, video recording and transcribing, student samples, field reports, and interviews as legitimate means of capturing a teacher's PCK. She asserted that "pedagogical content knowledge is a concept that represents the knowledge teachers' use in the process of teaching." According to Kind, "if we can identify this, our understanding of what 'good science teaching' looks like and how to develop this more consistently may be enhanced."

Kind's work is an ontological romp through PCK looking at various models, how PCK is put into practice, the interaction between PCK and subject matter knowledge, and evaluating research methods for clarifying PCK. It is an excellent theoretical treatise on the alternative ways to address the question of PCK, while highlighting the strengths and limitations of the different approaches.

The implications of Kind’s work for my research are that, in order to gain a complete understanding of the impact of the teaching cycle element of KFET on a new KIPP science teacher, both *in situ* and prompts had to be used. During the course of this study, I completed 30 *in situ* observations. A part of these observations involved the use of prompts, as will be described later.

Developing PCK in a Teaching/Learning Environment. Another approach to understanding PCK is taken by Sperandeo-Mineo et al. (2006). The aim of their case study was to: construct a teaching/learning environment providing for 28 prospective teachers or student teachers (ST)—enabling conditions for collaborative inquiry in model-building procedures; and investigate the correlations between the characteristics of the supplied teaching/learning environment and the competencies developed by STs in the direction of the construction of an appropriate PCK. Their findings attempted to demonstrate “ways to provide prospective teachers with a knowledge base that enables them to teach specific topics in a more effective and flexible way” (p. 262).

This is similar to the KIPP approach with the exception that student teachers are not involved. KIPP teachers are embedded in a KIPP environment and are expected to teach topics in an “effective and flexible way.” This impacted my study by enabling me to compare the method used here to that provided by KIPP in the implementation of the teaching cycle of KFET.

Sperandeo-Mineo et al. used a phenomenographic approach to analyze data collected from four sources: an admissions test that evaluated the basic content knowledge of student teachers (ST); pre- and post-tests to determine changes in the nature of STs’ models and explanations involved in the studied physical processes; an analysis of worksheets and other empirical material prepared by the STs in the workshop; and logbooks of two tutors and the researcher. According to Sperandeo-Mineo et al., this phenomenographic approach was carried out “in order to reveal the different ways in which some classroom learning episodes were experienced by our STs.”

The aim of phenomenography is to map different ways in which a phenomenon can appear and to find out an interpretation by grouping these ways into categories. The study’s limitation is whether its claims can be extrapolated to other populations and content areas. It does not include such expectations as classroom management due to the STs participating in a workshop and not in a classroom. One of the goals was “making ST’s experience the same learning environments they are supposed to realize in their future classrooms.” However, this study used other STs as students, which most assuredly skewed the outcome in a way that may not be a realistic indication of their future classrooms.

This study was presented here as simply another approach to the evaluation of PCK. No pre/post-tests related to content knowledge were administered as a part of my research. The focus of my study was not on subject matter knowledge held by the teachers, but on how teacher knowledge about content was transfered to students. However, there was an attempt to encourage my study participants to use logbooks. Due to the time commitments already placed upon the participants by KIPP, keeping logbooks became unfeasible. Instead, member checks were completed, as well as email correspondence related to clarification of activities observed in the class (Appendix B).

Using Rubrics to Evaluate PCK. Work by Park & Oliver (2008) used a multiple-case study to evaluate the PCK of three chemistry teachers. They used classroom observations, semistructured interviews, lesson plans, teachers' written reflections, students' work samples, and researchers' field notes to complete the evaluation. They looked at their data through three lenses: constant comparative method, enumerative approach, and in-depth analysis of explicit PCK.

The use of grounded theory with the constant comparative method in Park and Oliver's work is used, as Glaser (1965) indicated, as a means to "generate theory more systematically." Once the interview tapes were transcribed, the tool most often used to formulate some understanding of the process was a rubric. In a different study, Park, Jang, Chen, & Jung (2011) used a self-designed rubric as part of their attempt to determine if a teacher's PCK is a "necessary body of knowledge for reformed science teaching." This rubric used pre/post-observation interviews to measure a teacher's PCK. It is based upon the five components that are identified by Park and Oliver (2008) that I will describe later in this document.

In addition to using the self-developed rubric, Park et al. (2011) completed a quantitative evaluation using the *Reformed Teaching Observation Protocol* (RTOP). This tool was designed by the Arizona Collaborative for Excellence in the Preparation of Teachers. According to Sawada, Piburn, Judson, Turley, Falconer, Benford, & Bloom (2002), "The RTOP is a highly inductive instrument. It calls upon observers to make holistic judgments about broad categories of lesson design and classroom culture."

The tool "is a 25-item classroom observation protocol that is standards-based, inquiry-oriented, and student-centered." The collaborative observations are then quantified and differences in what was observed between evaluators are evaluated. The tool's role is to determine whether legitimate reform occurred in a classroom based on the observations.

The findings of Park et al. (2011) determined that there is a significant correlation between using their self-developed rubric and determining if a classroom is reform-oriented as measured by RTOP. Their PCK rubric demonstrated that two components of PCK that I am looking at—Knowledge of Student Understanding and Knowledge of Instructional Strategies and Representations—"are positively related to the reform orientedness of instruction" (p. 254). Further implications are that "the level of a teacher's PCK is highly connected with the degree to which his or her instruction is reform-oriented" (p. 253).

The implications of this study for my work are related to KIPP's effort to reform how teaching is done. The KFET has its own rubric that determines the fidelity of a KIPP teacher in carrying out what KIPP describes as excellent teaching. This rubric is used nationwide to evaluate KIPP teachers. I have correlated the elements of this rubric with the components of PCK. The goal is to determine if this rubric is effective in determining changes in PCK. If growth can be measured in participants' implementation of the KFET, this study will show if this translates into corresponding growth in PCK.

Evaluating Knowledge of Student Learning and Knowledge of Instructional Strategies. The next study evaluated is by Lee et al. (2007). It is an evaluation of 24 beginning secondary science teachers' yearlong development of PCK, focusing on two categories: Knowledge of Student Learning and Knowledge of Instructional Strategies. While this study does not encompass the seven criteria set forth by Shulman (1986), it does give an example of a different approach to qualitative research of PCK and suggests that exploration of PCK should occur during the first years of teaching in order to capture change in this unique knowledge base. The study used data from a pilot study that examined teachers' experience with four different types of induction groups: e-mentoring, general, intern, and science-specific. Teachers' beliefs about teaching, content knowledge, PCK, and understanding of the nature of science were monitored. The teachers also were observed on at least four occasions throughout the year.

The data from the study was initially coded by two researchers who independently used a PCK rubric developed by the group. The coding was then compared between the two, and an inter-rater reliability was calculated. Disputes were resolved with a third independent rater. Following the coding, a descriptive analysis was carried out, followed by an examination of the differences in PCK between the four groups using the Kruskal-Wallace test and a Wilcoxon signed-ranks test. The statistical software, SPSS, was used in the evaluations. The findings helped Lee et al. to better document the level of PCK in a beginning teacher's classroom, as well as provided a document that "initiates a discussion about the structure of PCK and how to assess it" (p. 58). It also is a tool that can be used to better understand the development of science teachers' PCK in their first few years. Their results demonstrated that there was not a significant difference between Knowledge of Student Learning and Knowledge of Instructional Strategies between the four groups of teachers.

This work provides a roadmap for determining the development of PCK. The base for my study is forming a link between the teaching cycle of the KFET and PCK. To accomplish this, I will discuss later how inter-rater reliability was used between these two concepts by two raters to form this link. This study also implemented the use of a rubric, which, as stated previously, will play a role in my study to determine the fidelity of the participants to the KFET and to enumerate instances of PCK.

Summary of PCK Evaluation. Each of the above studies evaluates PCK in unique formats. In order to evaluate a teacher's acquisition, transformation, and demonstration of PCK, a number of approaches will have to be taken. I have briefly discussed how the above studies play a role in this research project. The use and design of these methods should, as LeCompte and Preissle (1993, p. 54) indicate, answer “interrogatives” for “determining the ‘who,’ ‘what,’ ‘where,’ ‘when,’ ‘why’ and ‘how.’ *What* kind of data will you need from *whom; where* can the data be found and *when* is it accessible or conveniently obtained; *how* should it be recorded, collected, or stored, and most importantly, *why* is it needed anyway? What does it add to a study and do I have the resources to collect it?”

It is through LeCompte and Preissle’s interrogative lens that I have evaluated the different designs and approaches researchers have used in the past 10 years to study and assess science teachers’ pedagogical content knowledge (PCK) and determined if some part of their approach will be used in this study. These are all concerns that will have to be addressed throughout the course of completing my research. Described in this document are *who* is involved in this study, the answers to *what* kind of data will be needed, and from *whom* it will be collected. I have previously made a justification in this document as to *why* the data is needed.

Teaching Cycles

KIPP has at its central core the ideal that excellent teaching involves a notion of the “teaching cycle,” one of the five elements of the KFET. I will now discuss what the KFET describes as the teaching cycle and compare KIPP’s process to that of three other well-known theoretical bases for teaching. Those are The Learning Cycle by Anton Lawson; the Biological Science Curriculum Study (BSCS) 5E Instructional Model by Bybee, Taylor, Gardner et al.; and the Understanding by Design by Wiggin and McTighe (2005).

In order to formulate an evaluation of these different types of models, I will establish some guidelines by which each will be evaluated. The evaluation of a particular model can take a number of forms. Should each exhibit the sense of pragmatism espoused by John Dewey (1998)?

What about the impact of the law of effect or the law of exercise espoused by Thorndike (1898)? Should they address the three major components of Piaget's (Piaget & Inhelder, 1997) cognitive theory: Shemas, processes that enable transition, and the different stages of development? Or the social approach by Piaget's contemporary Vygotsky (1978), where each should exhibit a socio-cultural approach to learning? Before answering how the teaching cycle of the KFET and the other models that serve as theoretical bases for teaching will be evaluated, I will provide a description of the KFET, The Learning Cycle, the BSCS 5E Instructional Model, and the Understanding by Design model.

KIPP Framework for Excellent Teaching. The KFET was developed as a model by KIPP based upon how KIPP thinks its teachers can provide excellent teaching. I will now describe the structure of the KFET, as well as the teaching cycle observable behaviors of the KFET. Understanding the role these observable behaviors of the teaching cycle played in the development of a new KIPP science teacher's PCK will be the focus of my study.

The KIPP system is evolving. One of the benefits of KIPP being a charter system is the flexibility that it has in meeting its challenges. Early on, it was a by-the-seat-of-your-pants type of organization. As KIPP has matured and grown as a system, there have been changes that have required components to become standardize due to its new size. KIPP is still trying to remain true to its objective of teacher autonomy and allow the innovation that a charter school can implement. There are a number of studies that suggest the KIPP experience is making a difference. To date, research on KIPP has focused on the positive impact on student performance as related to state-mandated testing. (Angrist, Dynarski, Kane, Pathak, & Waters, 2012; Angrist, Dynarski, Kane, Pathak, & Walters, 2010; Hampton, 2009; Yeh, 2013; Woodworth, David, Guha, Wang, & Lopez-Torkos, 2008; Ross, McDonald, & Alberg, 2007). In the most extensive study to date, Tuttle et al. (2015) determined that the average impact of KIPP on student achievement is positive, statistically significant, and educationally substantial.

KIPP also has its share of detractors. Lack (2009) suggests that KIPP promotes undemocratic practices, such as militaristic discipline, pro-consumerism, and authoritarian modes of instruction. Yeh (2013) suggests that the KIPP model is difficult to extrapolate due to the lack of “highly dedicated teachers” who will be needed in the KIPP classrooms.

The foundation of this study and for KIPP itself is the KFET (Appendix A). KFET is being implemented in the KIPP world as one of those standardize components to foster a uniformed approach to student success across a national network of teachers. Its purpose, according to Levin (2012), one of the founders of KIPP, is to “provide a common language to start thinking about the question, what makes for excellent teaching?”

The KFET version implemented in the KIPP Metro Atlanta Schools is a modification of the national version of the framework. These changes were based upon feedback from the KIPP Metro Atlanta Schools’ teachers and instructional leadership teams’ “interpretation of the rapidly growing body of knowledge from policy, practice, and research of teacher observation and evaluation” (KIPP, 2015).

Figure 3 depicts the five elements that comprise the framework: 1. Self and Others; 2. Classroom Culture; 3. The Teaching Cycle; 4. Knowledge; and 5. Beliefs and Character (Ali, Bowen, Brenner, Campbell, Davis, DeAngelo, … Witter, 2012). All of the elements are unified by KIPP’s concept of beliefs and character, and support the ideal of student growth and achievement. For KIPP, this means that teaching enables students to “learn, grow and achieve transformative life outcomes.”

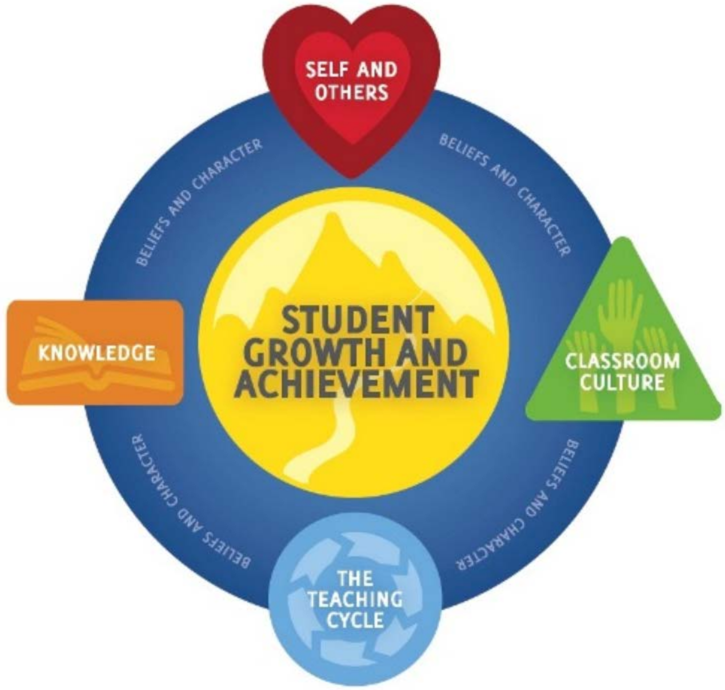

Figure 3: The KIPP: Framework for Excellent Teaching

Additionally, all of the KFET elements are linked by the expectation that the teacher's "beliefs and character affect who she is, her impact on relationships with others, her classroom environment, how she teaches, and what she knows" (Ali et al., 2012, p. 3).

A brief description of each element is in Table 5.

Table 5:
The Five Elements of the KIPP: Framework for Excellent Teaching (Ali et al., 2012, p. 3)

Self and Others	Excellent teaching requires understanding of oneself, one's connection to others, and a growth mindset that allows the teacher to take ownership for the success of all KIPPsters.
Classroom Culture	In an excellent classroom culture, the teacher focuses on countless tangible and intangible details in the space to create an environment where students are joyfully engaged and meaningfully on task, and they feel ownership for their individual and collective successes in college and in life.
The Teaching Cycle	Excellent teaching means planning and executing rigorous, engaging lessons that fit into a logical scope and sequence, as well as using student data to assess mastery of objectives and movement toward big goals for student achievement and growth. Excellent teaching requires a 1/12 mindset – meaning that even the tiniest details can dramatically impact student mastery.
Knowledge	Teaching is both an art and science. As the artists and scientists, we are responsible for building our understanding of child development, pedagogy, and content. We are responsible for knowing what we are teaching, how it fits in a Pre-K to 16 continuum, and to whom we are teaching.
Belief and Character	An excellent KIPP teacher is committed to KIPP's mission. She constantly pursues becoming a better person, just as she supports students in this pursuit. She understands that her beliefs and character affect who she is, her impact on and relationships with others, her classroom environment, how she teaches, and what she knows.

A refrain that I often heard while teaching at KIPP is an explanation for teacher's motivation to be a teacher at KIPP. This refrain centered on the belief that socioeconomic status should not be an impediment to a quality education. To stay at KIPP, teachers must support the KIPP mission. This mission is modified in each school, but carries similar ideals. For example, the KIPP school (KIPP: South Fulton Academy) that I was a part of had the mission: “To strengthen the knowledge, skills, character, and physical fitness of students in South Fulton County, thereby creating opportunities for success in top-notch high schools, colleges, and the competitive world beyond” (KIPPSouthFulton.org). Another aspect of the KFET is that teachers are “expected to become better persons, as well as inspire their students to do likewise” (Ali et al., 2012, p. 3).

The KFET is in a constant state of evaluation and modification. It currently encompasses 11 competencies and 27 observable behaviors that teachers in any classroom—*but especially a KIPP one*—should exhibit. KIPP states that the KFET was developed for five particular reasons as referenced in Table 6:

Table 6:
Reasons That the KFET Was Developed (Ali et.al, 2012, p. 2)

Reason	Description
We teach in schools, not classrooms	Teaching should be a concerted effort involving "the village" as mentioned in the African proverb, "It takes a village to raise a child." It involves interactions with students and others in the building. For example, teachers of the same content often have the same planning block. This affords time for cross collaboration. It is also expected that teachers do not take a "that's not my student, so it is not my problem" mindset.
We teach on a Pre-K to 16 continuum	Teaching involves supporting students from the moment they enter the first classroom until they walk across a college commencement stage. This involves "approaching each interaction with our children with an urgent patience, an understanding of what lies ahead of them, but also an absolutely insane focus on accomplishing the most we can with the moment in front of us."
Joy is a means and end in education	The notion of joy is "infused throughout the very act of teaching and learning ... Kids should enjoy school so much that they can't imagine missing a day and attendance rules become unnecessary."
We need a platform for sharing and innovation	KFET should become "a common language for talking about extraordinary teaching that facilitates a similar wave of problem-solving and sharing amongst teachers and leaders" across the entire network.
We want teaching to be a ray, not a line segment	Teaching has no "end point" and "becoming an excellent teacher is a lifelong pursuit."

Due to this broad nature of the KFET, my research focused on only one of the five elements: the teaching cycle. The teaching cycle is comprised of three competencies and the most observable behaviors (13) of any of the elements that comprise the KFET. A brief summary for each competency of the KFET teaching cycle is provided in Table 7 (KIPP, 2015).

Table 7
Summary of Competencies and Observable Behaviors Associated With the Teaching Cycle Element of KFET

Competency	Observable Behaviors
Plan	• END IN MIND – Plans backwards • SMART AIM – Plans a daily objective/aim that is achievable, rigorous, and measurable • THE WHAT MATCHING THE HOW – Establishes clear criteria for success for students and aligns each component of the lesson to the aim • LITERACY FOR EVERYONE – Vocabulary • LITERACY FOR EVERYONE - Reading and text-based writing strategies • DIFFERENTIATION - Pre-teaches, re-teaches, and extends as needed
Teach	• CLARITY – Delivers content in a well-organized, clear, and accessible manner, highlighting key points. Proactively addresses students' misconceptions • QUESTIONING – Incorporates higher order questions from Bloom's taxonomy and provides support when necessary to get students to high-quality responses • RIGOR - Uses a variety of strategies to increase the thinking, writing, analyzing, and speaking done by students • URGENT PATIENCE – Sets, communicate, and keeps pace during class time in order to maximize instructional time

Assess and Adjust So More Kids Learn	• ASSESS – Assesses all students against each lesson's learning objectives to inform teaching daily (exit tickets, class work, etc.); plans unit assessments and weekly/bi-weekly assessments that are appropriately spiraled, scaffolded, and differentiated; adapts, accommodates, and modifies assessments for students with special needs • CHECK FOR UNDERSTANDING (CFU) – Gets an accurate pulse on student understanding and immediately uses data from CFUs to correct misconceptions and determines whether to re-teach the entire class, target a smaller group, or support individual students • TRACK AND ANALYZE ASSESSMENT DATA – Tracks and analyzes assessment data regularly to drive short- and long-term planning, re-teaching and differentiation; accurately predicts level of student mastery in advance of exit tickets, student practice, weekly/biweekly assessments, unit assessments, etc.

Learning Through Observations and Experience. The Lawson Learning Cycle by Anton Lawson (1989, p. 5) is a method of teaching that consists of three phases:

- Exploration – Students learn through their own actions and reactions as they explore new materials and ideas. Exploration should raise questions, complexities, or contradictions
- Term introduction – Involves teaching the student a *new term* that relates to the questions that have been discovered while exploring. This may be accomplished by a

number of different means by the teacher, including using such methods as a lecture, textbook, video, or more modern mediums such as an iPad or blog

- Concept application **–** Involves the student taking the knowledge acquisition to the next level where the newfound knowledge is applied to new terms or different context

The genesis of the Lawson Learning Cycle was a visit by Professor Robert Karplus to the elementary classroom of his second-grade daughter. He left the visit thinking that the lesson was a conceptual disaster. He wanted to come up with a better way to teach science. Through further collaboration with Jean Piaget and J. Myron Atkin, Karplus refined his ideas on teaching science by focusing on students learning through their own observations and experiences. This approach was based on how he believed scientists go about inventing and using new concepts of nature.

The Lawson Learning Cycle is designed to improve both the declarative (knowing that) and procedural knowledge (knowing how). Questions should be raised, or problems posed, that require students to generate predictions based on prior beliefs (concepts and conceptual systems) and/or prior procedures. Predictions or procedures then lead to results that are ambiguous and/or contradicted, forcing students to argue and to reflect on the prior beliefs and/or procedures. Alternative beliefs and/or more effective procedures can now be suggested or be utilized to generate new predications and new data that allow either the change of old beliefs and/or the construction of new beliefs (concepts) (Lawson, 2001, p. 168).

There are three components of the Lawson Learning Cycle: descriptive, empirical-abductive and hypothetical-predictive. They are described in Table 8.

Table 8:
The Three Types of Learning Cycles

Type	Description
Descriptive	Requires patterns such as “seriation, classification, and conservation.” It answers the question of “what” but does not pursue the reason as to “why.”
Empirical-abductive	Intermediate and requires descriptive reasoning patterns, but generally involves some higher-order patterns. Students may discover a particular pattern and then attempt to find out why this pattern exists by developing and testing a casual hypothesis.
Hypothetical-predictive	Raises a question; the student generates a hypothesis, designs an experiment to test this hypothesis with predictions of outcomes. The results are evaluated and the hypothesis may be rejected or retained, and new “terms” may be discovered and the patterns found may be applied to other concepts.

Learning Through Engagement, Exploration, Explanation, Elaboration, and Evaluation. The Biological Science Curriculum Study (BSCS) 5E model can be traced back to instructional models developed by Johann Herbart and John Dewey. Work by Myron Atkin and Robert Karplus also served as a major pillar in the development of this model. Three of the five components of the 5E model are taken directly from the Lawson Learning Cycle based on their work. See Figure 4 (Bybee et al., 2006, p. 13) for an overview of the historical development of the model.

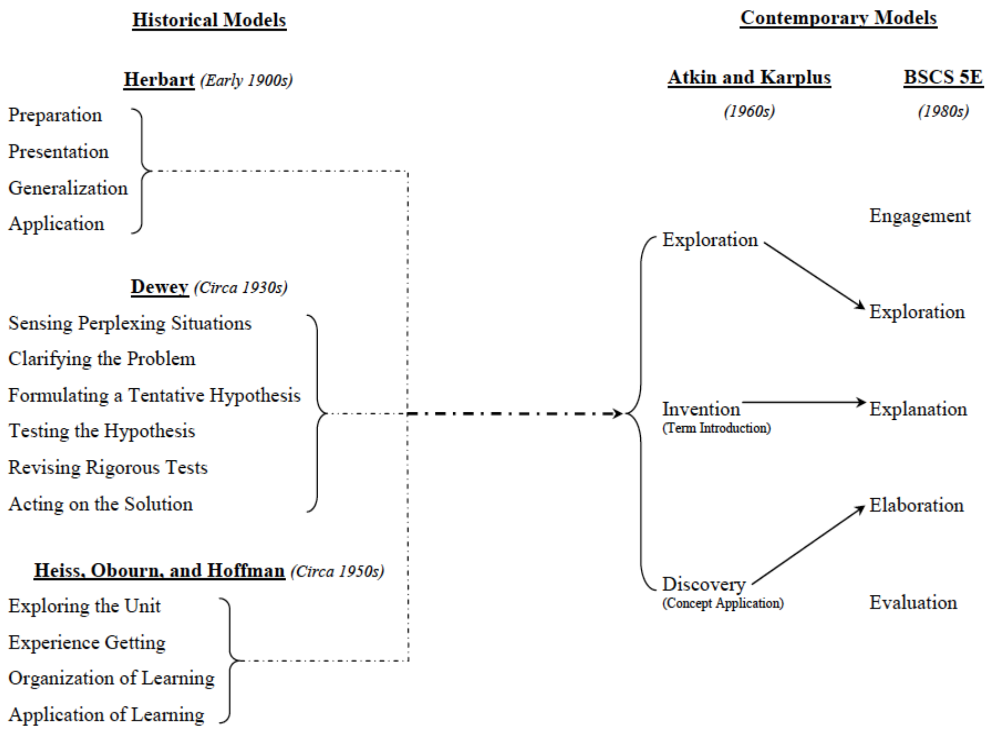

Figure 4: History of BSCS 5E Model

There are five phases associated with the BSCS 5E model. They are summarized in Table 9 (Bybee, 2009, p. 8)

Table 9:
Five Phases of BSCS 5E Model

Phase	Summary
Engagement	The teacher or a curriculum task accesses the learners' prior knowledge and helps them become engaged in a new concept through the use of short activities that promote curiosity and elicit prior knowledge. The activity should make connections between past and present learning experiences, expose prior conceptions, and organize students' thinking toward the learning outcomes of current activities.
Exploration	Exploration experiences provide students with a common base of activities within which current concepts (i.e., misconceptions), processes, and skills are identified and conceptual change is facilitated. Learners may complete lab activities that help them use prior knowledge to generate new ideas, explore questions, and possibilities, and design and conduct a preliminary investigation.
Explanation	The explanation phase focuses students' attention on a particular aspect of their engagement and exploration experiences, and provides opportunities to demonstrate their conceptual understanding, process skills or behaviors. This phase also provides opportunities for teachers to directly introduce a concept, process, or skill. Learners explain their understanding of the concept. An explanation from the teacher or the curriculum may guide them toward a deeper understanding, which is a critical part of this phase.
Elaboration	Teachers challenge and extend students' conceptual understanding and skills. Through new experiences, the students develop deeper and broader understanding, more information, and adequate skills. Students apply their understanding of the concept by conducting additional activities.
Evaluation	The evaluation phase encourages students to assess their understanding and abilities, and provides opportunities for teachers to evaluate student progress toward achieving the educational objectives.

This model has been used in a significant number of instructional programs, including state/school district science frameworks, university-level science courses, curriculum design, and teacher development, as well as in countless teacher lesson plans.

Learning Through the Design Process. The Understanding by Design (UbD) instructional model's purpose is to design curriculum, assessment, and instruction in such a way that "more students really understand what they are asked to learn" (Wiggins and McTighe, 2005). The teacher's ability to implement curriculum material in a way that fosters understanding is a pivotal aspect of the model's success. Wiggins and McTighe state that UbD is an attempt to better understand understanding especially for the purposes of assessment.

UbD identifies six facets of understanding: application, empathy, explanation, interpretation, perspective, and self-knowledge.

Questions that Understanding by Design proposes to answer are:

- What is the best way to design for both content mastery and understanding?
- How can understanding be accomplished if the textbooks used in the process dispense volumes of out-of-context knowledge?
- How realistic is teaching for understanding in a world of content standards and high-stakes tests?

At the core of answering these questions is the concept of "backwards design," whereby the teacher begins by identifying the end results that are desired and then "works backwards" to develop the instructional design that will achieve this outcome. To accomplish this, the teacher engages in a three-step process (Table 10).

Table 10:
The Three Stages of Backward Design

Stage	Explanation
Identify the desired results	What "enduring understanding" should the student obtain? This is the first stage of the process and requires teachers to develop a sense of "clarity about priorities." Standards that must adhere to the district, state, or national level are evaluated and there is a "review of curriculum expectations."
Determine the acceptable evidence	The teacher should consider what type of "evidence is needed to document and validate that the desired learning has been achieved"—not simply as content to be covered or as a series of learning activities. This requires the teacher to determine up front how they "will determine if students have attained the desired understandings."
Plan learning experiences and instruction	At this stage, the teacher should be asking: "What enabling knowledge (facts, concepts, principles) and skills (processes, procedures, strategies) will students need in order to perform effectively and achieve desired results? What activities will equip students with the needed knowledge and skills? What will need to be taught and coached, and how should it best be taught, in light of performance goals? What materials and resources are best suited to accomplish these goals?"

According to Wiggins & McTighe (2005, p. 4), UbD has nine principle goals:

1. Propose an approach to curriculum and instruction designed to engage students in inquiry, promote transfer of learning, provide a conceptual framework for helping students make sense of discrete facts and skills, and uncover big ideas of content
2. Examine an array of methods for appropriately assessing the degree of student understanding, knowledge, and skill
3. Consider the role that predictable student misunderstandings should play in the design of curricula, assessments, and instruction

4. Explore common curriculum, assessment and instruction practices that may interfere with the cultivation of student understanding and propose a *backward design* approach to planning that helps meet standards without sacrificing goals related to understanding
5. Present a theory of *six facets of understanding* and explore its theoretical and practical implications for curriculum, assessment, and teaching
6. Present a unit template to assist in the design of curricula and assessments that focuses on student understanding
7. Show how such individual units should be nested in a larger, more coherent framework of courses and programs also framed around big ideas, essential questions, and core-assessment tasks
8. Propose a set of design standards for achieving quality control in curriculum and assessment designs
9. Argue that designers need to work smarter, not harder, by sharing curriculum designs worldwide via a searchable Internet database

A Comparison of Teaching Cycle Models to the KFET. I will now compare the KFET to the three other "cyclical" theoretical bases for teaching: the Lawson Learning Cycle by Lawson; the BSCS 5E model by Bybee et al.; and the Understanding by Design model by Wiggins and McTighe.

I have previously indicated a number of ways that frameworks can be evaluated based on the work of Dewey (1998), Thorndike (1898), and Piaget & Inhelder (1997). I have decided to base this evaluation upon the work of Tyler (1949). His seminal work has served as the basis for a number of instructional frameworks related to this field. He identifies four fundamental questions that are critical to developing any particular framework. They are (p. 1):

1. What educational purposes should the school seek to attain?
2. What educational experiences can be provided that are likely to attain these purposes?
3. How can these educational experiences be effectively organized?
4. How can we determine whether these purposes are being attained?

This framework was to be the source of additional criteria as part of a revision that Tyler discussed. While the revision to his text was not completed in this article (Tyler, 1977), he indicated that the aspect of taking into account the active role of the learner and the role that non-school areas of the learner play in the student's learning process should both be additional considerations for his framework. I will base the evaluation of the different teaching cycles by discussing how each of the cycles is impacted by the fundamental questions posed by Tyler.

What educational purposes should the school seek to attain? Each theoretical framework establishes set goals, which, according to Tyler, should have a defined purpose. These educational objectives become the criteria by which materials are selected, content is outlined, instructional procedures are developed, and tests and examinations are prepared.

The purpose of the teaching cycle in the KFET framework is to serve as the bedrock of providing excellent teaching. All KIPP teachers are introduced to the teaching cycle of the KFET during their summer induction. They also are introduced to the big goals of KFET, which are to establish yearlong goals for student growth and achievement; make the big goals manageable; track and communicate progress; and connect the goals to student experiences and opportunities.

For the Lawson Learning Cycle, the goals are for students to develop a sense of "scientific literacy" through both content acquisition ("knowing that" - declarative knowledge) and process development ("knowing how" - procedural knowledge).

The goal of the BSCS 5E model is to enhance the science curriculum development process, as well as the enactment of curricular materials in science classrooms. This is accomplished through enhancing students' mastery of subject matter, assisting with the development of scientific reasoning, and cultivating students' interests and attitudes about science.

The UbD model's goal is for teachers to provide "good design" in learning experiences and to "be more thoughtful and specific about the purposes and what they imply." This is accomplished by "thinking through what those goals imply for the learner's activities and achievements" (p. 14).

What educational experiences can be provided that are likely to attain these purposes? With this inquiry, Tyler goes a step further by asking how instructional cycles enable teachers' goals to be attained. He asserted that learning takes place through experiences, thus requiring the planner to decide on the educational experiences that will be provided since it is through these experiences that the educational objectives will be attained. Students must have the opportunity to practice the kind of behavior implied in the objective and obtain satisfaction from carrying on these behaviors. The reactions desired in the experience span a wide range of possibility for the students involved. There are many experiences that can be used to obtain the same objective and the same learning experience will usually bring about several outcomes.

With the KFET teaching cycle, instructional goals are accomplished through the observable behaviors of lesson planning, rigor, lesson execution, ratio, pacing, and timing. The teacher is to perform such tasks as clearly identifying the criteria expected for the students' success; getting students to explain and defend their answers; providing each student with timely, structured feedback; creating external indicators; working within small groups to differentiate and ensure mastery; frequently engaging all students to think, speak, and write; planning for periods of active and passive engagement; and using a variety of methods to review and practice. For a more comprehensive description of what these competencies require, see Appendix A.

With the Lawson Learning Cycle, goals are accomplished by including the following elements in both what Lawson has described as declarative and formative knowledge: questions and problems should require students to generate predictions based on prior beliefs and/or procedures; these predictions should lead to results that are ambiguous and/or contradicted; alternative beliefs and/or more effective procedures can be suggested; and alternative beliefs and/or more effective procedures can be utilized to generate new predictions and new data that will allow either the change of old beliefs or the construct of new beliefs.

All of these concepts are incorporated in the exploration, term introduction, and concept application that are at the heart of the Lawson Teaching Cycle.

For the BSCS 5E framework, meeting the goals of educational experiences can be divided into five phases, each of which, according to Bybee, "has a specific function and contributes to the teacher's coherent instruction and the student's formulating a better understanding of scientific and technological knowledge, attitudes and skills" (p. 4). These phases are: engagement, exploration, explanation, elaboration, and evaluation. For a detailed explanation of each of these terms, refer back to Table 10.

In the UbD model, the goals are expected to be obtained by "… lessons, units, and courses being logically inferred from the results sought, not derived from the methods, books, and activities with which we are most comfortable. Curriculum should lay out the most effective ways of achieving specific results" (p. 14). This is obtained by following the three stages that are required to carry out the "backward design" process. They are: identify the desired results; determine acceptable evidence; and plan learning experiences and instruction. These steps have been defined in Table 11.

How can these educational experiences be effectively organized? Tyler (1949, pp. 84-86) suggests that learning experiences must be put together to form some kind of coherent program. This organization greatly influences the efficiency of instruction and the degree to which major educational changes are brought about in learners. The first criterion for this organization, continuity, involves the vertical reiteration of major curriculum elements; there should be a recurring and continuing opportunity for skills to be practiced and developed. The second criterion, sequence, emphasizes the importance of having each experience build upon the preceding one, but go more broadly and deeply into the matters involved. It does not emphasize duplication, but rather higher levels of treatment with each successive learning experience. Finally, the third criterion, integration, is the horizontal relationship of curriculum experiences. These experiences should increasingly help the student get a unified view and to unify behavior in relation to the elements dealt with.

With the KFET model, forming coherent programming is accomplished through the competency of the long-term goal setting and unit planning. To accomplish this, the model has borrowed extensively from the UbD plan. It requires the curriculum to exhibit backward plans from college-readiness, common core, and state standards to create assessments, goals, scopes and sequences, enduring understandings, essential questions, and unit plans.

The Lawson Learning Cycle is organized into three types: descriptive, empirical-abductive, and hypothetical-predictive. They are defined in Table 9 and represent points along a continuum. They also place differing demands on student initiative, knowledge, and reasoning skills. Lawson indicates that the difference among the three is the degree to which students either gather data in a descriptive fashion or initially set out to test alternative causal hypotheses.

The BSCS 5E organizational structure is based upon integrated instructional units. This phrase incorporates four critical principles that support effective learning environments as identified by the National Research Council's (1999, p. 79) report on *How People Learn: Brain, Mind, Experience, and School.* The four principles are: learner-centered environments; knowledge-centered environments; assessment to support learning; and community-centered environments.

According to this report:

> Integrated units interweave laboratory experiences with other types of science-learning activities, including lectures, reading, and discussion. Students are engaged in framing research questions, designing and executing experiments, gathering and analyzing data, and constructing arguments and conclusions as they carry out investigations. Diagnostic, formative assessments are embedded into the instructional sequences and can be used to gauge students' developing understanding and to promote their self-reflection on their thinking (p. 82).

For UbD, the organizational structure relies upon the backward design templates, which enable this framework to be more productive. The templates guide the teacher to the various elements of the effort while visually conveying the idea of backward design (p. 21). It serves as a practical cornerstone of UbD and is meant to reinforce the appropriate habits of mind needed to complete designs for student understanding.

How can we determine whether these purposes are being attained? Tyler suggested that the previous steps in curriculum development provide the plans for the day-by-day work of the school, but they do not complete the planning cycle. Evaluation is also an important operation in curriculum development (p. 104). These stages can be thought of as “intermediate” and require a more inclusive check as to whether these plans for learning experiences actually function to guide the teacher in producing the desired outcomes. This evaluation, then, becomes a process for finding out how far the learning experiences as developed and organized are actually producing the desired results. Additionally, the evaluation will involve identifying the strengths and weaknesses of the plans (p. 105). Evaluation tools may include observations, questionnaires, products made by students, and sampling.

For the KFET model, evaluation is accomplished through the competencies of assessment, analysis, and action. Assessments must be standards-aligned and can be both summative and formative. There must be diagnostics that determine what students know and do not know, and there must be some form of differentiation for students with special needs. These steps are accompanied with specific affirming and adjusting feedback about both academics and character to students. The data must be used to correct misconceptions and accurately predict student mastery through exit tickets, student practice, weekly/biweekly assessments, unit assignments, etc. Finally, timely and structured academic feedback must be provided. The success of this process in KIPP is determined by the coach, and the KFET rubric is used to document the success. The KFET identifies specific documents such as lesson plans, exams, and observations that the coach uses to determine the quality and effectiveness of student evaluation.

The Lawson Learning Cycle and the BSCS 5E have undergone extensive research studies to determine their effectiveness. Lawson cites a comprehensive review of the Lawson Learning Cycle that shows that it has been very effective at teaching science concepts and improving generalizable reasoning skills in students (p. 168). Studies from the comprehensive review have concluded: all three phases are necessary for optimum concept learning; students prefer learning cycles with all three phases; students dislike learning cycles with long and/or complex application phases; the combination of exploration and term-induction phases is more effective than term induction alone; and the application phase may substitute for term introduction if the application includes the use of the term(s) used to refer to the concept(s) (p. 169).

From a practical aspect, the Lawson Learning Cycle evaluation process involves ensuring that some form of conceptual change has occurred. This is accomplished through a three-step process: data is inconsistent with a prior concept; the availability of alternative conceptions/hypotheses/theories; and sufficient time, motivation, and reasoning skill to compare the alternatives and their predicted consequences with the evidence (p. 167).

With the BSCS 5E model, the practical approach is the evaluation phase that allows students to understand their abilities and teachers to evaluate student progress. Extensive research on the effectiveness and the incorporation of the BSCS 5E model has been completed. Bybee et al. (2006) list a plethora of studies that have incorporated the model. They state that "the BSCS 5E Instructional Model is grounded in sound educational theory, has a growing base of research to support its effectiveness, and has had a significant impact on science education" (p. 12).

The UbD model makes a point of distinguishing between assessment and evaluation. Assessment is more learning-focused and is used to determine the extent to which the desired results are being achieved or have been achieved. It is the umbrella term for the deliberate use of many methods of gathering evidence for meeting desired results, whether those results are state-content standards or local-curricular objectives. Assessment may include observations and dialogues, traditional quizzes and tests, and performance tasks and projects, as well as students' self-assessments gathered over time (p. 6).

On the other hand, evaluation, according to UbD, is more summative and credential-related, and does not require the assignment of a grade when giving feedback.

The ultimate question here is how does the KFET teaching cycle stack up to the more established "cyclical" instructional strategies such as the Lawson Learning Cycle, the BSCS 5E model and UbD. The most obvious comparison is the research that supports each strategy. The pedigree of the Lawson Learning Cycle has a lineage dating back to the Science Curriculum Improvement Study (SCIS). Both of these efforts are incorporated into components of the BSCS 5E model. Both also have been extensively studied for their impact on science education. Lawson (1995) has completed an extensive review of studies that have used the Lawson Learning Cycle. Bybee (2009, p. 29) lists recent work that has focused on the BSCS 5E model.

The KFET model is the new kid on the block and has anecdotal research that supports its effectiveness. To date, there has been no peer-reviewed research related to the KFET teaching cycle. While there has been an effort to examine the KIPP experience (Tuttle et al., 2015), the KFET was not a major component of the work.

The KFET is comparable to all of the cyclical strategies in that the teacher is the focus of implementation and the student, as expected, is the beneficiary of the effort. Each strategy incorporates the same expectation of assessment, inquiry, and improving student outcomes in learning science. While I think each of the cycles has aspects that can be used in a broader concept than teaching science, only the KFET and the UbD models are actually written for a broader audience.

The KFET model adheres to Tyler's suggestion that the frameworks extend themselves by "taking into account the active role of the learner and the role that non-school areas of the learner play in the student's learning process." The UbD design also incorporates this expectation; however, with its mission to serve underserved children, KIPP makes a significant effort to look at students' non-school areas through home visits, sharing the teacher's phone number with students and parents, extended days, and following the student from kindergarten through college.

The Lawson Learning Cycle and the BSCS 5E models also have been looked at in terms of fidelity. Data has shown that, if followed as described, there is a high rate of student success for learning science subject matter. No such data exists for the KFET learning cycle. Lack of data, however, does not preclude the fact that KIPP students consistently outperform students of a similar socioeconomic status, as well as compete effectively with students who are beyond the socioeconomic status of the typical KIPP student.

If we ask of each instructional model the four fundamental questions that are proposed by Tyler to determine if they may serve as legitimate instructional strategies, an argument may be made that on some level they all are. They differ in terms of the amount of research that is used to support their claims. They differ in the process that is used to carry them out. And they differ in terms of how they are organized. I will conclude the teaching cycle review with what Bybee, et al. (2006, p. 1) ask of all frameworks:

> The sustained use of an effective, research-based instructional model can help students learn fundamental concepts in science and other domains. If we accept that premise, then

an instructional model must be effective, supported with relevant research, and it must be implemented consistently and widely to have the desired effect on teaching and learning.

Induction Programs

I will now discuss the importance of induction programs in the development of a science teacher's PCK. This will begin with a brief description of my experience with induction programs and then move to describing other induction programs from the literature.

In 2004, I made the decision to leave a lucrative and satisfying career in the pharmaceutical industry to teach high school chemistry. This was not as difficult a decision as it may seem because I had served as an adjunct faculty member throughout my career. The stars aligned in such a way that, financially, it did not change my family's lifestyle and, personally, it allowed me to join my family in a new city. I had the option of staying in research, joining a college staff, or teaching chemistry in an urban high school. I chose the latter because of my belief that one cannot just *say* there ought to be a difference when one can actually *make* a difference. That summer, I spent a month gaining an understanding of teacher pedagogy and two weeks working alongside a physical science teacher. The last week, the teacher allowed me to take control of class instruction. In the seventh week, I got my own class.

The induction process continued with me attempting to get certified by taking courses on the psychology of learning, principles of science instruction, introduction to secondary teaching, and theory/pedagogy of science instruction. The greatest benefit for me, however, was Mrs. Jackson – my mentor. She was a retired chemistry teacher who also had been the department chair. In transitioning from a world where I was the boss—and was pandered to because of it—to a world where homework completion was a negotiation, I quickly recognized that I needed help. Mrs. Jackson met with me twice a month to provide a sounding board, give unconditional support, and help me place things into perspective. She was the main reason for me surviving my first year.

Fast forward two years when, at the insistence of my sixth-grade daughter, I accepted the position of eighth-grade science teacher at KIPP. I was given the responsibility to initiate the science curriculum for the first eighth-grade class at the charter school. The induction process consisted of being given a text book for the class, being shown where the classroom was located, and attending the annual KIPP Summit—a week of seminars on best practices and an opportunity to bond with others going through the same process.

There was quite the dichotomy in the two induction programs. The initial KIPP induction program had a lot to be desired due to the newness of the school and the “just get it done” approach. Due to the significant maturity of the Atlanta system, since then, there has been a significant change in how KIPP currently indoctrinates teachers.

A comparison of the KIPP teacher induction to other induction programs. I am first going to look at the process of teacher induction and examine how the current KIPP induction program matches up to other established programs. Induction programs have long been touted as a necessary requirement for new teachers. The National Science Teachers Association (2007) has recommended that schools and teacher-preparation programs provide new science teachers with comprehensive induction programs. Luft & Roehrig (2007) suggested that teachers in science-specific induction programs strengthened their beliefs about such issues as how a teacher maximizes student learning; how a teacher describes their roles as teachers; how a teacher knows when students understand; how they decide what to teach and what not to teach; how they decide when to move on to a new topic; how students learn science in their classrooms; and how a teacher knows when learning is occurring in the classroom.

There are consequences for the lack of a robust induction program. Breaux and Wong (2003) made the case for having an induction program in place by indicating the cost associated with the loss and replacement of teachers. They used unpublished data to suggest that it costs upwards of $50,000 of taxpayers' money to replace a teacher who leaves within the first three years. They referenced data indicating that it will cost $1,000,000 per district to deal with teacher recruitment and replacement. Cities like Chicago ($6,000,000) and New York ($8,000,000) have spent considerable amounts on recruitment.

A pilot study by the National Commission on Teaching and America's Future (2007) looked at the actual cost of teacher turnover in five school districts. They ranged from urban to rural, and large to small. Three of their findings indicate (p. 5) that the costs of teacher turnover are substantial. In a very large district like Chicago, the average cost was $17,872 per leaver. The total cost of turnover in the Chicago Public Schools is estimated to be more than $86 million per year. Moreover, teacher turnover undermines at-risk schools. Low school performance and high poverty were correlated with high teacher turnover in the Chicago, as well as in Milwaukee Public Schools. At-risk schools could recoup funds by investing in teacher retention. By implementing an effective retention strategy, such as a high-quality induction program at a cost of $6,000 per teacher, Chicago could reduce teacher turnover and save millions of dollars.

Other National Commission findings were related to using limited resources on teacher turnover, identifying the costs associated with turnover, and improving district data systems to control the costs of turnovers.

The Research Alliance for New York City Schools (2012) conducted a study examining factors related to teacher attrition. It surveyed more than 4,000 full-time middle school teachers working in 125 of the nearly 200 middle schools in New York City serving children in grades six through eight in the 2009-10 school year. One of the factors examined the quality of the induction program for new teachers and the probability of their leaving.

Only 28 percent of teachers in schools with the highest rated induction programs considered leaving, versus 54 percent of teachers at schools with programs ranked in the lowest quartile. After accounting for teachers' individual characteristics and school demographics, 32 percent of teachers in top-quartile schools considered leaving, compared to 47 percent of teachers with the weakest programs. The association between the quality of induction programs and thoughts of leaving thus is robust and sizeable (p. 40). Smith & Ingersoll (2004) determined that beginning teachers who participated in collective induction activities such as planning and collaboration with other teachers were less likely to move to other schools and less likely to leave the teaching occupation after their first year of teaching.

The basic components of an induction program have taken many forms, with each involving some aspect of support, guidance, and orientation. The NSTA (2007) has identified seven key elements that, if implemented in an induction program, have been shown to increase teacher effectiveness. Those elements are an articulated vision; an organized and ongoing training program; use of appropriate materials and strategies; an inclusion of planned and intentional sets of learning activities for mentees; a culture of collaboration; timely and effective communication; and an ongoing collection of data.

Some states are much better at implementing induction plans than others. The National Council on Teacher Quality ranks states on the effectiveness of induction programs. The Council (National Council on Teacher Quality, 2011, *p. 105)* has established three goals that states should consider in the implementation of induction programs:

- The state should ensure that new teachers receive mentoring of sufficient frequency and duration, especially in the first critical weeks of school
- Mentors should be carefully selected based on evidence of their own classroom effectiveness and subject-matter expertise. Mentors should be trained, and their performance as mentors should be evaluated
- Induction programs should include only strategies that can be successfully implemented, even in a poorly managed school. Such strategies include intensive mentoring, seminars appropriate to grade level or subject area, a reduced teaching load, and frequent release time to observe effective teachers

Based on these criteria, the state of South Carolina was a "best practice state" and the Georgia was one of nine states classified as "does not meet the goal." The reason for this was that "Georgia did not require a mentoring program or any other induction support for its new teachers. The state has a Teacher Induction Task Force to identify a state model for induction and create induction standards (p. 106)." In response, Georgia has created a Teacher Support Specialist Endorsement where experienced teachers will serve as role models and mentors for pre-service, beginning, and in-service teachers.

Moir (2003) looked at a number of factors that impact the success or failure of mentoring programs. Such issues as defining the role of the mentor, the selection process, mentor training, assessment and accountability, and the system's commitment to the program are all critical to the program's success. Breaux and Wong (2003) suggest that most successful induction programs go beyond mentoring. They are structured, sustained, intensive professional development programs that allow new teachers to observe others, to be observed by others, and to be part of networks of study groups where all teachers share with each other and learn to respect each other's work.

Research about teacher induction. I will now discuss efforts that looked into the effectiveness of induction programs. In a randomized study, the U.S. Department of Education looked at whether by augmenting the set of services districts usually provided to support beginning teachers with a more comprehensive induction program improves teacher retention rates and other positive teacher and student outcomes. The report divided induction programs into informal or low-intensity programs versus comprehensive programs.

The informal or low-intensity induction program may include pairing each new teacher with another full-time teacher without providing training, supplemental materials, or release time for the induction to occur.

The comprehensive induction is intensive, structured, and sequentially delivered. It is often delivered through experienced, trained, full-time mentors and may also include a combination of school and district orientation sessions, special in-service training (professional development), classroom observations, and constructive feedback through formative assessment.

After four years of research, the key findings were somewhat surprising (Glazerman, Isenberg, Dolfin, Bleeker, Johnson, Grider, & Jacobus, 2010, p. XXV). During the comprehensive induction program, treatment teachers received more support than control teachers. The extra induction support for treatment teachers did not translate into impacts on classroom practices in the first year. For teachers who received one year of comprehensive induction, there was no impact on student achievement. For teachers who received two years of comprehensive induction, there was no impact on student achievement; however, in the third year, there was a positive and statistically significant impact on student achievement. Neither exposure to one year nor exposure to two years of comprehensive induction had a positive impact on retention or other teacher workforce outcomes.

In a review of 15 empirical studies, Ingersoll and Strong (2011) pointed out that the outcomes obtained may not “hold true in other types of districts” due to limits of generalization for the Glazerman study. In other studies examined, they concluded that, while the studies had certain limitations and weaknesses, they provided empirical support for the claim that induction for beginning teachers and teacher mentoring programs in particular have a positive impact. Teachers who participated in induction programs had higher satisfaction, commitment, or retention. Their classroom practices were better and student achievement was higher (p. 225).

Types of induction programs. Teacher induction programs take many forms. There is the general form similar to the expectations in Hawaii. There are off-the-shelf programs such as the New Teacher Center’s Induction Program and the Educational Testing Systems (2013) Pathwise Framework Induction Program. There also are content-specific induction programs, including for science. Here, I change from the general induction programs meant for all content teachers to focus specifically on induction programs for science teachers and then discuss how the KIPP induction model has transformed in recent years.

Luft, Roehrig, & Patterson (2003) examined three different types of induction programs on secondary science teachers: one group participated in a science-focused support program, another participated in a general support program, and a third had no formal support. The results indicated that teachers who participated in induction programs “used practices that were congruent with standards-based lessons and received assistance that was invaluable throughout the year. This was not the case for their peers in the no induction program group” (p. 93). More importantly, however, were the results for the “science-specific” group. While there was an acknowledgment of the impact of university and district personnel, the science-specific group demonstrated teaching beliefs that were more transitional, conceptual, and constructivist. They also enacted more laboratories and standards-based lessons, and they did not indicate constraints to their instruction as their peers (p. 93). Luft suggested two factors that should be addressed (p. 94): it is essential that induction programs be configured to meet the unique needs of beginning science teachers; faculty and staff from universities or colleges and school districts should collaborate in designing and implementing induction programs.

Luft (2009) extended her look at science-specific induction programs by also examining the impact of physical proximity of “informal mentors” to the new teachers. They “provided materials (e.g., presentations and worksheets) to the teachers, planned lessons with the new teachers, and took time to talk with them. … The new teachers valued the mentors who interacted with them in ways that allowed them to develop as professionals and provided or pointed out resources that were useful for their instruction” (p. 2375). Ultimately, science-specific induction programs can “strengthen the beliefs and practices of beginning science teachers, and that such programs need to be developed in a manner that supports the learning of the new teacher” (p. 2380).

There is additional data (Roehrig and Luft, 2006) to suggest that beginning secondary science teachers should have access to teacher educators in their science area. Roehrig and Luft looked at beginning science teachers from four different certification programs: traditional secondary certification; traditional elementary certification; M.Ed./certification (science emphasis); and general, alternative certification program. Their results indicate “that an induction program designed to meet the specific needs of secondary science teachers can provide support to a variety of different teachers” (p. 979). In addition, “beliefs that may have been developed based on the type of certification program of a beginning teacher dictated the impact of a science-specific induction program” (p. 980).

Saka, Southerland, Kittleson, & Hutner (2013) looked at science teacher induction as a function of identity. They examined how a beginning science teacher's identity interacted with the teaching context. Their work demonstrates that school environment and induction support play a critical role in helping new teachers realize the importance of the school culture.

Bang (2013) looked at beginning elementary science teachers (K-8) whose mentors used technology to provide content-focused mentoring. The results described how new teachers become members of the community and how the use of technology enabled them to grow in their pedagogical content knowledge. It also provided mechanisms that enabled them to change practices and identities. Mentees were expected to develop knowledge about inquiry teaching, learning, and practices, and were identified as inquiry-based science teachers (p.12).

I have presented data that clearly demonstrates the heavy financial cost of teacher turnover. I also have discussed various induction programs that have played a role in increasing teacher job satisfaction and reducing teacher turnover. There is no one-size-fits-all induction program. This is especially true for school districts that must meet the needs of a diverse group of teachers. I have presented evidence of the benefit of induction programs that provide new science teachers access to science-focused support program, mentees in their science area, and use of technology. These efforts also play a major role in teacher retention and equip teachers to better serve their students.

CHAPTER 3

METHODOLOGY

Research Method and Research Methodology

The difficulty in evaluating PCK lies in what Loughran, Mulhall, & Berry (2004, pp. 372-373) described as:

> A teacher's PCK may not be evident to a researcher within the confines of one lesson or teaching experience; an extended period of time (e.g., a unit of work) may be needed for it to unfold. …Observations can provide only limited insight into a teacher's PCK, because it is partly an internal construct. ….Science teachers do not use a language that includes (nor necessarily resembles) the construct of PCK, and much of their knowledge of practice is tacit. …..For science teachers, there is little opportunity, time, expectation, or obvious reason to engage in discussions helping them to develop tacit knowledge of their professional experience into explicit, articulable forms to share across the profession. ….There is a lack of a common vocabulary among teachers about teaching and learning.

Loughran (et al., 2004) developed a method that looked at individual teachers and at teachers from a collective perspective. According to their study, "PCK resides in the body of science teachers as a whole while still carrying important individual diversity and idiosyncratic specialized teaching and learning practices." Other researchers have looked at evaluating PCK in the classroom.

Teacher's professional knowledge is difficult to define and categorize, and therefore exceptionally difficult to articulate and document. Yet, it is increasingly important to do so (Berry, Loughran, & van Driel, 2008). Measuring the fidelity of a teacher to the teaching cycle of KFET is captured through the Teacher Pathways Rubric 2015-2016 (Appendix A). I have previously discussed efforts by Kind (2009); Sperandeo-Mineo et al. (2006); Park & Oliver (2008); Park, et al. (2011); and Lee et al. (2007) to measure PCK. I have used a combination of their strategies to explore the impact of the teaching cycle of the KFET on new KIPP science teachers' PCK. I will describe my approach to accomplish this task.

Who are the participants? To date, there has been no research effort to determine the impact of the teaching cycle element of KFET on the PCK of science teachers new to the KIPP network. In order to conduct the study, I sought approval from the KIPP Foundation (which serves as the national clearinghouse for any research effort related to KIPP) and the KIPP Metro Atlanta Collaborative (KIPP MAC, the local network of KIPP schools) to carry out the research (C. Galindo, personal communication, January 6, 2014). KIPP MAC is comprised of one high school, four middle schools, and three elementary schools. Every day, more than 2,500 students attend KIPP MAC classes. There is a 93% college acceptance rate, 98% identify as African-American, and 90% qualify for free and reduced priced meals ("To and Through KIPP Metro Atlanta Schools 2015 Annual Report").

Since teachers who have been in the KIPP network for more than a year have had exposure to the KFET, they were excluded from the study. Purposeful sampling (Patton, 2002) was used to identify the participants. The following criteria were used for participant selection in the study in order to prevent a self-selection bias: only science teachers new to the KIPP network; only teachers who have the sole responsibility for the class; and only teachers who have not had to previously implement components of KFET in any capacity.

There are two routes to becoming a KIPP teacher. The traditional route is for interested applicants to apply and go through the selection process and, if selected, begin the induction program. As a result of the *Race to the Top* funding from the Obama administration, KIPP implemented a second process through a Fellows Program (Hampton, L., 2011) during the time of this study. Participants who are completing a degree from a local college are paired with a mentor teacher and spend a year working with that mentor and a school leader to learn about the teaching profession. After a year, they are given their own classroom. These individuals are then considered first-year teachers.

Individuals who have completed the Fellows Program were excluded from the study due to their exposure to the KFET. Teachers who were transferring from another KIPP school were also excluded from the study because they also had exposure to the KFET.

The number of teachers selected for the study was dependent on the number of new science teachers hired by KIPP MAC for that year. For this term, only three new science teachers who fit my criteria were offered contracts. The school director and the participants were first approached by the current Chief Academic Officer. One declined to be a part of the study. Two committed to participate in the study. These individuals are identified as Helen and Grace (pseudonyms).

Helen has a bachelor's degree in science and has been teaching science-related classes for the past six years. She was a Teach for America participant and obtained her teaching certificate through an alternative certification program. She has taught courses in anatomy, biology, forensics, environmental science, and healthy life/sexual education.

Grace has a bachelor's degree in engineering and a master's degree in education, and has been teaching science classes for the past three years. She also is a member of the Teach for America program and obtained her teaching certificate through alternative certification. She has taught courses in physical science, biology, chemistry, and physics.

After completion of the first semester at KIPP, Grace accepted a position in another school district. She completed an entire years' worth of content material in the semester that she was involved in the study. Prior to leaving KIPP, she provided me with her self-evaluation for the teaching cycle element of KFET, as well as completed her exit interview related to the study. She was replaced with a long-term substitute. The substitute did not meet the criteria that were established to be a part of the study. I informed my committee of Grace's departure and I increased the number of observations for Helen in the final semester of the study.

What about them will be studied? Due to the broad nature of the KIPP Framework for Excellent Teaching, my research will focus on the changes related solely to the teaching cycle element. The teaching cycle is defined as follows in the KFET:

> The Teaching Cycle: Excellent teaching means planning and executing rigorous, engaging lessons that fit into a logical scope and sequence, as well as using student data to assess mastery of objectives and movement toward big goals for student achievement and growth. (Appendix A: KFET Rubric 3.0, 2015-2016, p. 29).

My research focused on the impact of the teaching cycle element of the KIPP Framework for Excellent Teaching—a tool used to indoctrinate new teachers into the KIPP system—on a science teacher's PCK development. More specifically, my research questions begin with asking: How does implementing the teaching cycle element of the KFET impact the development of the components of new KIPP science teachers' PCK?

As stated previously, there have been a number of efforts to define PCK; however, I used the five components of PCK identified by Park & Oliver (2008) as depicted in Figure 5 and described previously:

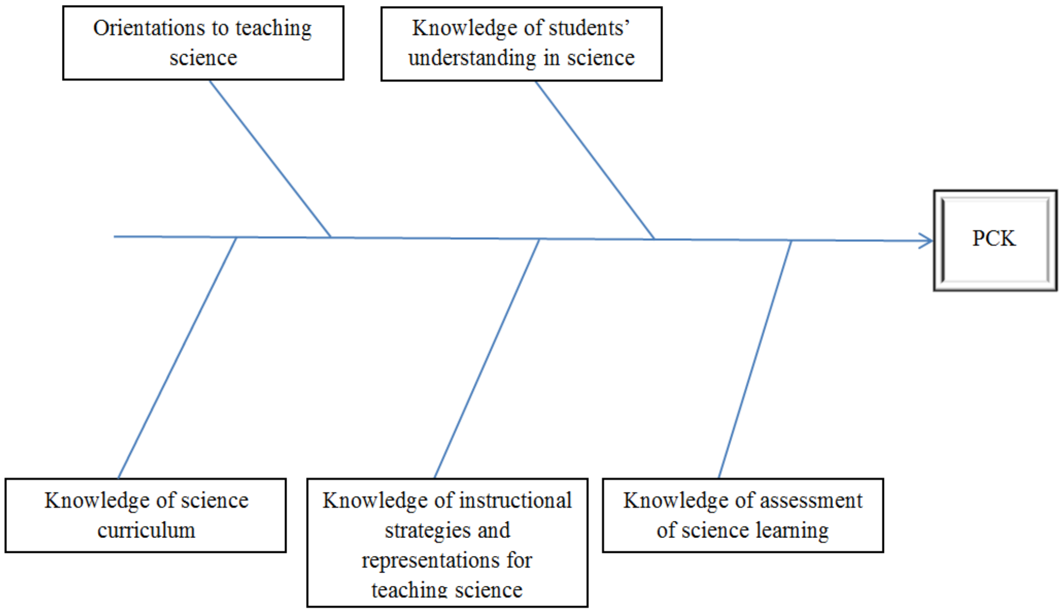

Figure 5. Components of PCK

These components help us to better understand teachers as professionals. The idea is that "teachers do not simply receive knowledge that others create to teach, but produce knowledge for teaching through their own experiences. Although teachers' knowledge can be influenced and improved by receptive learning, the most powerful changes result from experiences in practice - teachers are knowledge producers, not knowledge receivers" (Park & Oliver, 2008, p. 17).

The teaching cycle of the KFET plays a major role in how teachers "produce" this knowledge. Thus, a second research question of this study is: How does a teacher's "experience in practice" in a KIPP environment impact the development of their PCK? This is a separate concept from the first in that the teaching cycle element of the KFET is simply a document that defines what excellent teaching looks like from a KIPP perspective. It identities what observable behaviors to look for in a KIPP classroom, but does not explain how these tenets are implemented through both the induction process and professional recognition and development. Examining the “experience in practice” helped me to understand what actions the participant took to develop their PCK and then relate this to the teaching cycle element of KFET.

Additionally, Park and Oliver (2008) suggested that “the enactment of PCK within a given lesson requires a teacher to integrate different components of PCK and since each teacher develops those components as a result of different experiences and knowledge, teachers’ PCK is idiosyncratic to some degree” (p. 17). Therefore, my third research question: What role does the KFET teaching cycle have on this “idiosyncratic” aspect of a new science teacher’s PCK? This question will be answered by demonstrating the interpretive validity of the study.

How was data collected? This was a qualitative, multiple-case study involving teachers who were new to the KIPP KFET system. As previously indicated by Kind (2009), the success of determining the full range or quality of PCK is determined by the nature of the probe. For this study, there are a number of probes that were used in data collection. They are defined below:

1. Field notes taken by me while observing the classrooms
2. I was provided with copies of the participants’ classroom observations, both formal and spot observations, completed by the science department chair
3. I collected classroom artifacts ranging from photos, classroom notes, room decorations, exit tickets and do-it-now’s (Appendix B)
4. Lesson plans were provided by both participants
5. Teaching Cycle of the KFET rubric was completed by the participants, science department chair and myself related to the participants’ implementation of the teaching cycle of the KFET

6. I used a Classroom Observation Tool to tabulate the instances and types of PCK exhibited by the participants (Appendix C)
7. I completed informal, after-class interviews related to classroom observations
8. Pre-study and post-study formal interviews were completed (Appendix D)
9. Memos/email correspondence between the participants and myself where I asked for clarification or more detailed/critical response related to the course observations or questions (Appendix D)

The probes shown and defined above enabled me to evaluate the components of PCK that were being demonstrated by the teacher. Examples of each probe's contribution to the study are briefly outlined in Figure 6.

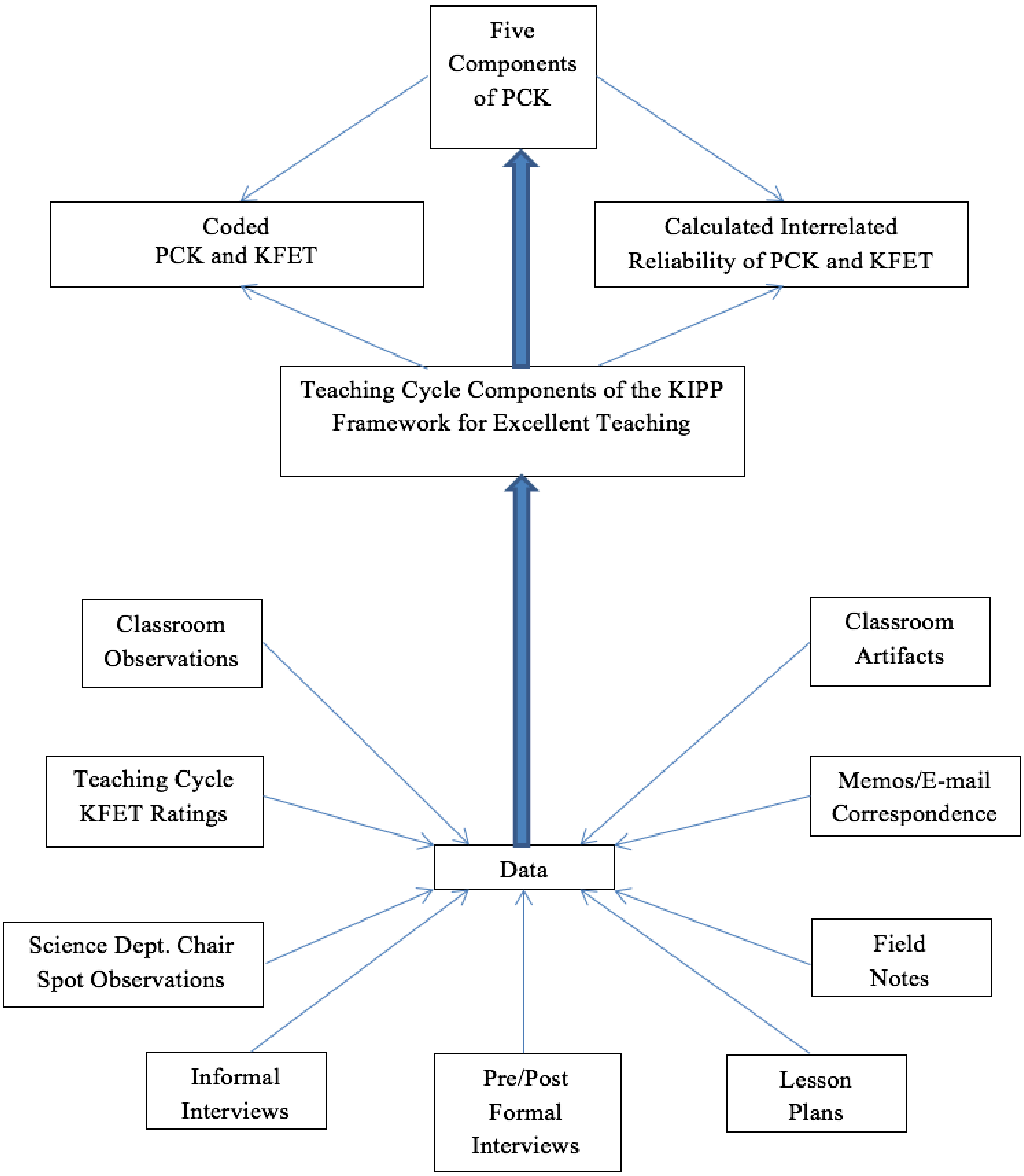

Figure 6: Probes Used in Collecting Data and Role in Evaluating PCK

The Relationship Between PCK Components and the KFET Elements

Efforts by Park and Chen (2012) and Abell (2008) suggested that research should look at the interaction of PCK components in addition to examining the individual components. Park and Oliver (2008) and Magnusson et al. (1999) described how the five components are related to each other.

In this study, I looked at the individual components of PCK and then discussed how the teaching cycle of the KFET impacts each. To develop questions for the interview, I first went through each of the observable behaviors for each element of the teaching cycle of the KFET and formulated questions that would capture data expected of the behavior. I then compared each question to the descriptions associated with each of the five components of PCK to determine where each behavior of the teaching cycle of the KFET fit with a particular component of PCK. The questions were then reviewed with my advisor and committee for refinement and expansion. A standardized, open-ended interview protocol (Patton, 2002) was then developed and utilized in the interview process. This process enabled me to relate any changes in PCK to a behavior of the teaching cycle of the KFET. A major part of this study is relating the five components of PCK to the elements of the teaching cycle of the KFET. More substantive descriptions of the specific ways that these two concepts relate are as follows.

PCK component: Orientation to teaching science. The KFET 3.0 Teacher PATHWAYS Rubric: An example of how this tool examines a teacher's orientation to teaching science is how the teaching cycle of the KFET evaluates rigor. Is the daily objective rigorous? Does the teacher challenge the students to explain and defend their answers if they are correct? Does the teacher accept partial answers or insists on sufficient detail both orally and in writing? Does the teacher unpack and repack incorrect answers for mastery and have students do the same? Another use of the rubric relating to the orientation of teaching science is evaluating the teacher's approach to how students learn science, and how to teach it in ways that make science attractive and comprehensible. Does the teacher incorporate different learning styles in the lesson plans? Are there appropriate pauses in the class to check for understanding? And are lessons teacher-centered or does the teacher hand over the class to students?

PCK component: Knowledge of students' understanding of science. The KFET 3.0 Teacher PATHWAYS Rubric: Solicits such information from the development of lessons that sets the bar for what mastery and excellence look like and that they are differentiated for all student groups. It evaluates if the lesson execution delivers content in a well-organized, clear, accessible manner, highlighting key points. It proactively addresses students' misconceptions. It also allows the evaluator to determine if the teacher connects current lesson material to past and future material, as well as material from other content area, and whether the teacher notices confusion and does something about it.

PCK component: Knowledge of science curriculum. The KFET3.0 Teacher PATHWAYS Rubric: Evaluates if the teacher has established clear criteria for success and a defined way to daily assess students' ability. Has the teacher matched materials/explanatory devices to her objective or developed compelling hooks throughout the lesson that are aligned to the objective, and written an aligned, interactive agenda? Has the teacher included an introduction to new material, guided and independent practice? Has the teacher built in dual purposes when possible; for example, character-academics?

PCK component: Knowledge of instructional strategies and representations for teaching science. The KFET 3.0 Teacher PATHWAYS Rubric: Attempts to determine if the teacher posts and communicates clear objectives, criteria for success and an engaging agenda for the lesson so students know what is to be learned, why it is to be learned, and how it is to be learned. Is the content delivered in a well-organized, clear, accessible manner, highlighting key points? Does the teacher proactively address students' misconceptions? Does the teacher connect current lesson material to past and future material, as well as material from other content areas? Does the teacher plan for periods of active and passive engagement?

PCK component: Knowledge of assessment of science learning. The KFET 3.0 Teacher PATHWAYS Rubric: Does the teacher assess all students against each lesson's learning objectives to inform teaching daily; plan unit assessments and weekly/bi-weekly assessments that are appropriately spiraled, scaffolded and differentiated; adapts, accommodates, and modifies assessments for students with special needs?

The Teaching Cycle of KFET. Collection of data related to the teaching cycle of KFET was obtained by use of the rubric associated with the KFET (Appendix A). The rubric was completed by the participants, the science department chair and me. It also stipulates what method of collection should be used to complete the evaluation.

Data Analysis. For an analysis of the data, the constant comparative method, the enumerative analysis approach (LeCompte and Preissle 1993), and tools such as ATLAS.ti were used. The interrelated reliability analysis was calculated between the science department chair and me related to the components of PCK and the 13 observable behaviors of the teaching cycle of KFET. In addition, one of the distinguishing factors associated with KFET is an evaluative rubric (Appendix A) that will be referenced to as the teaching cycle KFET ratings. This same evaluation rubric was used by the participant, the science department chair and me to determine the fidelity of the participants to the expectations of the teaching cycle. It should be noted that this rubric evaluates the participants on all five elements of the KFET. Since we have narrowed this study to the teaching cycle element, I will have access to only this part of the rubric from the participants, as well as the science department chair. I also will rate the participants only on the teaching cycle element of the KFET.

Another critical aspect of the study is how the 13 observable behaviors of the teaching cycle of the KFET correlate to the components of PCK. At the initiation of the study, my advisor and I coded the observable behaviors of the teaching cycle with the components of PCK. We reached a consensus on which observable behaviors of the teaching cycle of KFET best matched with the five components of PCK. The science department chair and I used the coding analysis toolkit (http://cat.ucsur.pitt.edu/) to complete a coding reliability analysis that enabled us to gain an understanding of each other's perspective of the components of PCK and the teaching cycle of KFET. Figure 7 depicts a summary of the consensus between my advisor, the science department chair, and myself on how the components of PCK and the observable behaviors of the teaching cycle of the KFET can best be correlated.

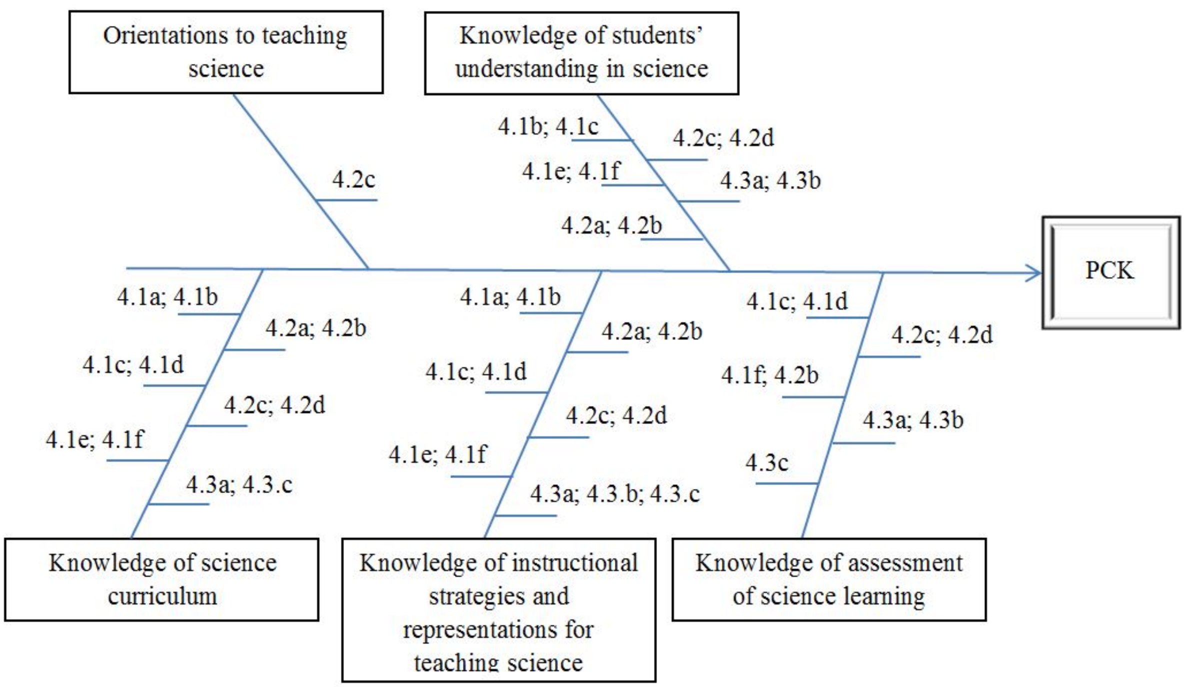

Figure 7: Diagram of the Interaction of the Components of PCK with the Observable Behaviors of the Teaching Cycle of KFET

I completed a total of 30 observations of 90-minute classes. The entire content for each course was taught in one semester. The study spanned across three semesters. This is equivalent to three years' worth of regular classroom time. Field notes and audio transcripts were obtained for each observation. The science department chair provided 18 items that included observations (12) and copies of lesson plans (6). A copy of the KFET evaluation rubric associated with teaching cycle element of the KFET was provided by both the participants and the science department chair. A total of 177 artifacts and photos were obtained. There are 38 memos that pertain to the study. A total of six interviews were conducted, including the initial and final formal interviews with the participants, as well as two formal interviews with the science department chair. Appendix B provides an itemized list of all documents associated with the study. During each observation, I used an observational tool that I developed to determine if an aspect of the five components of PCK was being demonstrated (Appendix C).

How long did this study continue? Participants were contacted prior to the beginning of their first semester. The study began in August 2015 and the participants were monitored until the end of April 2016. In January 2016, one participant accepted a position in another school district, so from that point on was no longer observed. Table 11 outlines the timeline for the study.

Table 11:
Data Collection Timeline for the School Year 2015-2016

June/July	August	September-April	May	June
Participant recruitment	Pre-study teacher interviews around their concepts of PCK	Ongoing participant evaluation, including classroom observations, informal discussions and artifact collection	Participant evaluation using KIPP KFET	Post-study interview on PCK

What was the classroom environment? Each participant's classroom was structured in a similar manner. The front board for each class indicated the "do-it-now," aim of the lesson, the agenda, and the homework assignment. Participants met students at the door, where there were bins for students to submit the previous night's homework assignment and to pick up that day's class notes. The school ran on a 90-minute class block schedule. Class began with a five- to 10-minute do-it-now, where the students were given questions related to previously taught content or content for that day's lesson. A brief do-it-now review initially lead by the participant would be completed, followed by class announcements, if any, and then the lecture or activity for the day. With approximately 10 minutes left in class, the participant would have students complete an exit ticket and, if time permitted, it would be reviewed.

The participants saw the same set of students each day for a semester. The entire content of the course was taught during one semester. A new set of students arrived at the beginning of each semester. Each participant taught three classes and had a planning block that was at the same time each day. Each class also had positive reinforcement mantras on the wall.

Each class had 24 to 30 students and represented a heterogeneous mixture of ability. The percent of students at this school who qualified for free and reduced lunch was 85%. The school's racial makeup was 95% African American; 4% Latino; and 1% Asian, Caucasian, and other. Each class was initially arranged by student performance on unit assessments. Students who performed the highest sat farther away from the teacher and had a choice of seats. Low-performing students sat closer to the front of the classroom at assigned seating. At the end of the semester, biology students took the Georgia Milestones test and chemistry students completed the Student Learning Outcome (SLO) exam.

In the chemistry classroom, Grace gave index cards to each student so that they could monitor their performance and behavior. This was a strategy for positive reinforcement. Students used this card to keep track of their “zest,” “grit” and “demerit” points. Zest points were a reward for class participation. Grit points were awarded based upon doing something stellar in class like leading a discussion or answering a hard question. Demerits points were given for lack of focus, misbehavior, or class disruptions. Points could be used at the school store to purchase uniform apparel or school supplies. There were also competitions between classes for the most zest and grit points obtained in the week.

The class was also allowed to listen to music through ear phones during various activities. Grace also played music while students completed the do-it-now. Each Monday, students were provided a handout that had a space for completion of each day’s do-it-now. Grace implemented the Cornell notes style for students.

The chemistry classroom had lab space in the area. The arrangement of the class was always as depicted in Figure 8. There were two students to each desk.

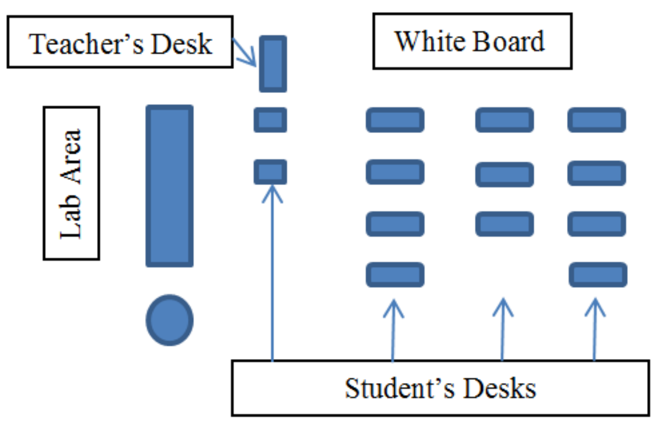

Figure 8: Chemistry Classroom Arrangement

In the biology classroom, Helen used the zest, grit, and demerit system, but no index cards were provided; students were responsible for coming up with their own system for keeping up with their points. On rare occasions, students were allowed to use their headphones to listen to music. Student activities for the class were more structured by the documents provided. Each day, students were provided class notes, which contained a do-it-now, as well as fill-in-the-blank questions related to the class lecture. The class notes also indicated the independent practice, the check for understanding, and vocabulary work that students completed as part of the class. Due to the number of students with individual learning plans in certain classes, a teaching assistant was a part of the class instruction.

The arrangement of the class was as depicted in Figure 9 for the majority of each semester. There were two students to each desk.

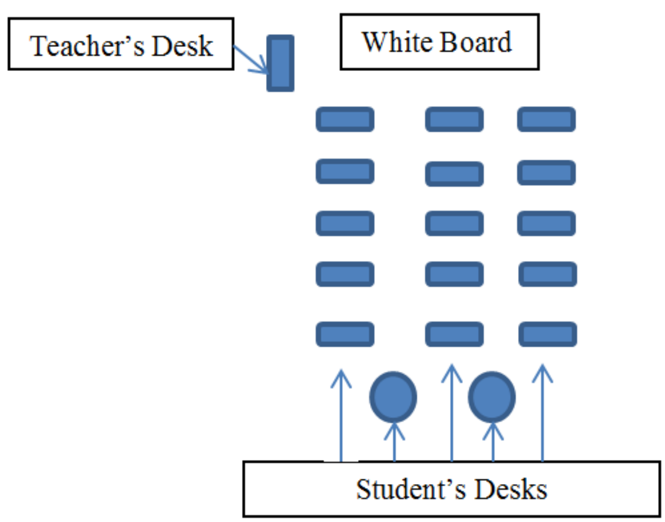

Figure 9: Biology Classroom Arrangement

Theoretical Framework

According to Corbin and Strauss (2008, p. 8), "The world is very complex. There are no simple explanations for things." My effort to try and explain the impact of the teaching cycle of KFET on the development of a new science teacher's pedagogy will be based entirely on my observation of the participant in her environment. The teacher implementing the KFET used some aspect of social constructionism to accomplish this task.

A constructivist teacher creates a context for learning in which students can become engaged in interesting activities that encourage and facilitate learning. The teacher does not simply stand by, however, and watch children explore and discover. Instead, s/he often guides students as they approach problems, may encourage them to work in groups to think about issues and questions, and will support them with encouragement and advice as they tackle problems, adventures, and challenges that are rooted in real-life situations that are both interesting to the students and satisfying in terms of the result of their work. Teachers thus facilitate cognitive growth and learning, as do peers and other members of the child's community. All classrooms do not have to look the same in order to be deemed socially constructive.

In its most simplistic form, the notion of social constructionism is the idea that people work together to learn. It “emphasizes the hold our culture has on us: it shapes the way in which we see things and gives us a quite different view of the world” (Crotty, 1998). This should be distinguished from Crotty’s concept of social *constructivism*, which “points out the unique experience of each of us. It suggests that each one’s way of making sense of the world is as valid and worthy of respect as any other” (p. 58). The goal with this research is not to validate the teacher’s unique perspective (social constructivism), but to determine the impact that the KIPP culture (social constructionism)—through the teaching cycle element of KFET—has on the development of teacher’s pedagogy.

The genesis of social constructionism is in sociocultural theories, which examine “how social factors influence cognition and development, and how social and cultural practices shape and define thought … and that all of the higher psychological processes had their origins in social interaction” (Bjorklund, 2005, p. 108). Kant (1951) suggested that the mind provides the categories of knowing, while experience yields the content. This had a major influence on Piaget

(1955), who argued that it is through the child's experiences of manipulating and changing the world that s/he acquires knowledge about relations within and between people and objects.

Vygotsky (1978) described the manner in which a child internalizes a social experience through a two-stage psychological transformation that is also present throughout the entire span of a human life:

> Every function in the child's cultural development appears twice: on two levels. First on the social, and later on the psychological level; first, between people as an interpsychological category, and then inside the child as an intrapsychological category. This applies equally to voluntary attention, to logical memory and to the formation of concepts. The actual relations between human individuals underlie all the higher functions (p. 45).

There are four principles that are applied in any Vygotskian classroom (Maddux, Johnson, Willis, 1997), including that learning and development is a social, collaborative activity; the Zone of Proximal Development can serve as a guide for curricular and lesson planning; school learning should occur in a meaningful context and not be separated from learning and knowledge; children develop in the "real world"; and out-of-school experiences should be related to the child's school experience (p. 139).

The most salient of the above principles is the Zone of Proximal Development. It is defined as "…the distance between the actual developmental level as determined by independent problem-solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978: 86).
This can best be represented by the following Figure 10:

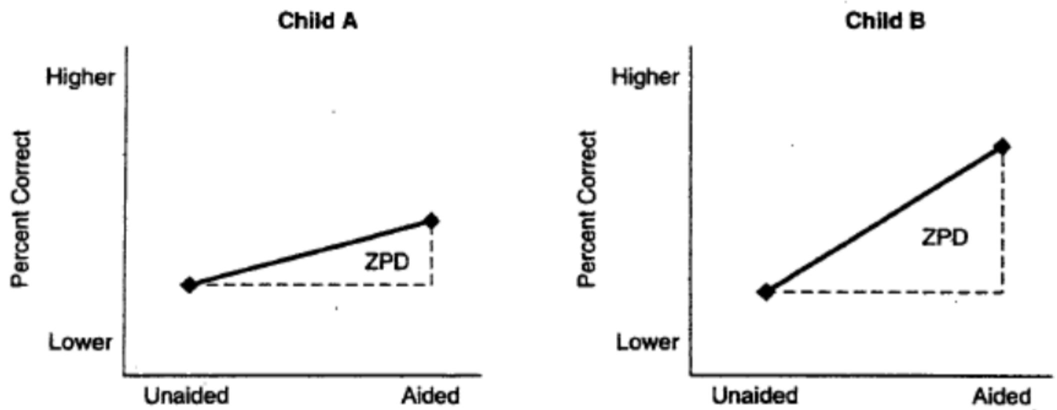

Figure 10: Two Children's Zones of Proximal Development (ZPD). The children's unaided performance is similar, but the child B benefits more from another person's help (Bjorklund, 2005, p. 112).

Finally, this study will have as the bases for its theoretical framework the concept of PCK. Abell (2008, p. 1407) indicates that PCK has four important characteristics: PCK includes discrete categories of knowledge that are applied synergistically to problems of practice; PCK is dynamic, not static; content (science subject matter) is central to PCK; and PCK involves the transformation of other types of knowledge. The discrete categories have been defined previously as the components of PCK in chapter three. The focus of the study is related to the change associated with their PCK as a result of implementing the KFET. Only participants science teaching will be examined and how they transform scientific knowledge for their students.

I began this section indicating that my observation of the participants would be through the teaching cycle of the KFET and indicated that the participants will use some aspect of social constructionism in implementing the teaching cycle of the KFET. I then described how a teacher incorporates aspects of social constructivism in a class. This was followed by the role various philosophers played in developing the concept of social constructionism. I concluded with the role that PCK will play in this theoretical framework

I will now describe how the results obtained during the course of this research study will be analyzed.

Data Analysis

Park (2005) described the use of the constant comparative method, the enumerative approach and in-depth analysis of explicit PCK to analyze PCK data. I implemented a similar strategy in the data analysis for this study, where there was an effort to use the five components of PCK as categories to code the observable behaviors of the teaching cycle of KFET. Later, I will describe the constant comparative method, the enumerative approach, and in-depth analysis of explicit PCK in more detail.

Secondly, using triangulation, I gained an understanding of how the participants were demonstrating their PCK. Finally, I merged the triangulation data for PCK with the triangulation data of the teaching cycle of KFET. Charmaz (2000) indicated that analysis can be done based on a number of comparisons. Examples used for this study included: between different people, data from the same individuals at different points in time, and data with category. In addition, the KFET has an evaluation rubric that measures the fidelity of the KIPP teachers' practices to observable behaviors of its teaching cycle. This rubric enabled me to complete the link between PCK and the teaching cycle of KFET in regards to the actions of the participants.

Constant comparative method. A researcher may choose the "analytical tool" that s/he feels most appropriate for the work that is being conducted. The key is to figure out the best approach and being able to substantiate the logic for its use. The challenge is, as Charmaz (2004) indicated, to "make implicit meanings visible." My effort was an inductive study in that the formation of my thinking changed as I became more informed about my participants' experiences. To make sense of my data, I began with the qualitative concept of the constant comparative method. It serves as a means to organize and analyze data to develop a grounded theory. Glaser (1965) indicated that “its purpose is to generate a theory which is integrated, consistent, plausible, and close to the data.…” He further described the four stages associated with it: comparing incidents applicable to each category – the analyst codes each incident in the data in as many categories of analysis as possible; integrating categories and their properties – units change from comparison of incidents to grouping units with similar properties; delimiting the theory – forming theories from the units with similar properties; and writing the theory – the end of the process where all the data is collated in support of the theories.

An application of this was the use of line-by-line coding of the teaching cycle of KFET. According to Holton (2010), “line-by-line coding forces the researcher to verify and saturate categories, minimizes missing an important category, and ensures relevance by generating codes with emergent fit to the substantive area under study. It also ensures relevance of the emerging theory by enabling the researcher to see which direction to take in theoretically sampling before becoming too selective and focused on a particular problem. The result is a rich, dense theory with the feeling that nothing has been left out” (p 24)”.

The concept of coding, defined as the process of “taking raw data and raising it to a conceptual level” (Corbin and Strauss, 2008, p. 66), began with Glaser and Strauss (1967). It requires that the researcher not begin with some preconceived notion of the why, but to be open to trends or categories that evolve from the data and follow those. It can be used to “denote theoretical constructs derived from qualitative analysis of data” (Corbin and Strauss, 2008, p 1).

Coding plays a major role in grounded theory. The initial work in grounded theory by Glaser and Strauss “refers to a specific methodology on how to get from systematically collecting data to producing a multivariate conceptual theory. It is a total methodological package. It provides a series of systematic, exact methods that start with collecting data and take the researcher to a theoretical piece that is publishable” (Glaser, 2010). However, there was a split between Glaser and Strauss over the notion that grounded theory “did not have a particular theoretical perspective” (Licqurish and Seibold, 2011). Strauss espoused the notion of action/interaction where “humans also shape their institutions; they create and change the world around them” (Corbin and Strauss, 2008).

My criteria for the evaluation of grounded theory were completed as follows (Roulston, 2011):

- Determine the fit: The theoretical categories discovered must be developed from analysis of the collected data and must fit them
- Work: The grounded theory must provide a useful conceptual rendering and ordering of the data that explains the studied phenomena
- Relevance: The analytic explanations should provide actual problems and basic processes in the research setting
- Modifiability: The modification of emerging or established analyses as conditions change or further data is gathered should be incorporated

One of the analytical tools used to assist in this process was the software ATLAS.ti. It has advanced to enable interviews, field notes, audio recordings, and artifacts to be used in generating codes without the need for transcription. It was used to complete the open-coding process, which Corbin and Straus (2008, p. 198) defined as breaking data apart and delineating concepts to stand for blocks of raw data.

As stated, I am looking at the impact of the teaching cycle of the KFET on the PCK of new KIPP science teachers. I have already established that the five components of PCK would serve as our categories. A discussion was completed between my advisor and me regarding the coding of the teaching cycle of KFET with the components of PCK. Any differences of opinion were discussed and a consensus was reached regarding where the 13 observable behaviors of the teaching cycle fell under the five components of PCK.

The science department chair and I had a slightly different approach. We calculated an inter-rater reliability for the nominal data related to the observable behaviors of the teaching cycle of KFET and the components of PCK. Lombard, Snyder-Duch, and Bracken (2002) defined inter-rater reliability as a measure of the extent to which independent judges make the same coding decision in evaluating the characteristics of messages. The online software titled the Coding Analysis Toolkit was used to calculate a Fleiss kappa and the Krippendorff's alpha scores as statistical measures to calculate the inter-rater reliability. Zapf, Castell, Morawietz, & Karch (2016) indicated a prerequisite of being able to ensure reliability is the application of appropriate statistical measures. For nominal data, these statistical measures provide the highest flexibility of the available reliability measures with respect to the raters and categories. A final score of 0.85 for the Fleiss kappa model was obtained. Landis and Koch (1977) published "benchmarks" suggested a score of 0.85 Fleiss kappa result would indicate almost perfect agreement among coders. It should also be pointed out that there are issues associated with the use of kappa scores. Gao, Pan, and Haber (2011) suggested they attain implausible values when the marginal distributions are skewed and/or unbalanced. Lombard et al. (2002) indicated that the role of chance in the results needs to be accounted for. They reviewed 200 studies related to inter-rater reliability and suggested 10 guidelines for use of these measurements, which were used during this analysis. They also indicated that there is no consensus on a single "best" index.

Using ATLAS.ti, I coded data from observations, lesson plans, teacher artifacts, field notes, memos and interviews to discover patterns that enabled me to formulate theories related to the data. I also completed “deviant case analysis.” Mays and Pope (2000, p. 51) indicated that this helps refine the analysis until it can explain all or the vast majority of the cases under scrutiny. Finally, the rubric associated with the teaching cycle of the KFET also was used in this comparative process “to provide supportive evidence for the existence and validity of the research categories” (LeCompte & Preissle, 1993).

Enumerative approach. LeCompte & Preissle (1993, pp. 185-187) indicated that an enumerative approach to qualitative research can be used for one of two strategies: (1) it functions to provide supportive evidence for the existence and validity of research categories and hypotheses, and comes after such categories and hypotheses have been developed in the study at hand; or (2) it consists of an overall analytic strategy whereby field-note data are coded into operationally defined categories, and frequency counts are made of phenomena in the different categories.

Materials used in this analysis of data included the classroom observations, set of field notes, artifacts, memos, and interviews. The items were looked at for examples where a component of PCK could be identified. ATLAS.ti was used to assist in the evaluation of each of the components. For each of the 30 observations, a tally was made of the number of instances where each component of PCK was observed. The tool (Appendix C) used for this purpose was a modification of the form developed by Park (2005), which involved the criteria used for determining orientation for science. Park’s form was heavily influenced by Magnusson et al. (1999) concept for the knowledge of orientation of science component of PCK. I used the criteria established by Friedrichsen et al. (2011) that focused knowledge of orientation to teaching science on the participant's beliefs and goals on science teaching, the nature of science, and science teaching and learning. All auxiliary information obtained during a particular observation (artifacts, memos, informal interviews), as well as when in the semester it was observed, was used for the tallying. This was done to determine if the number of instances of PCK components increased by the participants over time. The results from this effort served as part of the convergence of multiple sources to form themes in the study (Creswell & Miller, 2000).

In-depth analysis of PCK adaptation. To determine the impact of the teaching cycle of KFET on the development of PCK, I implemented a triangulation of data (Denzin, 1978). First results for the data obtained using the constant comparative method were used to link the participants' classroom activities to PCK. Secondly, I compared the completed rubrics that were completed by the participants, the science department chair, and myself for the teaching cycle of KFET. The participants completed a self-evaluation. The science department chair completed both a mid-year and an end-of-year evaluation. Only the mid-year evaluation and a self-evaluation were completed for Grace due to her leaving the study. Finally, an in-depth analysis was done comparing the teaching cycle of KFET data against the PCK data.

Subjectivity Statement

I bleed KIPP! I wanted strongly to adhere to the notion that "researchers should be familiar with the language, culture, intent and purposes of inquiry and research in their disciplines in a way that reflects the goals of integrating personal, professional, and intellectual competence and development" (Bentz & Shapiro, 1998, p. 10). I (and many others) have a profound interest in understanding what it is that makes KIPP the special place that it is: a place that aims to make socioeconomic status not be one of the requirements for a quality education; a place where everyone is expected to succeed; a place where the notion of graduating from high school and getting to and through college is the norm.

As an African-American male who has embraced the ideals of Western modern science, my perspective has been that it is all about the facts. My interest in helping students gain a quality education stems from my experience as a researcher at some of the top research laboratories in the world: The National Institutes of Health, the Centers for Disease Control and Prevention, Merck, Sandoz, and the Food and Drug Administration. I would look around and not see many others who looked like me. At Merck, I was challenged to go out and recruit. Candidates who I felt had the right qualifications were extremely difficult to find. In fact, I failed at recruiting. After attending conferences like the American Chemical Society, The National Organization of Black Chemists and Chemical Engineers, and The Eastern Analytical Symposium, the best I could do was get one white female hired. I realized that if people of color are to be found at these types of conferences in larger numbers, then they must be turned on at an early age to the wonders of science.

I have always had a love of teaching. I inherited it from a mother who continued to teach after she retired with more than 50 years of being in the classroom. I served as an instructor at KIPP for seven years. I was recruited to the organization with a full-court press from my daughter—a sixth grader at the time—and the school director. I was given a textbook and a room, and told to create an eighth-grade science curriculum. My daughter went on to become the poster child for KIPP. As a ninth grader, she was accepted into one of the top boarding schools in the country and later became KIPP Metro Atlanta’s first Ivy League college acceptance. She serves as proof that KIPP’s mantra of “Work Hard, Be Nice” can provide substantive rewards.

And yet, if KIPP had been an option for my youngest son, my wife and I would not have sent him there. As a teacher and a parent, I recognize that KIPP is not the right fit for everyone. This notion of fit takes into account the child's personality, work ethic, interests, parental commitment, and even financial resources.

I acknowledge that there are limitations to KIPP's impact. It simply does not have the resources to address the needs of all students who have an interest in attending. Like all well-performing charter schools, there is a lottery to get in and there are only certain allotments of the golden tickets. KIPP can serve as only one part of an educational strategy for a school district.

KIPP's co-founder, Mike Feinberg, readily acknowledged this limitation. His hope was that at some point in the dynamic between a KIPP school in a district of non-KIPP schools, a tipping point would occur. The impact of KIPP on a larger system would fundamentally change the larger system. To his disappointment, that has not happened with the Houston Independent School System, the birthplace of the KIPP concept. Granted that there has been some transference of ideas for improving the educational options in both directions, Feinberg doesn't think the change has been significant enough (personal communication, July 16, 2014).

What is the reason for KIPP's success? Is it the system, where there are specific rewards and consequences? Is it the long hours and teacher access? Is it the dedication, sheer will, and talent of the teachers? Is it the skill set of the administrator? These questions deserve to be the subject of many dissertations, forums, papers, and discussions to come.

The KIPP network provides a natural laboratory in which to study. It prides itself in removing the type of roadblocks that exist in large urban school systems. For example, the school leader has complete autonomy of his/her building. In addition, the data in terms of student performance is a story that KIPP wants to get out there. KIPP students routinely outperform students of a similar socioeconomic status on the battery of mandated high-stakes testing. The challenge remains to substantially move the needle on KIPP students graduating from college.

One challenge for me is my positionality with the ties that I have to my subjects. This study is my attempt to "locate an individual's research interests and projects within her being-in-the-world or personally configured universe" (Bentz & Shapiro, 1998, p. 5). Can the bias that I have for the KIPP network be overcome? How will I deal with the possibility that the reason that KIPP is effective has nothing to do with the teachers in a way that I feel it does? Maybe KIPP's success is the system itself. Maybe teachers only play a minor role in this success. Does the level of teacher experience have anything to do with this success? Or can the experience of Teach for America participants who have only a degree, ambition, and a summer camp experience adequately prepare them for their classroom experience?

Validity

There are a number of authors who have discussed procedures for establishing validity in qualitative studies (Lincoln & Guba, 1985; Mathison, 1988; Marriam, 1995; Maxwell, 1992; Golafshani, 2003). These strategies focused on issues related to enhancing the internal validity, reliability, generalizability, and trustworthiness of a study. Lincoln (1995) further indicated that credibility is demonstrated through member checks, peer debriefing, prolonged engagement, persistent observation, and audit trails. I have implemented each of these criteria in the course of this study. Each component of PCK was documented in the practices of the participants. A member check was completed by asking the participants to review what was documented for accuracy. Debriefing was done with both the participants and the science department chair either after an observation or in an informal conversation. My advisor and I engaged in weekly debriefings during the course of the observations. In addition, I met with my committee to debrief on interview questions and strategies related to completing the study. The study was completed over a 14-month time span; classroom observations were completed on a weekly basis; and audit trails were established using the ATLAS.ti software.

Maxwell (1992, 1996) suggested that validity is comprised of three components: descriptive validity (the factual accuracy of the study), interpretive validity (participants' perspective), and theoretical validity (the explanation of the data is credible and defensible). Appendix B lists the observation field notes, interviews, audio files, memos, artifacts, photos, and another observer's documentation—all of which describe what actually happened during the course of this study.

The use of the other observer—the chair of the science department –allowed for cross-checking to confirm what was actually observed in the participants' classrooms. These efforts support the descriptive validity of the study.

The interpretive validity of the study is supported by the interviews—both formal and informal—and participants' memos to gain an understanding of the meaning they attached to actions carried out in the classroom, as well as member checks preformed on data obtained from the participants. Theoretical validity can best be found by a discussion of the research findings later in this document.

Triangulation was a critical component of this qualitative study and can be defined as "a validity procedure where researchers search for convergence among multiple and different sources of information to form themes or categories in a study" (Creswell & Miller, 2000, p. 126). In addition, it provides more and better evidence from which researchers can construct meaningful propositions about the social world. The value of triangulation lies in providing evidence such that the researcher can construct explanations of the social phenomena from which they arise (Mathison, 1988). Johnson (1997) suggested that the use of triangulation in a constructivist framework to document reality is appropriate. He also suggested that one of the potential threats to validity is research bias. To avoid bias, I have made this an inductive study so that by keeping an open mind from the start, I would limit the collection of data that only served my purpose and some self-fulfilling-prophecy bias. I made every effort to be as objective as possible in recording information. My interviews, field notes, member checks, peer debriefing, observations, use of other observers, and prolonged engagement are as accurate a portrayal as possible. These sources of data were used as means of triangulation and added to the validity of the study (Patton, 2002). I acknowledge the limitations of my personal bias through my subjectivity statement, which underscores my interest in this qualitative study, as well as defines its importance to me and serves with all the remaining data as a means to increasing the internal validity of this study.

In addition, significant time was given to the teachers to provide their perspectives. This ranged from the extensive formal interviews to informal discussions after class and clarifying emails, as well as member checks. All of this contributed to the validity of the interview process (Seidman, 1998). Finally, there was an effort to identify rival explanations and deviant cases (Patton, 2002). These did not fit defined categories. They served as exceptions that disconfirmed and altered what appeared to be primary patterns.

Conclusion

In this chapter, I began by describing the challenges associated with evaluating a teacher's PCK. This involved what Loughran et al. (2004) described as the time it takes to observe it and the lack of a common vocabulary amongst teachers. I then described the criteria that were used in selecting the participants and what would be studied about them. I made the connection between the components of PCK and the elements of the teaching cycle of KFET, which is critical to the research questions associated with this study. I moved to explaining my theoretical framework and the relationship between the teaching cycle of the KFET and the role of social constructivism in the study, as well as my subjectivity to the study. I concluded by defining how the data obtained throughout the study will be analyzed. I will now present the results from the tools used to obtain the data.

CHAPTER 4

RESULTS

In this chapter, I will discuss the findings obtained in determining the impact of the teaching cycle of KFET on the PCK of new KIPP science teachers. It was important to have an understanding of the teachers' PCK and then ultimately determine whether it changed through exposure to the teaching cycle of the KFET. A part of this process involved identifying what factors impacted the participants' PCK, as well as identifying alternative explanations that may or may not have influenced a change in the participants' PCK. I will conclude by discussing how three research questions guided my analysis.

PCK Held by Participants

My approach with this study was to involve experienced science teachers who had already developed some aspect of their own PCK outside of the KIPP environment. Once they entered the KIPP world, I could then observe the interaction between implementation of the teaching cycle of the KFET and the development of the participants' PCK. Teachers, especially experienced ones, entering a classroom often have established some level of PCK (Boesdorfer, 2013; Cohen & Yarden, 2009; Eunmi, 2014; Fletcher & Luft, 2011). It is often comprised of their bag of tricks, their tried-and-true methods, their old exam questions, and their horror stories of what did not work. They know where in the curriculum students have struggled and where they have breezed through the content. To establish a baseline, I began with a formal interview to gauge the participants' concept of PCK. This was then followed by observations, gathering of artifacts, member checks, and an exit interview. In addition, after each observation, I utilized the classroom observation tool in Appendix C to tabulate the instances of PCK demonstrated by the teacher during that lesson. One purpose of this was to quantitatively demonstrate if more instances of PCK were observed throughout the time of the course. I will discuss later what was found in this effort.

Appendix D contains the interview questions that were used in both the initial and final interview with the participants to capture their epistemological beliefs. The questions were arranged around soliciting information related to the five components of PCK (orientation to teaching science; knowledge of students' understanding in science; knowledge of science curriculum; knowledge of instructional strategies, and knowledge of assessment of science learning).

To gain an understanding of the participants' PCK, I implemented a triangulation approach. Participants were formally interviewed at the beginning of the school year; they were observed by the science department chair and me; and a number of artifacts were obtained to support classroom observations. In Chapter 3, I described in detail the characteristics of the participants. Appendix B details a list of all artifacts and provides the dates of 30 completed observations.

At the beginning of the school year, new teachers arrived three days prior to the return of the veteran teachers to begin the induction program. For students, the academic year began with one of KIPP's hallmarks: a mandatory summer school that lasts two weeks in July. Teachers used this time to "KIPPtonize" the students, which included introducing themselves to students, teaching them the rules and expectations, and building a concept of team and family. It was during the three days prior to the return of the veteran teachers that I began the process of understanding the role that the teaching cycle of the KFET played in the development of the participants' PCK. I will now detail how each component of PCK was impacted by the teaching cycle of the KFET.

Orientation to Teaching Science

To gain an understanding of each participant's orientation to teaching science, I arranged questions around the idea of conceptual and methodological clarity espoused by Friedrichsen et al. (2011) and an adaptation of the of questions developed by Luft & Roehrig (2007). What resulted was a description of each participant's beliefs in how science should be taught, their beliefs in how the nature of science should be conveyed, and their beliefs in what the goals and functions of science education should be. An expression of those beliefs is what follows.

Helen's orientation to teaching science. Helen indicated in her interviews and throughout the initial observations in her class the notion that the goal of teaching science is first a fundamental belief that "all students can learn." In addition, she stated:

> "I have to understand *that* when I'm teaching science lessons. I also have to understand that science is a foreign language to some people. And I really have to be cognizant of that when teaching. And also some people really enjoy it. So you have that big spectrum of it. Also if they've never done well in it, they're going to feel a lot of anxiety and stress about it" (Helen, interview, August 21, 2015).

Helen wanted students to appreciate the idea that science is all around us. Her teaching philosophy is "that all students can learn. And, students should question everything. And, that is it my job as a teacher to inspire students to find their passion" (Helen, interview, August 21, 2015).

Evidence of this was demonstrated by the level of differentiation observed in her classroom. To bring biology to life, students were encouraged to submit projects that embraced their particular interest. Each unit required some form of white paper – a project where students were given wide discretion in choosing a topic. In the cell unit review, students created collages, drew pictures, built manipulatives for vocabulary terms, or created their own exams in order to prepare for the unit exam.

One of the components of the KFET teaching cycle is the notion of maximizing student learning in the classroom by having a 1/12th mindset. As explained previously, this is an intentional effort to use every moment of class for instructional purposes. In the beginning, Helen's mindset was:

> "…. I've just been taught that classroom management and planning go hand in hand. So if you have good planning, you have good classroom management. You have to plan for the unexpected. So I always have, if that were to happen, I always have some sort of a backup plan—some sort of review worksheet, something that I can come up with on the fly to kind of work through. In my first year of teaching, I did have situations like that where I thought it would take this amount of time, but it didn't—it took this amount of time. But I don't really have that now just because I think that I've gotten comfortable with how I structure my lessons, what I build into my lessons that I know it's going to take a certain amount of time. But if that were to happen, the students also have homework every night, so one example would be that they could just work on their homework. But it would be structured" (Helen, interview, August 21, 2015).

To determine what to teach in the classroom, Helen indicated that she begins with developing a scope and sequence. The process involved breaking the standards down into objectives of what should be covered to make sure the students met that particular standard. This way, she could see what has to be taught and the progression of it. This scope and sequence served as her road map. The decision to move on to new content in the class began with the exit ticket from the previous class. These documents were scaffolded so that if a breakdown of comprehension occurred, Helen did not move forward, but instead re-taught until the students had a better comprehension of the content. In addition, the do-it-now reviewed previous content and was completed prior to the beginning of the day's class. Another part of this was the check-for-understanding, which helped ensure that the class was on the right track. Finally, Helen stated that "diagnostics and student performance data play a big role, especially in the beginning of the year. If students understand some of the material, then the diagnostic will help limit what has to be covered in the class. If everybody fails an exam, then there is obviously a re-teaching that must be done" (Helen, interview, August 21, 2015).

Helen's belief on student learning is that "…every child learns differently. And every child has their own strengths. Some students are auditory learners. Others are very visual. Others are tactile. So you really have to incorporate all of those different components into your lesson" (Helen, interview, August 21, 2015). This was done in myriad ways in the classroom, including the addition of a co-teacher. Depending on the class size and the number of students in the class, a co-teacher assisted with instruction. Her role was to help students with completing assignments and to foster participation in the class. In one instance, she assisted with two students taking exams and quizzes in a more quiet setting. The co-teacher would sit by certain students to ensure that notes were being taken or provide answers to students who did not quite understand certain content. Helen also felt that providing guided notes, using hooks that bring the outside world into the classroom, online assessments, team and individual projects, using videos and songs, and providing afterschool tutorial all were factors that helped students learn best.

"So, for example, for a project, different students are going to ultimately be completing various different topics. It may be like a choice board almost where the student can choose their choice to make a project based off of what they want to do. In addition to unit tests, unit tests are differentiated. So for my students who have special needs, they will have a different form of a test. An example would be instead of having four-answer choices, they would have three-answer choices and a few less questions to really assess their mastery. As compared to a student that's at a higher level may have more questions at a higher difficulty level" (Helen, interview, June 23, 2016).

Helen came to believe that learning was occurring in the class first by comparing assessment data collected at the beginning of the year with current quizzes, through classroom observations, and with current exams that provided the "pinpoint" for determining if the content was mastered. For exit tickets (Appendix E), 80% became what was viewed as mastery. Helen stated:

"I don't really expect every student to get a 100 just because I don't think that that is a feasible task. In the sense that every student's different and to be able to achieve that with the amount of students that I have would be very difficult. But I look at where they came in" (Helen, interview, June 23, 2016).

Students who did not meet mastery on unit exams had to stay after school for remediation sessions and were then retested to show they had mastered certain content. Helen felt learning also could be demonstrated by students simply raising their hands to answer a question or saying they agree or disagree. The use of data in the diagnostics exam administered at the beginning of the year and the same exam given again at the end of the year should show growth. "But, again, for some students, it's going to look different. I don't expect all students to grow the same amount. I really look at where they came in, some of their challenges, and really make it an attainable goal for them based off of their initial ability," said Helen (Helen, interview, June 23, 2016).

Helen stated: "An example of this is the cell organelle unit. A student at a higher level would build a city and compare different organelles to the components of a city. A student with challenges would demonstrate mastery by just being able to recall simple definitions of the organelles" (Helen, interview, June 23, 2016).

Table 12 provides a summary of the findings related to Helen's orientation to teaching science.

Table 12:
Summary of Helen's Orientation to Teaching Science

Beliefs about the goals or purposes			
Of Science Teaching	**On the Nature of Science**	**On Science Teaching and Learning**	**Teaching Practice**
All students can learn	Science is all around us	Differentiate assessment	Break final exam down into units
Inspire students to find their passion	Students should question everything	Start with the end in mind	Incorporate real life examples into lessons
Cognizant that science is a foreign language		Modify lessons	Different forms of test
Some students really enjoy science			Exit tickets; Do-Now daily
Make science more attainable			Scaffold assessments
Learning style is big			Re-teach
Project based learning			Re-test
			Provide tutorial
			Check for Understanding
			Independent Practice
			Different criteria for project completion

Grace's orientation to teaching science. Grace stated that her role in the classroom was "…. making science more accessible for students, more relatable, letting them see that they have a lot of opportunities in it. And it's not just like you're good or bad at science. I guess just making them more comfortable with it and exposing them to all the opportunities that they have because science is such a broad topic" (Grace, interview, July 30, 2015).

Her teaching philosophy is best expressed by her statement:

"So, overall, science has kind of a bad name. It's scary for a lot of students. But in the world, after high school, science is very, it's like prestigious. People respect science and scientists, people who work with it. So just bridging that gap, making science more accessible for students, more relatable, letting them see that they have a lot of opportunities in it" (Grace, interview, July 30, 2015).

She accomplished this by sharing a lot of different experiences that she has had and by discussing scientists she knows—some of whom the students may have heard of. Her goal was to not just focus on theories of old, but new research and opportunities that students could relate to and have heard about. "I'm just bringing it down to their level and, again, making it accessible to them," she said (Grace, interview, July 30, 2015).

To maximize the learning environment in her class, Grace began by discussing how a student's conception of science is a "big thing as far as investment and engagement go." It should not be a "…scary thing or only dealing with something that they don't like" because Grace felt this will impact their willingness to invest in the classroom. The learning experience was improved by having students "transition from me teaching something new into them doing it on their own. A lot of differentiation is guided practice. How quickly can I let go of your hand, essentially" (Grace, interview March 25, 2015). This involves having work stations with groups of students based upon their skill set. In addition, learning styles play a huge role. Grace stated, "If I'm not teaching it to their learning style, they're not going to learn it" (Grace, interview

March 25, 2015). Grace also tried to “keep things very consistent.” There were practices that were done every day in the class such as the do-it-now. She provided her notes in class in the Cornell system and wanted her lessons to build in a “logical manner.” It started with what makes “sense” to her. Her goal was to be purposeful about breaking down the big standards into skills that she knew students would need to have before they can understand the standard. She stated:

> “For example, one of the standards is being able to name chemical compounds. Well, you can’t name chemical compounds until you understand oxidation numbers, and you can’t understand oxidation numbers until you understand valence electrons. Really breaking it down into very ground level and building up from there” (Grace, interview, July 30, 2015).

Another approach Grace used to make sure students understand material was the backwards planning idea.

> “This was the first thing I made for the course - which was essentially the final assessment: this is where I need students to be. And then from the final assessment, making the smaller assessments that’ll be given. And then from there, backing up and making sure everything is in line” (Grace, interview, March 25, 2016).

Lessons were modified based upon student participation. “Why are we doing textual understanding? If no one’s getting it, I need to spend more time on this. If almost everyone’s getting this, we can move on” (Grace, interview, March 25, 2016).

Determining what to teach begins with trial and error. According to Grace:

> “It basically comes down to what makes sense to me. My first degree is in science, and so I understand what the students need for college. So, making sure it builds in a logical manner. My scope and sequence is set on a skill base, and very much so building through

it. There is a lot of student observation, gauging the students' level of understanding, and modifying the lessons based upon this. As far as overall lesson planning, like what activities I'm going to do—a lot of times it's based on the class. What can the class handle, and building from there" (Grace, interview, July 30, 2015).

The decision for Grace to move on in a lesson began with providing students with a number of differentiation options.

"Having lots of options for the students, if you're ready to move on, move on. Once I've cleared, you got this, go ahead—and even bringing them back. If you have higher level students who are really, really getting it, I allow them to help other students. Kind of like a co-teaching model amongst the students. I like to use it when I can. I don't like to stand up and talk all day. I try as much as I can to let the students guide and lead their own thinking" (Grace, interview, July 30, 2015).

Grace expressed that students learn best when they are invested and engaged. "Their overall conception of—on the very basic level of good or bad, fun or not fun, scary, whatever—definitely impacts how willing they are to learn in the classroom" (Grace, interview, July 30, 2015).

Another part to student learning for Grace was teaching to many learning styles. "I definitely think learning styles play a huge role because, especially as high school students, very few of them know the way they learn best" (Grace, interview, July 30, 2015).

The way that Grace said she knew learning was occurring in her class room was first based on formative and summative assessments:

"So, every day you'll have some sort of formative data: where are we in this topic either in the form of an activity or an exit ticket or both, for whatever the objective might be for the day. And then doing labs, how well are they mastering not only the content like ‘Can I remember this?’ but also ‘Can I apply it in the form of labs?’ Then, normal assessments that are a mix of the different levels of questioning, and bringing back in writing or creating/applying a component rather than just multiple choice” (Grace, interview, March 25, 2016).

Table 13 provides a summary of the findings related to Grace’s orientation to teaching science.

Table 13:
Summary of Grace's Orientation to Teaching Science

Beliefs about the goals or purposes			
Of Science Teaching	**On the Nature of Science**	**On Science Teaching and Learning**	**Teaching Practice**
Work with different learning styles	Science has a bad name	Try and keep things consistent	Do-It-Now every day
Breaking goal into smaller pieces	Outside of high school it is prestigious	Differentiate Guided Practice	Cornell Notes
Consistency in daily routine	It should bridge the gap	Backward Design plan	Allow Drawing
Provide as much inquiry as possible	Science is broad	Formative/summative assessments	Movement around Class
Make science more accessible to students	Will be needed regardless of profession	Re-teach	Use of Music
		Observations	Creating final exam first
		Use of data	Use of labs
		Getting work back in timely manner	Student teaching
			Online grading; trading grades

Knowledge of Student Understanding

Questions used to capture the participants' knowledge of student understanding were based on work by Lee et al. (2007). As previously stated, they focused on the teachers' knowledge of three aspects of student learning and conceptions: prior knowledge, variations in students' approaches to learning, and students' difficulties with specific science concepts. Questions also were designed to gain an understanding of how the participants determined what students know prior to the lesson, their approach to differentiation, and how they discovered areas of likely difficulty (Appendix A).

Helen's knowledge of student understanding. At the beginning of the year, Helen administered a diagnostic exam – now referred to as the Milestone Assessment. This was an exam previously released by the Georgia Department of Education that covered the entire content of the course. The same diagnostic exam was given as the final at the end of the semester and prior to the official Milestone Assessment. She stated that she chose this exam "because that's ultimately what the students needed to do from beginning to end, and was the best indicator." Helen structured the class so that, prior to each unit, there was a pre-assessment, "so I can see what they know coming into individual units." Students compared their scores between the initial diagnostic and the final exam to demonstrate how prepared they were for the official exam.

To discover areas of likely difficulty in student learning, I questioned and observed Helen on how she dealt with students' misconceptions, how she implemented differentiation, and the role of student data in unit planning. She indicated in the beginning that "students truly just have never understood science or it's been one of those subjects that's been difficult. As a result, there will be a lot of stress and anxiety about learning science." She felt that she had to take this into consideration when teaching. In the final interview, she discussed how she addressed this by encouraging "free thought" in the classroom. "There was no such thing as a silly question and you can ask any question. I really welcomed any and all opinions that students had about any biological science concept.” She took the time to discuss the random facts that students wanted to talk about. One of many examples occurred during the evolution unit. She began by expressing that she was not there “to prove or disprove what they may have learned or believe as a part of their religion. Her job was to talk about the science aspect of it and what science believed” (Helen, interview, June 23, 2016). A student wanted to know if a human embryo could be placed into a cow and give birth to it. Helen explained why, from a physiology standpoint, there are scientific challenges associated with this task.

Differentiation in Helen’s class began with trying to relate the content to real-world examples. One classic example was discussing the lock-and-key concept while explaining enzymes. Other areas for differentiation included efforts that spoke to the students’ different learning styles. Often, in-class lessons were interspersed with songs and videos. Activities that would apply to all of the different type of learning styles were incorporated into lessons. An example was “Amoeba Sisters,” a YouTube site whose goal is to demystify science. In addition, each unit had a required white paper review assignment, which is something Helen started this year at KIPP. Students created the type of review sheets that they would use for unit exam purposes. A template would be implemented that contained unit components. This template “pushed” the students to go back through their class notes and pull out relevant content knowledge and create a “holistic” review sheet that they would then keep and use for review purposes.

For students who had specific learning disabilities, Helen decreased answer choices from four options to two or three in the unit multiple choice tests. The special education teacher would go through reading assignments and underline or highlight key words that students should pay attention to. This was also done for other students whom Helen felt needed this type of assistance, but may not have had an individual development plan. For students who performed at a higher level, Helen provided an online curriculum where they would perform independent, self-guided study. Her goal was to prepare them for more advanced placement level courses. Based upon her experiences in the first semester, Helen decided in the second semester that a lot more foundational content needed to be “embedded” into the course because this benefited both high- and low-level students. Throughout the course, she included tactile assignments. For photosynthesis and respiration material, students had to write on cards the different reactions and products associated with the process. Students then had to manipulate the cards to make sure the reaction was correct. In the second semester, a guest speaker was invited to the class to provide sheep brains for students to dissect as part of a class on neuroscience that was an extension on the unit on cells and anatomy.

Helen used data to discover areas of difficulty for the students. If results from an exit ticket indicated that the majority of the class did not “master” a concept, then the next day a majority of the class period was spent re-teaching that concept. The unit plan would be “adjusted so that I had enough time to go back and reteach that topic. I noticed that [exit tickets indicating that students did not master the concept] a lot with mitosis and meiosis, as well as with photosynthesis and cell respiration. This was for both semesters” (Helen, interview, June 23, 2016).

One “big” change made after the first semester was how tutorial for students was scheduled. A student tracker and standards mastery system was implemented. Individual student’s mastery of a particular standard was posted in the class. There also was a posting of what days a particular standard would be focused on during tutorial. “If students did not master a particular standard, they had to come to tutorial on that specific date to remediate that specific standard" (Helen, interview, June 23, 2016). Table 14 provides a summary of the findings related to Helen's knowledge of students' understanding in science.

Table 14:
Summary of Helen's Knowledge of Students' Understanding in Science

Goals and Behaviors			
Determination of Prior Knowledge	**Differentiation in Classroom Instruction**	**Discovery of areas of likely difficulty**	**Teaching Practice**
Use of diagnostics	Use of Student data	Deal with students level of stress and anxiety	Used Practice Georgia Milestone Assessment at the beginning of the year and prior to taking the exam
Do-It-Now	Relate content to Real World Experiences	Use of Previous Teaching Experience	Provide a space for student being able to express ideas as they see them
	Students Create Their Own Content For Review	Student Performance Data	No silly questions
	Modified Assignments	Exit Ticket	Use of Lock & Key System to Explain Enzymes
		Tutorial	Use of Songs and Videos
			White Paper Assignment
			Use of Student Tracker and Performance on Standards bases Assessments

Grace's knowledge of student understanding. Initially, Grace used a pre-test to determine prior knowledge. However:

"The pre-test is more so—it's not like what do you remember from what you've already known, it's more like how have you extended your knowledge and probably what they already know will be based on those formative things, and more observation than anything. I know coming into chemistry a lot of times—chemistry isn't something that's really spiraled into many other subjects" (Grace, interview, July 30, 2015).

By the end of the semester, Grace determined prior knowledge with the do-it-now administered at the beginning of class and graded during the first 10 minutes of the class, a general class discussion, or engagement activities at the beginning of a unit. She would indicate to students that "I know you have learned about this or that you have seen this before, and let's talk about what we already know about it and then build from there " (Grace, personal observation, December 12, 2015).

Students' conceptions of science "played a role in how I would introduce material or reintroduce material. Taking that whatever they considered fun or boring and planning that into my lessons" (Grace, interview, March 35, 2016). An example observed in Grace's class was her having students do the math associated with a lab prior to the mixing of items together for the lab. Students' misconceptions were often brought to the forefront of the class, "so they didn't learn something in the wrong way because of how I spiral my class with the standards" (Grace, interview, March 25, 2016).

Several different approaches were used by Grace for differentiation. It began with instructions. For lower-level students, more instructions were provided for an activity than for higher-level students. On a number of occasions, higher-level students were given the responsibility for solving certain problems on their own. Other activities involved changing the tests and quizzes for students who had a documented learning disability.

Lab differentiation was done with stations—areas in the class where specific tasks related to the lesson were carried out—and with grouping students based upon their overall ability for the skill. “So with the different stations, going back to the [Bloom’s taxonomy] or the depth of knowledge levels, at station 1 we’re having to apply, but at station 2 we’re having to match/identify, things like that” (Grace, interview, March 25, 2016). Students’ learning styles also play a role in their understanding. “If you have a student who isn’t auditory at all and all you’re doing is lecturing, they are not going to pick up any of the information” (Grace, interview, March 25, 2016). When new information was introduced, Grace made an effort to ensure that the students heard it, wrote it, and, if possible, manipulated something tactile with it. “That way, we are hitting all of the four big learning styles with the same objective. That way, every kid is not only getting it in their main learning style, but it is also reinforced with the others” (Grace, interview, March 25, 2016).

Grace used her prior knowledge of the content and data to help in discovering areas of likely difficulty. KIPP places a significant focus on the use of data to drive instruction. The teaching cycle of the KFET stipulates that data is used to assess mastery of objectives and movement toward big goals for student achievement and growth. This role for data was a new concept with Grace. In the past, she stated that data was used “for a lot of grouping strategies.” It was collected on a school-wide basis, but “we didn’t do much with it.” Initially at KIPP, the plan was to use observations of students and discussions with the department chair to determine the role of data. It developed for Grace into a tool to “make sure we were still on track. It served as a kind of guide to determine if we are ready to move into independent work. Do we need more guided work? How ready are the students for me to back away and let them do it on their own”

(Grace, interview, March 25, 2016)? Table 15 provides a summary of the findings related to Grace's knowledge of students understanding in science.

Table 15:
Summary of Graces Knowledge of Student's Understanding in Science

Goals and Behaviors			
Determination of Prior Knowledge	**Differentiation in Classroom Instruction**	**Discovery of areas of likely difficulty**	**Teaching Practice**
Use of a Pre-Test	Different Student Instructions	Prior Teaching Knowledge of Content	General Class Discussion
Do-It-Now	Levels of Problem Solving	Use of Student Assessment Data	Reminded Students of What They Had Already Learned
Understanding Student's Misconceptions	Use of Lab Work Stations		Complete Content Related Math Problems
	Grouping of Students based on ability		Higher Level Students provided Fewer instructions
	Adapt Instruction to Various Learning Styles		Changing Tests and Quizzes for Students with Learning Disability
			Students Hear, Write and Manipulate

Knowledge of Science Curriculum

In looking at Helen's and Grace's knowledge of science curriculum, the focus was primarily on determining their understanding of the importance of topics relative to the curriculum as a whole. This began with understanding how they determined the components of their scope and sequence. Why would they modify a lesson? What strategies were involved in modifying a lesson? What were their thoughts on covering the curriculum and ensuring content was mastered? How did they look at student growth and achievement related to course content? How were the criteria for success determined and measured? How did they prepare clear and accessible lessons? And finally, how did they connect prior knowledge to introduction of new material?

Helen's knowledge of science curriculum. For Helen, the knowledge of science curriculum began with the scope and sequence, which "…served like a road map. I take the standards and break them down into objectives of what should be covered to make sure they meet that particular standard. And then I map it out on a scope and sequence so I can see what has to be taught when, and also the progression of it" (Helen, interview, August 21, 2015). Helen modified lessons on a routine basis when required:

> "If in second period I did something and I realized that the directions were unclear or that the assignment wasn't actually helping the students, I would modify it right there in the moment to make sure that by third period I'm not repeating the same mistake and I'm fixing it. But like on the semester to semester, or just even modify simply based off of data. If the data tells me that I need to change it because everybody bombed it, then that would be it. Or on the converse side, if everybody did really well, that means that the next time I teach it, I really have to up what I'm teaching, up the rigor" (Helen, interview, June 23, 2016).

Most often, if material was modified, Helen accomplished this through board instruction rather than through the PowerPoint if there was not enough time. Since the exit tickets were scanned immediately through an online grading system, instant feedback was provided on the success of a lesson "to see if it was effective or not, and I would switch it up immediately," stated Helen. In one example, she discussed the role of sexual and asexual reproduction for the first period by sticking to the PowerPoint presentation. In the second period, she completed the PowerPoint review and then went to the board and compared and contrasted the two concepts by repeating the information and providing advantages and disadvantages, and the role of parents in each.

In terms of covering the curriculum and student mastery of content, Helen felt it was "…crucial. At the end of the day, I need to make sure that my students are learning and that my students are walking away with the knowledge they need to ultimately be successful." At the beginning of each class, students were provided a set of handouts related to the class content covered that day. Each contained the do-it-now. The packet also contained the independent practice, as well as several check-for-understanding segments. The class would stop and students would either answer questions in the notes or work with a partner to solve problems, followed by a review of the check-for-understanding assignment. This part of the class would normally take about 10 minutes to complete. To assist with content mastery, Helen often used real-world experiences. "That's also why I like to tie in the real-world concepts. Because, ultimately, if they don't go into a field where they need to use biology, I still want them to be able to say, 'Oh, I know why somebody is lactose intolerant,' or 'Oh, I know what that means.' To just kind of be better citizens" (Helen, interview, June 23, 2016).

The goal for student growth initially for Helen was defined as "significant" growth within each content domain for the course as measured by the diagnostic given at the beginning and end of the course. "But, again, for some students, it's going to look different. I don't expect all students to grow the same amount. I really look at where they came in, some of their challenges, and really make it an attainable goal for them based on their initial ability." An example of this is a dyslexic student who struggled with reading. Helen stated:

"So for him, I'm looking at a growth as whether I can verbally explain the information and can he verbally explain it back to me. Whereas, then, I have another student who came in my second period and she came in with a lot of prior knowledge. So for her, I'm looking for her to be at an AP level by the time that she leaves my class" (Helen, interview, June 23, 2016).

One of the criteria-for-success for the students became students achieving an 80% passing score on assessments. According to Helen, this "was given to us by the State and the school in terms of the expectation for the pass rate percentage, as well as what is considered to be passing." In the first semester, Helen's students scored in the 70% range on the Milestone Assessment. This did not meet the State level for passing, which was 80%. So for the second semester, the pass rate for unit tests, quizzes, and for the class was changed to 80%. Helen stated, "If a student got a 70%, they would still pass the class, but they had to come to remediation—lunch, or after school, or Saturday tutorial—until they got to the 80%."

In connecting prior knowledge to what was currently being taught, Helen used the do-it-now that was related to the previous class. There were also "readings where students had to ask questions to really incorporate prior knowledge into assignments and it allowed them to showcase what they already knew and what they've understood," stated Helen. This moved to a lot of open conversations and dialogue in classrooms. "This allowed me to engage them in what they already knew initially just because they came in with knowledge" (Helen, interview, June 23, 2016). An example involved content related to adaptation of plants and animals. There was a discussion on water loss. One of the students talked about an experience he had with watching "Animal Planet," where the show discussed how an athlete was injured due to drinking too much water. Table 16 provides a summary of the findings related to Helen's knowledge of science curriculum.

Table 16:
Summary of Helen's Knowledge of Science Curriculum

Goals and Behaviors				
Determination of Scope and Sequence Components	**Lesson Modification**	**Covering Curriculum**	**Student Growth and Achievement**	**Teaching Practice**
Use of State Standards	Recognize Directions are Unclear	Ensure Students Have the Knowledge to be Successful	Significant Growth Within Each Content Domain	Match Lesson Objectives with State Standards
	Assignment Not Helping Student Learn	Use Real-World Experiences	Establish Criteria-For-Success	Modify Lesson in the Moment
	Use of Board Instruction	Connecting Prior Knowledge		Increase/Decrease Lesson Rigor
				Provide Lesson Packet
				Use of Diagnostic
				Growth Different for Each Student
				Remediation
				Classroom Readings
				Open Conversations

Grace's knowledge of science curriculum. Initially, Grace indicated that she determined the components of her scope and sequence by "…trial and error. Basically, when it came down to it, it was what makes sense to me. My first degree is in science, and so I understand what the students need for college. So, I’m making sure it builds in a logical manner. My scope and sequence is set on a skill base, and very much so building through it” (Grace, interview, July 30, 2015). During her exit interview, she indicated that in order to make sure students did not see something once and not again until the final exam, the determination for scope and sequence also included her content standards and “making sure they were aligned and revisited.” The approach maintained her interest in making sure the scope and sequence was “a logical process and making sure the skills they were learning built as we went through out the semester” (Grace, interview, March 25, 2016).

Lesson modifications for Grace were based upon the specific class. A class could be modified “every five minutes based on students’ participation,” according to Grace. Some classes moved through the material faster than others. A large part of the class pace was based upon how the students were responding. More examples were added or the pace was quickened to allow time to go deeper into the content. On a number of occasions, modifications were done as a “grouping thing.” Certain students worked together on a specific assignment while Grace worked with other students to help them figure something out. “As far as modifying the overall lesson, I had a game plan for the semester before it ever started. Once I learned my students and the class dynamics, I changed it by taking away labs or activities based on how students responded or interacted with each other” (Grace, interview, March 25, 2016).

There are behaviors exhibited by the teacher that can easily fit into a more than one component of PCK. This is an example of one where the behavior fits both under the component of science curriculum and in this instance also knowledge of instructional strategies. This was an instructional strategy implemented by Grace as both a means of recognizing and adapting to the difference in the students’ academic ability to master the material as well as an acknowledgment that personalities play a role in the success or failure of an assignment. The amount of time spent on student mastery depended upon the skill. “A higher priority was placed on a certain skill and certain standards that students would need after my class … knowing that the majority of the students would be taking college-level science. I would prioritize the different skills and objectives based upon that” (Grace, interview, March 25, 2016). An example, according to Grace, was writing formulas or nomenclature. “That is something they are going to need in their college-level courses … and that is something I would spend more time on.” For growth and achievement, Grace began with a pre-test to establish the baseline. There was then monitoring throughout the semester using course performance on projects, quizzes, unit tests, and classroom participation.

Success in the class was based on learning the standards in a measurable way, and using formative and summative assessments to see if students were meeting them. “Some of them are very—either you can or cannot balance an equation. But ‘can you apply the scientific method?’ is much more of a—it’s not a can or cannot, it’s much more like a rubric-based thing. I have different types of grading and make that very transparent to the students so they know what they need for a numerical form of success. So being really purposeful of grading…. Overall, I think for me knowing students as people not just as numbers is important” (Grace, interview, March 25, 2016).

To make lessons clear and accessible to all learners, the focus for Grace was on making sure that there was consistency in terms of students knowing what to expect in class structure. Certain actions were a part of each class. Each day, the board indicated the class agenda; the do-it-now was done independently; cards for tabulating zest and grit points were handed out; and class announcements were made. Grace made an effort to hit all learning types during a lesson cycle. “Really making sure that there are a lot of different choices and even if it’s within the same activity …, we’re reaching all of those different learning styles at once. Easier said than done, but that’s the goal” (Grace, interview, July 30, 2015). An example was a lesson on the five different types of chemical reactions. Students had to read a story based upon a dating relationship that incorporated the five reactions. They then had to write their own story, were given bonus points if they used illustrations as part of it, and they had to make certain that all of the different reactions were demonstrated by some action in their story.

To connect content to previous material, Grace explained to the students why they were learning that particular lesson at the beginning of every lecture. “That was the time where students would discuss with me or with other students, ok, what do we already know about this or why do we really care about this. The goal was to “explain what students already knew or trying to push their thinking for what am I going to learn” (Grace, interview, March 25, 2016). Grace emphasized this at the beginning of class with the use of Cornell notes - a strategy for note taking that is structured around recoding, questioning, reciting, reflecting, and reviewing Perna and Jones (2013). For Grace this was a means of demonstrating to students how to document important content in the course. Students were given a lesson on how to write Cornell notes at the beginning of the semester. Grace also wrote her notes on the whiteboard in the Cornell notes format style. Table 17 provides a summary of the findings related to Grace’s knowledge of science curriculum.

Table 17:
Summary of Grace's Knowledge of Science Curriculum

Goals and Behaviors				
Determination of Scope and Sequence Components	**Lesson Modification**	**Covering Curriculum**	**Student Growth and Achievement**	**Teaching Practice**
Use of Trail and Error	Based Upon a Specific Class	Prioritize Material	Use of Formative and Summative Assessments	What Makes Sense
Use of State Standards	Student's Response	Consistency in Students Knowing What to Expect With Class Structure	Knowing Students as People	Spiral Reviews
	Grouping	Connect Content to Previous Material	Use of Cornell Notes	Modify Based Upon Student's Participation
				Add More Examples
				Increase Pace of the Class
				Provide Specific Group Instruction
				Understand Student's Personalities
				Use of Class Board
				Zest and Grit Points

Knowledge of Instructional Strategies and Representations for Teaching

To understand PCK on instructional strategies and representations for teaching science, Lee et al. (2007) looked at new science teachers' science specific strategies (scientific inquiry) and representation. They used observations and interviews to determine the teacher's proficiency in levels of PCK. This research was used to develop a rubric to help gauge the level of PCK in beginning science teachers. A part of their efforts involved modifying questions to probe more deeply into the instructional decision-making of secondary science teachers. In my study, ten questions were modified in order to accomplish the same type of goal for determining the instructional strategies and representations for teaching science for Helen and Grace. The specific questions can be found in Appendix D.

Helen's knowledge of instructional strategies and representations for teaching science. To make lessons clear and accessible for all learners, Helen indicated that she liked to:

> "….incorporate a lot of tactile, both visual, hands-on, as well as guided notes information to make sure I'm hitting a lot of learning styles. So I do a lot of that. I have a hook in the beginning of the class that'll kind of bring in the outside world into what science would look like. I have notes, but my notes are guided so that students can follow along both for audio and visual learners, so they can see it. It's color-coded also on my screen" (Helen, interview, August 21, 2015).

Helen also chunked her lessons, and specific readings or questions were incorporated as checkpoints to make sure the information was clear before moving forward. Guided practices, as well as independent practices, were used to allow the students to manipulate the information in their own way to make sure the information was learned.

Imbedded into each set of student notes was a section titled check-for-understanding. This provided Helen with specific, concrete evidence of whether students understand or did not understand. The exit tickets were used for each class. An example was a lesson on cell energy where Helen discovered through a check-for-understanding that the lesson was not made clear.

In addition, students kept repeating the same questions. At that point, she stated that “I needed to stop and go back and reteach” what she thought the students had already learned.

Helen indicated that she would “never establish different learning objectives for students because my philosophy is that, regardless of the students’ learning ability, the expectation is that you are still going to have to learn the same information. How you learn it might be a little bit different and the length of time that it requires for you to get it, but I am never going to lower my expectations for you” (Helen, interview, August 21, 2015).

The method Helen used to convey specific objectives was always to post them on the board and discuss them at the beginning of class. For example, a board objective would indicate: Students will be able to explain, compare and contrast cell organelles. “If it’s going to end up being differentiated as we’re working on different assignments, the notes would ultimately be the same, but the practice is going to look a little different for some students” (Helen, interview, April 27, 2016).

Inquiry-oriented instruction was an activity that Helen indicated she really enjoyed. She tried to embed a lot of inquiry into her lessons. She felt “there is a level of thought that I believe students should engage in to be in a science class. When we talked about cancer, students had to complete a case study that required them to really dive into what they know about to help solve the problem” (Helen, interview, June 23, 2016).

To transition between lesson cycles from the day-to-day, Helen provided students with a homework assignment that led into either reviewing the concept and/or preparing for the next day. In between sessions, “…a lot of times, I’ll do like a countdown if we’re moving from one part of a lesson to the other. I’ll be like, ‘Okay you have 10, 9, 8’ whatever so students know that I’m coming back together” (Helen, interview, June 23, 2016). For unit transition, there was always a culminating conversation where the students would get feedback on individual standards in terms of how they performed. Toward the end of the year, this was posted on a master chart in the classroom.

Differentiation to demonstrate mastery of content involved students completing various projects. “It may be like a choice board almost where the student can choose a project based on what they want to do. In addition, unit tests are differentiated. So for my students who have special needs, they will have a different form of a test” (Helen, interview, June 23, 2016). Mastery was also considered 80% or greater.

To provide students the opportunity to think, speak, and write in the class, Helen stated:

> “….that even though I am a talker, I love to have student participation. So I do these things in my guided notes called think boxes where I’ll ask a question that pertains to the information and they have to go back into their notes and kind of apply it. So then they have an opportunity to turn to their partner, have a conversation about it, and then share out. During the guided practice and partner practice, they do different activities that are allowing them to write and have conversation about the information. Then we’ll come back together and share out. For example, yesterday, they did a food and macromolecule activity where they had different foods listed. The foods weren’t actually listed; they were mystery foods. There were descriptions about the food. They had to identify from the description of the foods which macromolecule it belonged to. That was with a partner. Then they had to address those and what did they notice about that” (Helen, interview, June 23, 2016).

To balance the class the time between teacher-led verses student-focused efforts, Helen indicated that “if the teacher is doing the majority of talking during the class period, the teacher is doing the learning. So, ultimately, the focus is always going to be on the students." Each class began with Helen introducing the material. The students would participate with the planned check-for-understanding; by raising questions during the presentation related to the material; or through guided or independent practice outlined in the class notes.

To move the class at a particular pace, Helen would often state that "this part of the class was going to move very quickly." She often encouraged students to attend tutorials if they felt significant material was not understood. In addition, Helen used the check-for-understanding for two purposes: 1. determine that students were learning what they needed to learn, and 2. determine that students were moving on the right track.

Timing events was another strategy Helen used in the class to balance periods of active/passive engagement. "In my first year of teaching, I did have situations where I thought it would take this amount of time, but it didn't, it took this amount of time. But I don't really have that now just because I think that I've gotten comfortable with how I structure my lessons, what I build into my lessons that I know it's going to take a certain amount of time" (Helen, interview, June 23, 2016). In each student's class notes packet were both guided and independent practices. If a student finished the guided practice early, then s/he could move on to the independent practice component of the class. There were also nightly homework assignments. Students could begin working on this if time permitted. Helen stated, "Because we were on such a time limit, most students finished most of the work on time together or at about the same pace." Table 18 provides a summary of the findings related to Helen's knowledge of instructional strategies and representations for teaching science.

Table 18:
Summary of Helen's Knowledge of Instructional Strategies and Representations for Teaching Science

Goals and Behaviors		
Science Specific Strategies	**Instructional Decision Making**	**Teaching Practice**
Incorporate Tactile, visual and Hands-On Activities	Chunked Lessons	Provided Packet of Class Notes
Guided Notes	Use of Checkpoints	Bring In Outside World Examples
Beginning Class With an Instructional Hook	Guided Practice	Complete Case Studies
Color Code Notes During Lecture	Independent Practice	Differentiate Work Assignments
Use of Countdown	Same Learning Objectives for All Students	Homework Involved Either Review or Preparation for Next Class
Culminating Conversation	Post Objectives	Individual Feedback
Remediation	Inquiry-Oriented Instruction	Online Grading
	Criteria for Content Mastery	State Class Will Move Quickly
	Teacher Lead and Student Focused	Provide Tutorials

Grace's knowledge of instructional strategies and representations for teaching science. Grace's approach to ensuring that science content was understood by the students revolved around formative and summative data that she obtained daily. Projects, labs, exit tickets, and unit assessments were used to determine understanding. There also were teacher observations of the class, "just overall observation - keeping those mental notes. You get to know your students" (Grace, interview, March 25, 2016).

This process began by modifying a lesson based upon student participation. If everyone understood the concept, then Grace moved on with the class. However, Grace was new to the concept of using student data. She came from a system that collected data, but did not do much with it. "So student data is a big push with KIPP, which is something that will be new for me. I think actually being able to use that data—okay there are 20% of students who didn't master this objective, let's get them in for extra time, and let's see where those holes came in" (Grace, interview, July 30, 2015).

To establish different learning objectives for the students, Grace was consistent in breaking the big standards into skills she knew they needed to have before she felt they could truly understand the standard. There was also an effort on her part to make sure the objectives were measurable and the right content. It often involved taking what the state required and breaking that into manageable chunks for the students.

To convey specific objectives, Grace's strategy involved implementing various strategies while keeping the same structure - for example, always taking notes the same way, providing a demonstration during labs, and giving students a few different ways to practice the same content. "It goes back to what exactly do they have to do. Is it terminology? Is it applying it to an experiment? Is it figuring something out? I try to bring in a lot of different methods based on what they're actually going to have to do" (Grace, interview, July 30, 2015).

Inquiry-oriented instruction was used as much as possible because Grace felt "that is what science is. Once you leave school, if you're in a realm of science, you're going to have to use inquiry regardless of what your profession is" (Grace, interview, July 30, 2015). Inquiry was used primarily with the labs that centered on certain objectives. An example involved factors that affect reaction times. It was not talked about initially. Students did a lab and talked about the data in order to figure out what impacted the rate of the reaction. "It worked out well for the majority of the students. There was a little bit of misconception in how decreasing the time for the reaction to go to completion may mean you have a faster rate. This enabled the lecture to go much quicker because the students had a good concept of this content when we discussed it" (Grace, interview, March 25, 2016).

To transition between lesson cycles, Grace first relied on students' prior knowledge to make certain they understood the relationship between old and new information. She also depended on:

> "… the consistency that I have in the classroom. I'm very much so a planner and things need to make sense in my head so I can actually teach them well. If it's for a single day, making sure the students are aware upfront, 'Okay, we're going to do this for the first half and then we're going to switch gears and do this.' And if it's day-to-day, again making sure that any data I'm collecting is consistent with how it flows or if it's broken, and making sure my activities are aligned" (Grace, interview, March 25, 2016).

To ensure students have the opportunity to think, speak, and write, Grace's approach was to make certain that Cornell notes were implemented in class. This enabled students to write down why the objective of the day was important, as well as summarize it at the end and we would always share those summaries. Students would discuss what they learned that day and what they found interesting. Grace also had students write stories or create books as part of projects. Something that Grace admits she had to practice was:

> "…making sure they have a good bit of thinking time. Saying 'think about this' for thirty seconds and giving them the space to write it, if they want, giving them a space. Some kids just like to think and everyone's different. Giving them the time to do those things is the first part. And really bringing in through textual understanding or when we're discussing things letting them talk and write and things like that. And then not just letting them do it, but holding them accountable is big. Even if it's just me circulating and listening in, or calling them to share, or having them writing it in their notes, maybe do a note check later. Definitely having them work and talk together is something that's really big for me" (Grace, interview, March 25, 2016).

To balance teacher-led verses independent thinking, initially Grace felt that she wanted to "do as much inquiry as I can. Kind of let them figure out the chain of reaction of events. But a lot of the time, when it's like foreign skills, those are the days that I have to do a good bit of introduction to new material. But after that, it's more or less who needs more help from me, who needs less help from me" (Grace, interview, March 25, 2016).

She acknowledged that there was not a good balance of teacher-led and independent practice throughout the year. "I did a lot of teacher-led instruction, which, in reflection, was not the best for students, but that is just how I felt I needed to be. I would allow students who were advanced to do small groups or come up in front of the class to solve different problems or teach different things" (Grace, interview, March 25, 2016). This was observed when solving problems associated with the do-it-now or challenging problems in the class. Students would often present different ways of explaining how to solve various problems in class.

To move the class at the expected pace, Grace often used a video timer that students could observe while completing the assignment. Often during the do-it-now, music was played or, if students had independent work to complete, they could listen to their headphones until the class was called back together. Lessons were broken down into manageable time pieces.

To balance periods of active/passive engagement, Grace indicated that she often involved students in active engagement by having them up and moving or doing something with one another. She also stated:

> "I always have something up my sleeve in case that happens. I have check box videos, or we would discuss current events related to what we were learning, or read an article. I always have something else they can do, especially in the form of reading or writing, or something in the form of remediation for students who need it" (Grace, interview, March 25, 2016). Table 19 provides a summary of the findings related to Grace's knowledge of instructional strategies and representations for teaching science.

Table 19:
Summary of Grace's Knowledge of Instructional Strategies and Representations for Teaching Science

Goals and Behaviors		
Science Specific Strategies	**Instructional Decision Making**	**Teaching Practice**
Daily Use of Formative and Summative Assessments	Lesson Modification Based on Student's Participation	Projects, Labs, Exit Tickets, and Unit Assessments
Provide Extra Time Based off Student Data	Use of Student Data	Use of Cornell Notes
Always Taking Notes the Same Way	Breaking Down Standards	Provided a Demonstratio n Prior to Completing a Lab
Problem Based Learning	Inquiry-Oriented Instruction	Write Stories
Use of Student Prior Knowledge		Think for Thirty Seconds
Provide Thinking Time		Group Assignments
Video Timer		Students Solve Problems in Front of Class
Play Music		Movement

Knowledge of Assessment of Science Learning

I have used the definition by Park & Oliver (2008) as a means of defining the PCK component knowledge of assessment: it is comprised of knowledge of the dimensions of science learning important to assess, and knowledge of the methods by which that learning can be assessed. In addition, Magnusson et al. (1999) indicated that teachers' knowledge of methods of assessment includes knowledge of specific instruments, approaches, or activities that can be used during a particular unit of study to assess important dimensions of science learning. These ideals were used to gain an understanding of the participant's knowledge of assessment and are also detailed in Appendix D**.**

Helen's knowledge of assessment of science learning. Helen stated that her ability to break goals into components where students' accomplishments can be effectively assessed and facilitated is established through her prior knowledge and experience. She has been able to identify where there are specific gaps in the structure and content, or where students have struggled.

> "So with enzymes, for example, if I'm teaching a lesson, I'm going to stop the lesson at individual parts before I transition. If I'm talking about the structure, I might stop it after a couple of slides of structure to have a think box where they're going to have to answer questions and go back to their notes about that particular structure to address that, and then I'll move on to the function. So that way I can address—it's chunked in the lesson in that it's broken up so I can see if the break down was with structure, if the break down was with function, or if the break down was with application" (Helen, interview, June 23, 2016).

In addition, she had students set their own goals at the beginning of the semester so that they could always reference back to them and see what they were pushing themselves toward. In her exit interview, the focus stayed on the 80% mastery. Helen talked about it every time there was a quiz or a test in the class.

Students were responsible for monitoring their own progress in the class by using an individual tracker. They would get a printout at the end of each unit test that indicated their mastery of a particular content standard. This was a template kept in their binder and, in the second semester, it was posted in the classroom. There also was ranked seating. Students who scored higher on the unit exam were able to sit farther away from the teacher in the classroom.

Formative assessments in the class involved the daily exit ticket, as well as the big unit tests. With summative assessments, Helen stated, “I like to do a lot of project-based learning so, that way, the students can showcase their knowledge through different means, as well.” This often involved a white paper assignment that students had to complete at the end of the unit to demonstrate mastery. There was a wide range of options for students to use in completion of this effort. Projects included picture books, posters, raps, songs, student-generated review guides, and student-generated tests.

Helen indicated that diagnostics were useful in determining students’ prior knowledge. They were administered at the beginning of the year and played a big role in guiding her instructional practices. “…With formative and summative assessments, if everybody failed it, then I end up having to go back. But they also give me a holistic view of what each individual student already knows” (Helen, interview, June 23, 2016).

To make sure that material was appropriately spiraled, Helen indicated that she first looked at the foundational skills and then the advanced placement (AP) skills that the students needed to know. She would then include both AP skills, as well as American College Testing material throughout the year. She stated, “I plan with the end in mind. So when I’m building the assessment, I use the rigor scale to make sure I’m going all the way from basic-recall questions all the way to analysis questions” (Helen, interview, August 21, 2015). An example would be charts and graphs that were a part of the work students completed related to determining enzyme activity. Students would have to interpret the data from the graph to determine the effect of a catalyst.

To accommodate special needs in students, various approaches were taken. There was a dyslexic student in one class who was provided a computer with his own PowerPoint slides related to the class content so that he could work at his own pace. In addition, questions were read to him, which allowed him to verbalize the answer if he needed to. For other students with special needs, key words were highlighted or underlined, small group instruction was given to certain students, or exams had fewer questions or fewer answer choices. In some classes, a teaching assistant helped out with students who had a specific development plan.

Assessment data always focused on performance on the Georgia Milestones Assessment. Throughout the school year, benchmark data was used to prepare for the exam. Students who did not score well on one of the standards during benchmark testing focused on that standard during the review process for the Georgia Milestone Assessment. One of the challenges for Helen involved students who did not come to tutorial. She started providing food, and participation attendance rates increased. She also started making it mandatory for certain students whose performance required it. Helen did not have much time for remediation in class due to the course being taught on the block system. This meant that one year’s worth of course content was taught in one semester. This made the use of benchmark testing results all the more critical in order to focus remediation on where it was needed.

The conveying of the criteria for success involved using a qualifier page that was associated with each unit. This showed students what was needed to master content prior to taking the unit exam. In addition, students knew that mastery on any assessment meant 80% or higher score. Less than this often required retesting, tutorial, or re-teaching.

Initially, Helen’s strategy to ensure that student work was graded and promptly returned was to “stay here until endless hours of the day until it’s done” (Helen, interview, June 23, 2016). In her exit interview, a more sophisticated strategy involved using an online program to scan and grade students' exit tickets and quizzes immediately. This provided immediate feedback to both Helen and the students. Students were then required to write down the questions that were marked incorrect and were responsible for making the corrections. For a quiz and exit ticket, they did not get points back. For a unit test, they had to identify the incorrect answer, why they got the question incorrect, find the correct answer, and then explain why the correct answer was correct – in order to get points back. Table 20 provides a summary of the findings related to Helen’s knowledge of assessment of science learning.

Table 20:
Summary of Helen's Knowledge of Assessment of Science Learning

Goals and Behaviors		
Dimensions of Science Learning Important to Assess	**Methods**	**Teaching Practice**
Georgia State Standards	Use Teacher Pryor Knowledge to Break Down Goals	Stop Lesson to Debrief Before Transition
	Determine if Breakdown was a Function, Structure, or Application	Students Monitor Own Progress
	Students Set Own Goals	Do-It-Now
	Formative Assessments	Exit Tickets
	Project Based Teams	White Paper Assignments
	Diagnostics	Released State Exams
	Spiral Content	Use AP & ACT Skills
	Plan With-End In-Mind	Charts and Graphs to Interpret Data
	Standards Based Tutorial	Mandatory Tutorial Based on Performance
	Establish Criteria for Success	Use Online Grading
		For Unit Tests Identify Correct Answer, Why Incorrect, Find and Explain Correct Answer

Grace’s knowledge of assessment of science learning. For Grace, backwards planning also was used to break goals into components where students' accomplishments could be effectively assessed. The process started with the State Standards and moved to backwards planning. “So, this involved making the final exam first, and then breaking it into these units that make the most sense content-wise” (Grace, interview, March 25, 2016). It also involved knowledge of where she knew students found information “fairly easy or difficult.” In addition, it was based upon student observation. This was a day-to-day effort where Grace made a determination on whether the class was moving too slow or too fast.

To track the students’ progress, Grace initially relied on observation: “Just keeping those mental notes. You learn your students. Most of it would come from those formative assessments that we’re doing every day” (Grace, interview, March 25, 2016). She also kept a data wall, as well as a clip board that kept a log of daily data for students. These contained attendance, overall participation, and daily homework, as well as exit ticket scores. This information was easily transmitted and maintained on an Excel sheet to give a snapshot on where the class was overall.

Formative assessments included the do-it-now and the exit tickets that allowed Grace to quickly gauge where the students were for that day or the previous day. For summative assessments, there were quizzes covering one or two objectives. An exam at the end of each unit also covered anywhere between eight to 12 objectives. They also served the purpose of determining which students needed to come in for remediation, as well as identifying who was ready for an extension project.

Diagnostics were initially viewed from the perspective of students who had to take the American College Test (ACT). "The ACT is going to be spiraled into a lot of what we’re doing in class. Using those ACT benchmarks not only to invest the kids in their education, but also saying where do I need to put more of this into my everyday lesson," Grace remarked. She felt that benchmark data for diagnostics related to the course was not that reliable.

> "I do not think they have a huge role simply because the diagnostic used was very similar to what they would be taking at the final exam. And, as a student, when you have that much information put in front of you that you don't know you tend to give up. So it is not that creditable data. I think it could have been done better. For the diagnostic that was used, that data did not really show that much throughout the course" (Grace, interview, March 25, 2016).

To ensure that assessments were appropriately spiraled, Grace indicated initially this involved mapping to determine the depth of the students' knowledge that is required with the tests. She stated her plan was to work with her department chair to make "sure that I'm not too low, not too high, and being really open and ready for that sort of critique and help." Prior to the first exam, students had shown that they knew the data. After taking the exam, they did a lot worse than she thought they were going to do. The department chair walked her through how to rearrange the questions to increase student performance overall so that the objectives were grouped together. If there were multiple questions on an objective, the class started on a lower level of Blooms Taxonomy and then gradually increased in difficulty as students went through the questions.

Students with special needs were accommodated with the differentiation that she implemented in the class. A part of this was teaching to different learning styles. Certain students were given more individual attention in class. In one class, there was a co-teacher who assisted with students who needed additional help. She also followed the individual plan that a student may have had in his or her file.

Assessment data in terms of quizzes was used to see where students were on learning material. They indicated by student performance if there was a need for re-teaching. Helen used the data to determine if re-teaching was needed for the entire class or could it be isolated to particular students. “The assessment data will be building towards that end goal and making sure that, as my assessments go, they’re not only focusing on this unit, but they’re cumulative like the end assessment will be” (Grace, interview, July 30, 2015). Criteria for success involved “just really being open, posting it, and talking about it. Showing students their data and making it visible. Making sure they understand, ‘If I didn’t master this, I need to come in until I do master it. Because if I can’t get this, I’m not going to be able to get the next goal” (Grace, interview, March 25, 2016). The class had posters around the room that indicated stellar scientists, student data spot, performance, and student work.

To ensure that students’ work was promptly graded and returned, Grace stated:

> “One of my biggest pet peeves when I was in school was waiting three weeks to get back an assignment. Because I know it bothers me, I’m really big on getting things graded and back in a very timely manner, like two or three days tops. And that’s not always feasible. Students need to know. They’re worried about it. They’re going to consistently ask you about it. I’m going to do my part. And not being afraid to ask for help where it can be taken” (Grace, interview, July 30, 2015).

Strategies implemented involved formative assignments that were spread out enough in the scope and sequence so that there was enough time to grade the work. Students graded each other’s work. Grace also implemented a strategy of simply asking students where are you and where do you stand on content. Online grading also was used for multiple-choice assessments.

Table 21 provides a summary of the findings related to Grace's knowledge of assessment of science learning.

Table 21:
Summary of Grace's Knowledge of Assessment of Science Learning

Goals and Behaviors		
Dimensions of Science Learning Important to Assess	**Methods**	**Teaching Practice**
Georgia State Standards	Backwards Planning	Make Final Exam First
	Use of Teacher Prior Knowledge on Where Students Struggled	Use of Student Data Wall
	Student Observation	Use of Clip Board to Monitor Daily Homework, Class Participation, and Exit Ticket Scores
	Formative Assessments	Do-It-Now and Exit Tickets
	Diagnostics	Unit Exams
	Spiraling Lessons	Use Different Learning Styles
	Differentiation	Individual Attention
		Tutorial
		Asking Students Where They Stand on Content

Teaching Cycle of the KFET

As previously stated, teachers, especially experienced ones, often have developed some level of PCK. As a corollary, the tenets of the teaching cycle are comprised of competencies and observable behaviors that *all* KIPP teachers are expected to display in their classroom practices. KIPP defines the teaching cycle as:

> Excellent teaching means planning and executing rigorous, engaging lessons that fit into logical scope and sequence, as well as using student data to assess mastery of objectives and movements toward big goals for student achievement and growth (KIPP p.29, 2015).

How this is accomplished is not provided within the document. That is the role of teachers to demonstrate. Their success at this task is then evaluated and judged across a spectrum of tiers – from developing teacher to master teacher. There are also benchmarks that must be met for each tier. Where they may falter, assistance and guidance are provided. There are three competencies associated with the teaching cycle for the KFET and 13 specific observable behaviors. The evaluation involves the teacher completing a self-evaluation and the department chair completing the official evaluation. For this study, I also completed evaluations for each participant. The KFET identifies what method of data collection should be used to base the ranking upon. The department chair and I based our evaluations upon observations, lesson plans, unit plans, student work, and O3s. A KIPP O3 is a one-on-one meeting that coaches have with their direct reports. They check in on agenda items the teacher has, agenda items the coach has, and progress towards short- and long-term goals.

Appendix F indicates the results from the rankings associated with the teaching cycle of the KFET evaluations by the participants, the science department chair, and me. The participants completed two self-evaluations: a mid-year and an end-of-year. Since Grace left the study mid-year, she did not complete an end-of-year self-evaluation. It should be noted, however, that the mid-year evaluation for Grace was completed after she taught the entire content for the course due to the school operating on a block schedule. With the block schedule, an entire years' worth of material is covered in one semester.

The science department chair and I completed three separate teaching cycles of the KFET evaluations: a formative (or initial evaluation), a mid-year, and an end-of-year. Each of the 13 observable behaviors of the teaching cycle of the KFET was ranked based on a tiered scale of 1-5. The final rating is calculated by averaging all of the tiered behavioral rankings. Table 22 summarizes the average ranking for each evaluation.

Table 22:
Evaluation Ranking of Participants

Helen

Formative Assessment 1

	SDC	Hampton
	2.8	3.0

Mid-Year Assessment 1

Helen	SDC	Hampton
2.8	2.7	3.0

End-of-Year Assessment 1

Helen	SDC	Hampton
3.5	3.2	3.6

Grace

Formative Assessment 1

	SDC	Hampton
	3.2	3.1

Mid-Year Assessment 1

Grace	SDC	Hampton
2.9	3.2	3.5

Each participant's evaluation is based on the teaching cycle of the KFET. The participants based their ranking on their own determination of how they felt they met the criteria for the behavior associated with the particular element of the teaching cycle component of the KFET. The ranking by the science department chair and myself is based on an amalgam of perspectives gained through observations of the classes, interviews, field notes, and classroom artifacts. I sought out the participants or the science department chair for a deeper perspective wherever there were significant differences in the evaluation. Since Grace left the study after one semester, her evaluation is based upon her formative and a mid-year evaluation by both the science department chair and me.

Classroom Observation Tool

The enumerative approach espoused by LeCompte & Preissle (1993) indicated how field-note data is coded into operationally defined categories, and frequency counts are made of phenomena in the different categories. For the purpose of this study, the operationally defined categories are the components of PCK. I used my field notes and artifacts taken during the 30 observations to enumerate the number of instances of PCK observed. In addition, the audio recordings of the observations were used to enumerate the number of instances in certain categories – for examples similes and metaphors. I used the classroom observation tool (Appendix C) to collect the data. Data from early in the semester and late in the semester of class for each participant is presented in Table 23.

Table 23:
Enumeration of Instances of PCK

Teacher		Components of PCK				
		OTS	KSU	KSC	KIS	KA
Grace	Early	2	2	2	24	8
	Late	2	20	7	51	17
Helen	Early	2	12	1	16	4
	Late	3	23	9	97	35

The main focus of this study involved using the triangulation approach to document the participant's implementation of the teaching cycle of the KFET and then comparing the data obtained to the components of PCK. I have previously (tables 12-21) documented how behaviors observed in the class relate to the components of PCK. The next step in this process is to relate those behaviors to the teaching cycle of the KFET. This is part of the same data the science department chair gathered to determine the ranking of each participant related to the elements of the KFET. The exception is that I was only looking for observable behaviors related to the teaching cycle and the science department was looking for observable behaviors related to all five elements of the KFET. The three competencies – Plan, Teach, and Get Better So More Kids Learn - of the teaching cycle of the KFET are further subdivided into thirteen observable behaviors. For each of the competencies I have created a table that lists the data that was obtained during this study. Table 24 provides a directory of the tables, what KFET competency is included, and a brief description of the competency. What these tables document is the substantial linkage between each of the participant's implementation of the teaching cycle of the KFET and the relationship between the components of PCK. What they cannot demonstrate is how this relationship changed over time. For this my filed notes as well as the use of an observation tool were used to document this process.

Table 24:
Index of Tables Relating the teaching cycle of the KFET to PCK

Table #	KFET Competency	Description
25	Plan 4.1A	End In Mind
26	Plan 4.1B	Smart Aim
27	Plan 4.1C	The "What" Matching the "How"
28	Plan 4.1D	Literacy for Everyone: Vocabulary
29	Plan 4.1E	Literacy for Everyone
30 & 31	Plan 4.1F	Differentiation
32 & 33	Teach 4.2A	Clarity
34	Teach 4.2B	Questioning
35	Teach 4.2C	Rigor
36 & 37	Teach 4.2D	Urgent Patience
38 & 39	Access and Adjust so More Kids Learn 4.3A	Access
40 & 41	Access and Adjust so More Kids Learn 4.3B	Check for Understanding
42	Access and Adjust so More Kids Learn 4.3C	Track and Analyze Data

Table 25:

KFET Teaching Cycle Competency Plan: End In Mind (4.1A)

Component of KFET	Component of PCK									
	Orientation to Teaching Science		Knowledge of Student Understanding		Knowledge of Instructional Strategies and Representations for Teaching Science		Knowledge of Science Curriculum		Knowledge of Assessment of Science Learning	
Plan	Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace
4.1A End In Mind: Consistently uses the regional or school curriculum resources OR a teacher-created scope and sequence to plan logical units with objectives.	Project based learning Modify lessons Break final exam down into units	Breaking goal into smaller pieces Backward design plan Creating final exam first	Do-It-Now Use of student tracker and performance on standards bases assessments	Teacher created Scope and sequence	Incorporate tactile, visual and hands-on activities Guided notes Beginning class with an instructional hook Culminating conversation Remediation Chunked lessons Use of checkpoints Guided practice Independent practice Same learning objectives for all students Post objectives Inquiry-oriented instruction Criteria for content mastery Teacher lead and student focused Provided packet of class notes Complete case studies Differentiate work assignments Homework involved either review or preparation for next class Individual feedback Provide tutorials	Daily use of formative and summative assessments Always taking notes the same way Problem based learning Use of student prior knowledge Lesson modification based on student's participation Use of student data Breaking down standards Inquiry-oriented instruction Projects, Labs, exit tickets, and unit assessments Provided a demonstration prior to completing a lab Think for thirty seconds Group assignments Students solve problems in front of class	Use of state standards Use of board instruction Ensure students have the knowledge to be successful Use real-world experiences Connecting prior knowledge Significant growth within each content domain Establish criteria-for-success Match lesson objectives with state standards Modify lesson in the moment Increase/decrease lesson rigor Provide Lesson packet Use of diagnostic Growth different for each student Remediation Classroom readings	Use of state standards Teacher created scope and sequence Based upon a specific class Student's response Grouping Prioritize material Consistency in students knowing what to expect with class structure Connect content to previous material Use of formative and summative assessments Spiral reviews Modify based Upon student's participation Add more examples Provide specific group instruction Use of class board	Georgia State Standards Use teacher pryor knowledge to break down goals Determine if breakdown was a function, structure, or application Formative assessments Project based teams Diagnostics Spiral content Plan with-end in-mind Standards based tutorial Do-It-Now Exit Tickets White paper assignments Released state exams Charts and graphs to interpret data For unit tests identify correct answer, why incorrect, find and explain correct answer	Georgia State Standards Backwards planning Use of teacher prior knowledge on where students struggled Formative assessments Diagnostics Spiraling lessons Differentiation Make final exam first Unit exams Individual attention

Table 26:
KFET Teaching Cycle Competency Plan: Smart Aim (4.1B)

Component of KFET		**Component of PCK**									
		Orientation to Teaching Science		**Knowledge of Student Understanding**		**Knowledge of Instructional Strategies and Representations for Teaching Science**		**Knowledge of Science Curriculum**		**Knowledge of Assessment of Science Learning**	
Plan		Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace
	4.1B Smart Aim: Aims are achievable, rigorous, and measur-able 76-85% of the time; they include what students need to know and should be able to do.	Cognizant that science is a foreign language Scaffold assessments	Formative /summative assessments	Do-It-Now Levels of problem solving Grouping of students based on ability	Incorporate tactile, visual and hands-On activities Guided notes Beginning class with an instructional hook Culminating conversation Remediation Chunked lessons Use of checkpoints Guided practice I ndependent practice Same learning objectives for all students Post objectives Inquiry-oriented instruction Criteria for content mastery Teacher lead and student focused Provided packet of class notes Complete case studies Differentiate work assignments Homework involved either	Daily use of formative and summative assessments Provide extra time based off student data Always taking notes the same way Problem based learning Use of student prior knowledge Lesson modification based on student's participation Lesson modification based on student's knowledge Use of student data Breaking down standards Inquiry-oriented instruction Projects, Labs, exit tickets, and unit assessments Provided a demonstration prior to completing a lab Write stories Think for thirty seconds Group assignments Students solve problems in front of class	Use of state standards Recognize directions are unclear Assignment not helping student learn Use of board instruction Ensure students have the knowledge to be successful Use real-world experiences Connecting prior knowledge Match lesson objectives with state standards Modify lesson in the moment Increase/decrease lesson rigor Provide Lesson packet Use of diagnostic Growth different for each student Remediation Classroom readings	Use of state standards Student's response Grouping Prioritize material Consistency in students knowing what to expect with class structure Connect content to previous material Use of formative and summative assessments Spiral reviews Modify based Upon student's participation Add more examples Provide specific group instruction Zest and grit points	Georgia State Standards Use teacher pryor knowledge to break down goals Determine if breakdown was a function, structure, or application Formative assessments Project based teams Diagnostics Spiral content Plan with-end in-mind Standards based tutorial Establish criteria-for-success Do-It-Now Exit Tickets White paper assignments Released state exams Charts and graphs to interpret data Mandatory tutorial based on performance For unit tests identify correct answer, why incorrect, find and explain correct answer	Georgia State Standards Backwards planning Use of teacher prior knowledge on where students struggled Formative assessments Diagnostics Spiraling lessons Differentiation Make final exam first Use of student data wall Do-It-Now and Exit Tickets Unit exams Use different learning styles Individual attention	

Table 27:

KFET Teaching Cycle Competency Plan: The "What" Matching the "How" (4.1C)

Component of KFET		**Component of PCK**									
		Orientation to Teaching Science		**Knowledge of Student Understanding**		**Knowledge of Instructional Strategies and Representations for Teaching Science**		**Knowledge of Science Curriculum**		**Knowledge of Assessment of Science Learning**	
Plan		Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace
	4.1C The "What" Matching the "How": The key points and exit ticket or CFS are aligned to content and cognition of the aim.	Start with the end in mind Exit tickets; Do-Now daily Check for Understanding	Do-It-Now every day	Use of diagnostics Modified assignments Exit Ticket		Incorporate tactile, visual and hands-On activities Guided notes Beginning class with an instructional hook Color code notes during lecture Culminating conversation Remediation Chunked lessons Use of checkpoints Guided practice I ndependent practice Same learning objectives for all students Post objectives Inquiry-oriented instruction Criteria for content mastery Teacher lead and student focused Provided packet of class notes Bring In outside world examples Complete case studies Differentiate work assignments Homework involved either review or preparation for next class Individual feedback Provide tutorials	Daily use of formative and summative assessments Provide extra time based off student data Always taking notes the same way Problem based learning Use of student prior knowledge Use of student data Breaking down standards Inquiry-oriented instruction Projects, Labs, exit tickets, and unit assessments Write stories Think for thirty seconds Group assignments Students solve problems in front of class	Use of state standards Recognize directions are unclear Assignment not helping student learn Use of board instruction Ensure students have the knowledge to be successful Ensure students have the knowledge to be successful Use real-world experiences Connecting prior knowledge Significant growth within each content domain Establish criteria-for-success Match lesson objectives with state standards Modify lesson in the moment Provide Lesson packet Use of diagnostic Growth different for each student Remediation	Use of trail and error Use of state standards Based upon a specific class Student's response Grouping Prioritize material Consistency in students knowing what to expect with class structure Connect content to previous material Use of formative and summative assessments Modify based Upon student's participation Add more examples Provide specific group instruction Use of class board Zest and grit points	Georgia State Standards Use teacher pryor knowledge to break down goals Determine if breakdown was a function, structure, or application Formative assessments Project based teams Diagnostics Spiral content Standards based tutorial Do-It-Now Exit Tickets White paper assignments Released state exams Charts and graphs to interpret data Mandatory tutorial based on performance For unit tests identify correct answer, why incorrect, find and explain correct answer	Georgia State Standards Backwards planning Use of teacher prior knowledge on where students struggled Student observation Formative assessments Diagnostics Spiraling lessons Differentiation Make final exam first Use of student data wall Use of clip board to monitor daily homework, class participation, and exit ticket scores Do-It-Now and Exit Tickets Unit exams Use different learning styles Tutorial Asking students where they stand on content

Table 28:

KFET Teaching Cycle Competency Plan: Literacy For Everyone: Vocabulary (4.1D)

Component of KFET		**Component of PCK**									
		Orientation to Teaching Science		**Knowledge of Student Understanding**		**Knowledge of Instructional Strategies and Representations for Teaching Science**		**Knowledge of Science Curriculum**		**Knowledge of Assessment of Science Learning**	
Plan		Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace
	4.1D Literacy For Everyone: Vocabulary Models, teaches, and holds students accountable for learning and using age-appropriate and subject-specific vocabulary.			Students create their own content for review		Guided notes Beginning class with an instructional hook Color code notes during lecture Culminating conversation Remediation Chunked lessons Use of checkpoints Guided practice I ndependent practice Same learning objectives for all students Post objectives Inquiry-oriented instruction Criteria for content mastery Teacher lead and student focused Provided packet of class notes Complete case studies Differentiate work assignments Homework involved either review or preparation for next class Individual feedback Provide tutorials	Daily use of formative and summative assessments the same way Problem based learning Use of student prior knowledge Use of student data Inquiry-oriented instruction Projects, Labs, exit tickets, and unit assessments Provided a demonstration prior to completing a lab Write stories Group assignments Students solve problems in front of class	Use of state standards Recognize directions are unclear Assignment not helping student learn Use of board instruction Ensure students have the knowledge to be successful Use real-world experiences Use real-world experiences Connecting prior knowledge Significant growth within each content domain Establish criteria-for-success Match lesson objectives with state standards Modify lesson in the moment Increase/decrease lesson rigor Provide Lesson packet Use of diagnostic Growth different for each student Remediation Classroom readings	Use of state standards Based upon a specific class Student's response Grouping Prioritize material Connect content to previous material Use of formative and summative assessments Spiral reviews Modify based Upon student's participation Add more examples Provide specific group instruction Use of class board	Georgia State Standards Use teacher pryor knowledge to break down goals Formative assessments Project based teams Diagnostics Spiral content Plan with-end in-mind Standards based tutorial Establish criteria-for-success Students monitor own progress Do-It-Now Exit Tickets White paper assignments Charts and graphs to interpret data Mandatory tutorial based on performance For unit tests identify correct answer, why incorrect, find and explain correct answer	Georgia State Standards Backwards planning Use of teacher prior knowledge on where students struggled Student observation Formative assessments Diagnostics Spiraling lessons Differentiation Do-It-Now and Exit Tickets Use different learning styles Individual attention

Table 29:
KFET Teaching Cycle Competency Plan: Literacy For Everyone (4.1E)

Component of KFET		**Component of PCK**									
		Orientation to Teaching Science		**Knowledge of Student Understanding**		**Knowledge of Instructional Strategies and Representations for Teaching Science**		**Knowledge of Science Curriculum**		**Knowledge of Assessment of Science Learning**	
Plan		Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace
	4.1E Literacy for Everyone : When looking at the unit plan and lesson plans, written and oral responses regularly (51-75%) require students to draw evidence or information from the text to support analysis, reflection, and/or research.		Cornell Notes	Use of student tracker and performance on standards bases assessments		Guided notes Beginning class with an instructional hook Culminating conversation Remediation Chunked lessons Use of checkpoints Guided practice I ndependent practice Same learning objectives for all students Post objectives Inquiry-oriented instruction Criteria for content mastery Teacher lead and student focused Provided packet of class notes Bring In outside world examples Complete case studies Complete case studies Differentiate work assignments Homework involved eitherreview or preparation for next class Individual feedback Provide tutorials	Daily use of formative and summative assessments Provide extra time based off student data Always taking notes the same way Problem based learning Use of student prior knowledge Lesson modification based on student's participation Use of student data Breaking down standards Inquiry-oriented instruction Projects, Labs, exit tickets, and unit assessments Provided a demonstration prior to completing a lab Think for thirty seconds Group assignments Students solve problems in front of class	Use of state standards Recognize directions are unclear Assignment not helping student learn Use of board instruction Ensure students have the knowledge to be successful Connecting prior knowledge Match lesson objectives with state standards Modify lesson in the moment Increase/decrease lesson rigor Provide Lesson packet Use of diagnostic Growth different for each student Remediation Classroom readings	Use of state standards Based upon a specific class Student's response Prioritize material Connect content to previous material Use of formative and summative assessments What makes sense Spiral reviews Modify based Upon student's participation	Georgia State Standards Use teacher pryor knowledge to break down goals Determine if breakdown was a function, structure, or application Formative assessments Diagnostics Spiral content Plan with-end in-mind Standards based tutorial Establish criteria-for-success Do-It-Now Exit Tickets White paper assignments Mandatory tutorial based on performance For unit tests identify correct answer, why incorrect, find and explain correct answer	Georgia State Standards Backwards planning Use of teacher prior knowledge on where students struggled Student observation Formative assessments Diagnostics Spiraling lessons Differentiation Do-It-Now and Exit Tickets Unit exams Use different learning styles Individual attention

Table 30:
KFET Teaching Cycle Competency Plan: Differentiation (4.1F)

Component of KFET	**Component of PCK**									
	Orientation to Teaching Science		**Knowledge of Student Understanding**		**Knowledge of Instructional Strategies and Representations for Teaching Science**		**Knowledge of Science Curriculum**		**Knowledge of Assessment of Science Learning**	
Plan	Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace
4.1F Differentiation: Designs plans and accountability systems to initiate various forms of structured differentiation (e.g. teacher rotating among established student groupings).	Differentiate assessment Incorporate real life examples into lessons Different forms of test Different criteria for project completion	Work with different learning styles Differentiate Guided Practice Allow Drawing Movement around Class Use of Music	Use of Student data Use of previous teaching experience Tutorial Used practice Georgia Milestone Assessment at the beginning of the year and prior to taking the exam Use of lock & key system to explain enzymes Use of songs and videos White Paper assignmen Understanding student's misconception	Understanding student's misconceptions Different student instructions Use of Lab Work Stations Adapt instruction to various learning styles Reminded students of what they had already learned Higher level students provided fewer instructions Students hear, write and manipulate	Incorporate tactile, visual and hands-On activities Guided notes Beginning class with an instructional hook Color code notes during lecture Culminating conversation Remediation Chunked lessons Use of checkpoints Guided practice I ndependent practice Inquiry-oriented instruction Criteria for content mastery Teacher lead and student focused Provided packet of class notes Bring In outside world examples Complete case studies Differentiate work assignments	Daily use of formative and summative assessments Provide extra time based off student data Always taking notes the same way Problem based learning Use of student prior knowledge Video timer Play Music Use of student data Breaking down standards Inquiry-oriented instruction Projects, Labs, exit tickets, and unit assessments Use of Cornell Notes Provided a demonstration prior to completing a lab Write stories Think for thirty seconds	Use of state standards Recognize directions are unclear Use of board instruction Ensure students have the knowledge to be successful Use real-world experiences Connecting prior knowledge Match lesson objectives with state standards Modify lesson in the moment Increase/decrease lesson rigor Provide Lesson packet Use of diagnostic Growth different for each student Remediation Classroom readings	Use of trail and error Use of state standards Based upon a specific class Student's response Prioritize material Consistency in students knowing what to expect with class structure Connect content to previous material Use of formative and summative assessments What makes sense Spiral reviews Modify based Upon student's participation Add more examples Increase pace of the class Provide specific group instruction Use of class board Zest and grit points	Georgia State Standards Use teacher pryor knowledge to break down goals Determine if breakdown was a function, structure, or application Students set own goals Formative assessments Diagnostics Spiral content Plan with-end in-mind Standards based tutorial Establish criteria-for-success Stop lesson to debrief before transition Students monitor own progress Do-It-Now Exit Tickets White paper assignments Released state exams Use AP & ACT skills Charts and graphs to interpret data	Georgia State Standards Backwards planning Use of teacher prior knowledge on where students struggled Student observation Formative assessments Diagnostics Spiraling lessons Differentiation Use of clip board to monitor daily homework, class participation, and exit ticket scores Do-It-Now and Exit Tickets Unit exams Use different learning styles Individual attention

Table 31:

KFET Teaching Cycle Competency Plan: Differentiation (4.1F) continued

Component of KFET		Component of PCK									
		Orientation to Teaching Science		**Knowledge of Student Understanding**		**Knowledge of Instructional Strategies and Representations for Teaching Science**		**Knowledge of Science Curriculum**		**Knowledge of Assessment of Science Learning**	
Plan		Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace
	4.1F Differentiation: Designs plans and accountability systems to initiate various forms of structured differentiation (e.g. teacher rotating among established student groupings).					Homework involved either review or preparation for next class Individual feedback State class will move quickly Provide tutorial	Group assignments Students solve problems in front of class Movement	Open conversations		Mandatory tutorial based on performance Use online grading For unit tests identify correct answer, why incorrect, find and explain correct answer	Tutorial Asking students where they stand on content

Table 32:

KFET Teaching Cycle Competency Teach:Clarity(4.2A)

Component of KFET		Component of PCK									
		Orientation to Teaching Science		Knowledge of Student Understanding		Knowledge of Instructional Strategies and Representations for Teaching Science		Knowledge of Science Curriculum		Knowledge of Assessment of Science Learning	
Teach		Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace
	4.2A Clarity : Regularly delivers content in a well-organized, clear, accessible manner, with a focus on key points.	Make science more attainable Incorporate real life examples into lessons Different forms of test Scaffold assessments	Work with different learning styles Breaking goal into smaller pieces Consistency in daily routine Make science more accessible to students Try and keep things consistent Differentiate Guided Practice Backward Design plan	Do-It-Now Relate content to real world experiences Use of previous teaching experience	Do-It-Now Students hear, write and manipulate	Guided notes Beginning class with an instructional hook Color code notes during lecture Use of countdown Culminating conversation Remediation Chunked lessons Use of checkpoints Guided practice II ndependent practice Same learning objectives for all students Post objectives Inquiry-oriented instruction Criteria for content mastery Teacher lead and student focused Provided packet of class notes Bring In outside world examples Complete case studies Differentiate work assignments	Daily use of formative and summative assessments Provide extra time based off student data Always taking notes the same way Problem based learning Use of student prior knowledge Lesson modification based on student's participation Use of student data Breaking down standards Inquiry-oriented instruction Projects, Labs, exit tickets, and unit assessments Use of Cornell Notes Provided a demonstration prior to completing a lab Write stories Think for thirty seconds	Recognize directions are unclear Assignment not helping student learn Use of board instruction Ensure students have the knowledge to be successful Use real-world experiences Connecting prior knowledge Establish criteria-for-success Match lesson objectives with state standards Modify lesson in the moment Increase/decrease lesson rigor Provide Lesson packet Use of diagnostic Growth different for each student Remediation Classroom readings	Use of state standards Student's response Prioritize material Consistency in students knowing what to expect with class structure Connect content to previous material Use of formative and summative assessments Knowing students as people What makes sense Spiral reviews Modify based Upon student's participation Add more examples Provide specific group instruction Use of class board Zest and grit points	Georgia State Standards Use teacher pryor knowledge to break down goals Determine if breakdown was a function, structure, or application Students set own goals Formative assessments Project based teams Diagnostics Spiral content Plan with-end in-mind Standards based tutorial Establish criteria-for-success Stop lesson to debrief before transition Students monitor own progress Do-It-Now Exit Tickets White paper assignments Released state exams Charts and graphs to interpret data	Georgia State Standards Backwards planning Use of teacher prior knowledge on where students struggled Student observation Formative assessments Diagnostics Spiraling lessons Differentiation Make final exam first Use of student data wall Use of clip board to monitor daily homework, class participation, and exit ticket scores Do-It-Now and Exit Tickets Unit exams Use different learning styles

Table 33:

KFET Teaching Cycle Competency Teach: Clarity(4.2A) continued

Component of KFET		**Component of PCK**									
		Orientation to Teaching Science		**Knowledge of Student Understanding**		**Knowledge of Instructional Strategies and Representations for Teaching Science**		**Knowledge of Science Curriculum**		**Knowledge of Assessment of Science Learning**	
Teach		Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace
	4.2A Clarity: Regularly delivers content in a well-organized, clear, accessible manner, with a focus on key points.					Homework involved either review or preparation for next class Individual feedback Provide tutorials	Group assignments Students solve problems in front of class			Mandatory tutorial based on performance Use online grading For unit tests identify correct answer, why incorrect, find and explain correct answer	Individual attention Tutorial Asking students where they stand on content

Table 34:

KFET Teaching Cycle Competency Teach: Questioning (4.2B)

Component of KFET		**Component of PCK**									
		Orientation to Teaching Science		**Knowledge of Student Understanding**		**Knowledge of Instructional Strategies and Representations for Teaching Science**		**Knowledge of Science Curriculum**		**Knowledge of Assessment of Science Learning**	
Teach		Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace
	4.2B Questioning : The level of questions asked by the teacher incorporates some higher-order questions from Bloom's and results in consistent intellectual engagement by students.	All students can learn Make science more attainable Project based learning Helen- Students should question everything Different criteria for project completion	Provide as much inquiry as possible Make science more accessible to students Differentiate Guided Practice Formative/summ ative assessments		Understanding student's misconceptions Levels of problem solving Use of Lab Work Stations Grouping of students based on ability General class discussion Reminded students of what they had already learned	Incorporate tactile, visual and hands-On activities Guided notes Beginning class with an instructional hook Color code notes during lecture Use of countdown Culminating conversation Chunked lessons Use of checkpoints Guided practice I ndependent practice Criteria for content mastery Teacher lead and student focused Provided packet of class notes Bring In outside world examples Complete case studies Complete case studies Differentiate work assignments Homework involved either review or preparation for next class Individual feedback Provide tutorials	Daily use of formative and summative assessments Problem based learning Projects, Labs, exit tickets, and unit assessments Group assignments Students solve problems in front of class	Use of state standards Use of board instruction Ensure students have the knowledge to be successful Use real-world experiences Use real-world experiences Connecting prior knowledge Significant growth within each content domain Establish criteria-for-success Match lesson objectives with state standards Modify lesson in the moment Increase/decrease lesson rigor Provide Lesson packet Classroom readings Open conversations	Use of trail and error Use of state standards Student's response Prioritize material Consistency in students knowing what to expect with class structure Connect content to previous material Use of formative and summative assessments Knowing students as people What makes sense Spiral reviews Modify based Upon student's participation Add more examples Increase pace of the class Provide specific group instruction Use of class board Zest and grit points	Georgia State Standards Use teacher pryor knowledge to break down goals Determine if breakdown was a function, structure, or application Formative assessments Project based teams Diagnostics Spiral content Plan with-end in-mind Standards based tutorial Stop lesson to debrief before transition Do-It-Now Exit Tickets Use AP & ACT skills Charts and graphs to interpret data Mandatory tutorial based on performance For unit tests identify correct answer, why incorrect, find and explain correct answer	Georgia State Standards Backwards planning Use of teacher prior knowledge on where students struggled Student observation Formative assessments Diagnostics Spiraling lessons Differentiate Make final exam first Use of student data wall Unit exams Tutorial Asking students where they stand on content

Table 35:
KFET Teaching Cycle Competency Teach: Rigor (4.2C)

Component of KFET		Component of PCK									
		Orientation to Teaching Science		**Knowledge of Student Understanding**		**Knowledge of Instructional Strategies and Representations for Teaching Science**		**Knowledge of Science Curriculum**		**Knowledge of Assessment of Science Learning**	
Teach		Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace
	4.2C Rigor : Teacher uses instructional tasks that require students to use higher-level thinking skills.	All students can learn Make science more attainable Project based learning Students should question everything Differentiate assessment Independent Practice	Work with different learning styles Provide as much inquiry as possible Make science more accessible to students Cornell Notes Use of labs Student teaching	Modified assignments Used practice Georgia Milestone Assessment at the beginning of the year and prior to taking the exam Use of lock & key system to explain enzymes	Use of a pre-test Different student instructions Levels of problem solving Use of Lab Work Stations Complete content related math problems Higher level students provided fewer instructions Changing tests and quizzes for students with learning disability	Incorporate tactile, visual and hands-On activities Color code notes during lecture Culminating conversation Chunked lessons Guided practice I ndependent practice Post objectives Inquiry-oriented instruction Criteria for content mastery Bring In outside world examples Complete case studies Differentiate work assignments Homework involved eitherreview or preparation for next class Individual feedback State class will move quickly	Daily use of formative and summative assessments Problem based learning Use of student prior knowledge Provide thinking time Lesson modification based on student's participation Use of student data Breaking down standards Inquiry-oriented instruction Projects, Labs, exit tickets, and unit assessments Provided a demonstration prior to completing a lab Write stories Think for thirty seconds Group assignments Students solve problems in front of class	Use of state standards Use of board instruction Ensure students have the knowledge to be successful Use real-world experiences Use real-world experiences Significant growth within each content domain Establish criteria-for-success Match lesson objectives with state standards Modify lesson in the moment Increase/decrease lesson rigor Use of diagnostic Growth different for each student Classroom readings Open conversations Group assignments	Student's response Prioritize material Connect content to previous material Use of formative and summative assessments Add more examples Increase pace of the class Use of class board Zest and grit points	Georgia State Standards Use teacher pryor knowledge to break down goals Determine if breakdown was a function, structure, or application Formative assessments Project based teams Diagnostics Spiral content Plan with-end in-mind Standards based tutorial Establish criteria-for-success Do-It-Now Exit Tickets White paper assignments Released state exams Use AP & ACT skills For unit tests identify correct answer, why incorrect, find and explain	Georgia State Standards Backwards planning Use of teacher prior knowledge on where students struggled Student observation Formative assessments Diagnostics Spiraling lessons Differentiation Make final exam first Use of student data wall Do-It-Now and Exit Tickets Unit exams Use different learning styles Individual attention

Table 36:
KFET Teaching Cycle Competency Teach: Urgent Patience (4.2D)

Component of KFET		Component of PCK									
		Orientation to Teaching Science		**Knowledge of Student Understanding**		**Knowledge of Instructional Strategies and Representations for Teaching Science**		**Knowledge of Science Curriculum**		**Knowledge of Assessment of Science Learning**	
Teach		Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace
	4.2D Urgent Patience : Follows lesson plans faithfully, while flexibly making adjustments based on in-the-mo- ment circumstances, as necessary.	Modify lessons		Modified assignments White Paper assignment	Adapt instruction to various learning styles	Incorporate tactile, visual and hands-On activities Guided notes Beginning class with an instructional hook Color code notes during lecture Use of countdown Culminating conversation Remediation Chunked lessons Use of checkpoints Guided practice I ndependent practice Inquiry-oriented instruction Criteria for content mastery Teacher lead and student focused Provided packet of class notes Bring In outside world examples Complete case studies Differentiate work assignments	Daily use of formative and summative assessments Provide extra time based off student data Problem based learning Use of student prior knowledge Provide thinking time Video timer assessments Provided a demonstration prior to completing a lab Think for thirty seconds Group assignments Students solve problems in front of class	Use of state standards Recognize directions are unclear Assignment not helping student learn Use of board instruction Ensure students have the knowledge to be successful Use real-world experiences Connecting prior knowledge Significant growth within each content domain Establish criteria-for-success Match lesson objectives with state standards Modify lesson in the moment Increase/decrease lesson rigor Provide Lesson packet Growth different for each student	Use of trail and error Use of state standards Student's response Prioritize material Connect content to previous material Use of formative and summative assessments Use of Cornell Notes What makes sense Spiral reviews Modify based Upon student's participation Add more examples Increase pace of the class Provide specific group instruction Use of class board	Georgia State Standards Use teacher pryor knowledge to break down goals Determine if breakdown was a function, structure, or application Students set own goals Formative assessments Project based teams Diagnostics Spiral content Plan with-end in-mind Standards based tutorial Establish criteria-for-success Do-It-Now Exit Tickets White paper assignments Released state exams Use AP & ACT skills Charts and graphs to interpret data	

Table 37:
KFET Teaching Cycle Competency Plan: Urgent Patience (4.2D) continued

Component of KFET		**Component of PCK**									
		Orientation to Teaching Science		**Knowledge of Student Understanding**		**Knowledge of Instructional Strategies and Representations for Teaching Science**		**Knowledge of Science Curriculum**		**Knowledge of Assessment of Science Learning**	
Teach		Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace
	4.2D *Urgent Patience* : Follows lesson plans faithfully, while flexibly making adjustments based on in-the-mo- ment circumstances, as necessary.					Homework involved either review or preparation for next class Individual feedback State class will move quickly Provide tutorials		Classroom readings Open conversations Group assignments		Mandatory tutorial based on performance For unit tests identify correct answer, why incorrect, find and explain correct answer	

Table 38:

*KFET Teaching Cycle Competency Access and Adjust so More Kids Learn: Access (4.3A (*4.3A)

Component of KFET	**Component of PCK**									
	Orientation to Teaching Science		**Knowledge of Student Understanding**		**Knowledge of Instructional Strategies and Representations for Teaching Science**		**Knowledge of Science Curriculum**		**Knowledge of Assessment of Science Learning**	
Assess and Adjust so More Kids Learn	Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace
4.3A Assess: To inform teaching, s/he regularly assesses all students against each lesson's learning objectives by using daily, weekly/bi-weekly, and unit assessments.	Make science more attainable Project based learning Students should question everything Differentiate assessment Break final exam down into units Different forms of test Exit tickets; Do-Now daily Re-test Independent Practice	Provide as much inquiry as possible Make science more accessible to students Formative/summative assessments Do-It-Now every day Creating final exam first	Use of diagnostics Do-It-Now Use of Student data Exit Ticket White Paper assignment	Use of a pre-test Do-It-Now Different student instructions Levels of problem solving Use of Lab Work Stations Grouping of students based on ability General class discussion Complete content related math problems Higher level students provided fewer instructions Changing tests and quizzes for students with learning disability	Incorporate tactile, visual and hands-On activities Beginning class with an instructional hook Use of countdown Culminating conversation Remediation Chunked lessons Use of checkpoints Guided practice I ndependent practice Same learning objectives for all students Inquiry-oriented instruction Criteria for content mastery Teacher lead and student focused Provided packet of class notes Complete case studies Differentiate work assignments	Daily use of formative and summative assessments Provide extra time based off student data Always taking notes the same way Problem based learning Provide thinking time Lesson modification based on student's participation Use of student data Breaking down standards Inquiry-oriented instruction Provided a demonstration prior to completing a lab Think for thirty seconds Group assignments Students solve problems in front of class	Ensure students have the knowledge to be successful Use real-world experiences Connecting prior knowledge Establish criteria-for-success Match lesson objectives with state standards Provide Lesson packe instruction Projects, Labs, exit tickets, and unit assessments	Student's response Prioritize material Connect content to previous material Use of formative and summative assessments Spiral reviews Add more examples Increase pace of the class Provide specific group instruction Zest and grit points	Standards Use teacher pryor knowledge to break down goals Determine if breakdown was a function, structure, or application Students set own goals Formative assessments Project based teams Establish criteria-for-success Stop lesson to debrief before transition Students monitor own progress Do-It-Now Exit Tickets White paper assignments Released state exams Charts and graphs to interpret data	Backwards planning Use of teacher prior knowledge on where students struggled Student observation Formative assessments Diagnostics Spiraling lessons Differentiation Use of student data wall Use of clip board to monitor daily homework, class participation, and exit ticket scores Do-It-Now and Exit Tickets Unit exams Use different learning styles Individual attention Asking students where they stand on content

Table 39:

KFET Teaching Cycle Competency Access and Adjust so More Kids Learn: Access (4.3A) continued

Component of KFET		Component of PCK									
		Orientation to Teaching Science		Knowledge of Student Understanding		Knowledge of Instructional Strategies and Representations for Teaching Science		Knowledge of Science Curriculum		Knowledge of Assessment of Science Learning	
Assess and Adjust so More Kids Learn		Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace
	4.3A Assess: To inform teaching, s/he regularly assesses all students against each lesson's learning objectives by using daily, weekly/bi-weekly, and unit assessments.					Homework involved either review or preparation for next class Individual feedback State class will move quickly Provide tutorials				Mandatory tutorial based on performance For unit tests identify correct answer, why incorrect, find and explain correct answer	

Table 40:

KFET Teaching Cycle Competency Access and Adjust so More Kids Learn: Check for Understanding (4.3B)

Component of KFET	**Component of PCK**									
	Orientation to Teaching Science		**Knowledge of Student Understanding**		**Knowledge of Instructional Strategies and Representations for Teaching Science**		**Knowledge of Science Curriculum**		**Knowledge of Assessment of Science Learning**	
Assess and Adjust so More Kids Learn	Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace
4.3B Check for Understanding : The teacher sometimes gets an accurate “pulse” at key moments by using one or more checks that provide information about the depth of understanding for the students assessed, when appropriate.	Make science more attainable Project based learning Students should question everything Differentiate assessment Exit tickets; Do-Now daily Check for Understanding		Relate content to real world experiences Modified assignments Deal with students level of stress and anxiety No silly questions Use of songs and videos	Understanding student's misconceptions Use of Lab Work Stations Adapt instruction to various learning styles General class discussion Reminded students of what they had already learned Complete content related math problems Higher level students provided fewer instructions Changing tests and quizzes for students with learning disability	Incorporate tactile, visual and hands-On activities Guided notes Beginning class with an instructional hook Color code notes during lecture Use of checkpoints Guided practice Post objectives Inquiry-oriented instruction Criteria for content mastery Teacher lead and student focused Provided packet of class notes Bring In outside world examples Complete case studies Differentiate work assignments	Daily use of formative and summative assessments Provide extra time based off student data Problem based learning Use of student prior knowledge Provide thinking time Lesson modification based on student's participation Use of student data Breaking down standards Inquiry-oriented instruction Use of Cornell Notes Provided a demonstration prior to completing a lab Write stories Think for thirty seconds	Recognize directions are unclear Assignment not helping student learn Use of board instruction Connecting prior knowledge Modify lesson in the moment Increase/decrease lesson rigor Projects, Labs, exit tickets, and unit assessments	Based upon a specific class Student's response Consistency in students knowing what to expect with class structure Connect content to previous material Use of formative and summative assessments Knowing students as people Use of Cornell Notes What makes sense Spiral reviews Modify based Upon student's participation Provide specific group instruction Use of class board Zest and grit points	Standards Use teacher pryor knowledge to break down goals Determine if breakdown was a function, structure, or application Students set own goals Formative assessments Project based teams Establish criteria-for-success Stop lesson to debrief before transition Students monitor own progress Do-It-Now Exit Tickets White paper assignments Released state exams White paper assignments Released state exams Use AP & ACT skills	Backwards planning Use of teacher prior knowledge on where students struggled Student observation Formative assessments Diagnostics Differentiation Make final exam first Use of student data wall Use of clip board to monitor daily homework, class participation, and exit ticket scores Do-It-Now and Exit Tickets Unit exams Use different learning styles Individual attention

Table 41:

KFET Teaching Cycle Competency Access and Adjust so More Kids Learn: Check for Understanding (4.3B) continued

Component of KFET		**Component of PCK**									
		Orientation to Teaching Science		**Knowledge of Student Understanding**		**Knowledge of Instructional Strategies and Representations for Teaching Science**		**Knowledge of Science Curriculum**		**Knowledge of Assessment of Science Learning**	
Assess and Adjust so More Kids Learn		Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace
	4.3B *Check for Understanding* : The teacher sometimes gets an accurate "pulse" at key moments by using one or more checks that provide information about the depth of understanding for the students assessed, when appropriate.				Students hear, write and manipulate	Homework involved either review or preparation for next class	Group assignments Students solve problems in front of class		Use of class board Zest and grit points	Charts and graphs to interpret data Mandatory tutorial based on performance Use online grading For unit tests identify correct answer, why incorrect, find and explain correct answer	Asking students where they stand on content

Table 42:

KFET Teaching Cycle Competency Access and Adjust so More Kids Learn: Track and Analyze Assessment Data (4.3C)

Component of KFET		**Component of PCK**									
		Orientation to Teaching Science		**Knowledge of Student Understanding**		**Knowledge of Instructional Strategies and Representations for Teaching Science**		**Knowledge of Science Curriculum**		**Knowledge of Assessment of Science Learning**	
Assess and Adjust so More Students Learn		Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace	Helen	Grace
	4.3C Track and Analyze Assessment Data : Tracks and analyzes assessment data on a regular basis (i.e. interims, benchmarks, and trimester assessments).	Differentiate assessment Incorporate real life examples into lessons Different forms of test	Getting work back in timely manner Online grading; trading grades	Use of diagnostics Use of Student data Tutorial Used practice Georgia Milestone Assessment at the beginning of the year and prior to taking the exam Use of student tracker and performance on standards bases assessments	Use of a pre-test		Lesson modification based on student's participation Use of student data	Use of state standards Significant growth within each content domain Use of diagnostic Growth different for each student Projects, Labs, exit tickets, and unit assessments	Use of trail and error Use of state standards Use of formative and summative assessments	Georgia State Standards Diagnostics Spiral content Plan with-end in-mind Standards based tutorial Establish criteria-for-success Charts and graphs to interpret data Mandatory tutorial based on performance For unit tests identify correct answer, why incorrect, find and explain correct answer	Georgia State Standards Formative assessments Diagnostics Spiraling lessons Differentiation Make final exam first Use of student data wall Unit exams Use different learning styles

I will now use the data from the charts to demonstrate the change in the participants' PCK as a result of implementing the observable behaviors of the teaching cycle of the KFET. To accomplish this, I have looked at the data from my observation tool that was used to identify incidences of PCK and my field notes. There are 13 observable behaviors of the KFET. I have selected for discussion three observable behaviors (4.1A; 4.1F; 4.2A) that demonstrated the most dramatic change to the participants' PCK. I will focus the discussion on the components of PCK impacted greatest by these observable behaviors: knowledge of instructional strategies (KIS), knowledge of science curriculum (KSC), and knowledge of assessment (KA).

Plan: 4.1A: The End in Mind: This observable behavior of the KFET involves the participants using regional or school curriculum resources or a teacher-created scope and sequence to plan logical units with objectives. The participants also are expected to allocate time appropriately based on the content to be taught, and plans for contingencies, remediation, and enrichment. For Helen, the changes to her KIS PCK moved from a hook at the beginning of class that may have been a series of multiple choice questions to open-ended questions that required students to discuss amongst themselves the answers, followed by a group discussion to close out the do-it-now. An example of the later involved Helen challenging each student to come up with an acronym for species classification then discussing it with another classmate. The more creative ones were presented in front of the class. Helen also changed her KIS with regard to how remediation was accomplished. In the beginning, she opened tutorial to anyone who felt they needed it. This changed to a greater focus on the standards tutorial. She indicated in class what standards were being covered in the tutorial; students kept a record of their performance on all of the standards. Students then determined when to attend tutorial based upon when the standard that they were struggling with was the focus of the tutorial. Also, Helen started using phrases in the class that encouraged students to participate. Such phrases included: “That is what the notes say. I want to hear what do you say. Rephrase it in your own words.” “Somebody closest to the wall respond.”.\ “Does anyone want to add something we have not heard?” “Say that one more time.” “I need more specifics facts. I am not your biology teacher. I am someone on the streets.”

The KIS for Grace changed most in her implementation of inquiry-oriented instruction. The beginning of the year involved a heavy dose of lecturing. This transitioned into demonstrations before labs, as well as project-based assignments. Her daily use of formative assessments changed from a teacher-led review to allowing students who had demonstrated mastery to lead a problem-solving session for the class. This enabled Grace to focus her attention on students who needed more individual attention. Her use of exit tickets evolved from multiple choice options to rigorous problem-solving sets related to the day’s content. The students had to figure out the answer rather than it being provided in a multiple choice question. Grace also realized that she needed to provide students time to think. She changed her classroom lecture by stating that students now have 30 seconds to think about the answer prior to answering the question. She came to realize that this enabled students to provide more insightful responses and it gave time to those students who were reluctant to answer questions because they needed more time to figure it out.

For Helen, the KSC changed in her use of the Georgia State Standards. In the beginning, she did not feel the need to cover basic concepts that she thought the students should have covered previously. After her first semester, she realized that there was a need to make certain that concepts did not go over the students’ head. Some of the material that she taught at a higher level was too rigorous. An example involved her discussion of cancer and the role of interphase in meiosis. She used vocabulary such as G1S and G2 checkpoints that were involved in the proliferation of cancer cells. She recognized that:

> "This was too much information that went over their heads and confused them because there were so many moving pieces. So it was subsequently taught as more a foundational level. The cell cycle was taught as interphase, mitoses, and cytokinesis, and I eliminated the more intricate parts of interphase that play into cancer. I still taught cancer as it relates to uncontrollable cell growth, we just didn't touch on how the cell monitors its growth" (Helen, interview, June 23, 2016)

With Grace, KSC was also modified with the use of the Georgia State Standards. She created her own scope and sequence. She began to modify it based upon each specific class and often modified it in the moment. As a result, her four classes were not always at the same part of the course. If she detected that student participation was lacking, this became her clue to modify the content. She recognized that more examples were needed for certain classes than for others. For example, this translated into more problems related to stoichiometric calculations, balancing chemical reactions, and understanding the role of valence electrons in the chemical process.

Helen's KA changed in how she used the Georgia State Standards and her prior knowledge to break down the goals into manageable chucks to relate content to students. This enabled her to create assessments that enabled the students to demonstrate mastery of the content. This also provided her with data to determine if the lack of mastery was related to function, structure, or application. A major implementation of assessment for Helen was the use of "white papers." This concept gave the students the power to decide how they would review material, prepare for a test, or complete a project. She started using released tests from the state and, in order to improve performance on unit exams, began a process where students had to provide corrections for missed questions on both formative and summative assessments.

Grace's approach to KA began with backwards planning. To create unit exams, she began with the Georgia State Standards and moved to the content that was necessary for students to demonstrate mastery. While she used diagnostics, she came to feel that a better predictor of student performance was class participation and the interaction based upon her individual attention. Her assessments changed during the course to unit exams that had sections relating to a specific content and increasing complexity and rigor of the questions as the exam progressed.

Plan: 4.1F: Differentiation: The objective of this observable behavior is for the teacher to design plans and accountability systems to initiate various forms of structured differentiation. Examples of where this impacted Helen's KIS occurred where initially she provided guided notes for students to complete during the lecture. She realized that some students still were not able to generate a complete set of notes. She changed her lecture strategy to highlight important content presented in the lecture by color coding it. In addition, she started emphasizing to students that they write specific information down. She implemented more checkpoints during the lecture to confirm that students were documenting where appropriate and understanding what was being presented.

Helen also believed that all students could benefit by the differentiation provided to students who had an individual development plan. She incorporated such actions as repetition of content, individual attention, alternate exams, and instruction techniques that addressed various learning styles throughout the lesson. During the semester, lab activities were mostly digital or involved a worksheet assignment. Towards the end of the second semester during Brain Awareness Week, Helen decided to provide an activity that incorporated tactile, visual, and a hands-on lab session. She turned her class over to a guest lecturer, who gave students the opportunity to dissect sheep brains. Helen also changed the independent practice towards the end of the semester. She implemented assignments that required more critical thinking and more group effort in resolving. An example occurred with the review for the Georgia Milestone Test. She rearranged the class by placing the desks in triangle groupings. Teams were identified based upon a musical artist. They worked together to complete assignments related to reviewing content for the exam. She incorporated case studies and utilized rea- world examples to make a point.

With Grace the use of formative and summative assessments provided a means that she demonstrated a change in her KIS. There was a disconnect between what she was seeing with the formative assessment and the students' performance on the summative assessments. They would demonstrate mastery with the formative assessment and flounder with the summative exams. She restructured her summative exams so that similar content was together and the rigor of the questions increased within content strands. She learned to provide extra time for students to complete assessments based on previous students' efforts. One aspect of Grace's class did not demonstrate differentiation. She insisted that students complete their notes using the Connell style of note taking. Even during her lectures, notes were provided using this style of note taking. She felt this method of instruction best prepared students for exams and for the future classes that they would be taking.

Changes in differentiation observed in Helen's KSC revolved around implementing the Georgia State Standards. She increased her use of real-world experiences during the class lecture. Sometimes, this involved the students wanting to discuss something that they had observed outside of the class and sometimes it was Helen who used a current event to draw the students into a discussion related to the content. An example is her use of the O.J. Simpson case to explain the enzyme substrate interaction. Helen also changed her approach to the use of reading assignments. In the beginning, it was used to allow students to demonstrate what they already knew. In the second semester, it changed to a technique to review the curriculum. She also recognized that the growth of a student in the class was different for each student. While each student had to master the standard, how the student got there depended on where the student started.

With Grace, differentiation related to KSC began with a trial-and-error approach. She still incorporated the Georgia State Standards, but based student interaction she changed what was done – for example the steps in explaining a lab would be different from one class to another. She changed the number of problems used in examples, as well as the complexity of the problems, depending on student response. An example is in balancing chemical equations. Depending on the class, the complexity of the compounds used in the example would increase or decrease. She also increased or decreased the pace of the class depending on results from formative assessments.

Differentiation with Helen's KA changed across a broad spectrum of assignments. The most significant of which was her implementation of the white paper assignment. I have described this assessment previously in a number of places in this document. Its purpose was to give students the opportunity be creative, show a part of their individuality and provide a tool that was most effective for their purpose – as long as it met the criteria of the grading rubric. There was a big focus by the school on students performing well on the ACT. She began using reading materials, vocabulary, and homework assignments that were taken from ACT and AP material. Helen also differentiated her assessments based on a student's ability. Exams began to vary by the level of rigor, number of questions, answer choice options, and type of delivery. Students could leave the classroom for another space to complete exams if that was required and sometimes when a student felt the need to. She placed the individual student in charge of monitoring their progress. Each student was provided with feedback on their performance on the mandated standards. Each student kept track of how they were doing and was encouraged to develop a plan that was individual to their needs.

For Grace, differentiation related to her KA began with backwards design – an observable behavior of the teaching cycle of the KFET. All of her final exams were generated at the beginning of the year. She developed labs, formative assessments, and summative assessments from this. She used her prior knowledge both from her experience with previous teaching assignments and with other classes that she taught at KIPP to where students struggled to differentiate assessments. Her use of data with homework assignments, class participation, exit tickets, do-it-nows, as well as student participation fostered her ability to differentiate among the class assessments. In addition, Grace used the simple question of asking students where they stand on content to assess comprehension.

Teach: 4.2A: Clarity: This observable behavior requires the participant to regularly deliver content in a well-organized, clear, accessible manner with a focus on key points. With KIS, when Helen's students entered class, they first had to turn in their homework assignment in a bin and obtain the class notes for the day. These were guided notes that students had to complete while listening to the lecture. In the beginning, Helen pointed out when students should fill in information. This transitioned to her not pointing this out at all and expecting the students to decipher what information was critical to document. To assist in this process, Helen began to color code the slides that were used in her lecture. Other changes that occurred during the year in

Helen’s class relating to clarity and KIS involved an increase use of checkpoints throughout the class. She recognized from the questions being asked that some information was not as clear as it should be. Helen worked with her science department chair to provide more explicit directions. An example involved her telling students what to do. Helen stated that she “worked to provide directions that were more specific, concise, and consequential. An example was class you will have five minutes to complete your guided practice assignment with your partner. It will be silent.” During class, Helen began making statements such as, “The class will be moving quickly through this section. Does anyone have any questions? Show me by raising your hand if you understand.”

For Grace, clarity with KIS was demonstrated by consistency in her practice. She used daily formative and summative assessments and took the time after each formative assessment to review and clarify content. She began to allow students to conduct the review of class problem sets and would call on other students in the class to ask if they could explain what was just mentioned. In implementing problem based learning she allowed the students to struggle with a concept and then provided clarifying insights to complete the assignment. She recognized that students needed a demonstration of the lab procedure and implemented this practice. She also used her student data to provide more time on certain concepts. These often involved areas where math was a heavy component of the curriculum - for example in calculating molar mass, figuring out oxidation numbers in a chemical reaction, and stoichiometric equations.

For Helen and Grace, KSC again relied heavily on the Georgia State Standards. Helen recognized that she needed to complete more instructional time at the white board to add foundational details that may not have been captured in the guided notes. She often went to the board to draw out additional examples from the notes. An example occurred with the discussion on the enzyme energy activation concept. While the guided notes explained what was involved in the process, Helen drew on the white board a diagram that graphically depicted how the reaction occurred and how the energy of activation was impacted by adding an enzyme and when an enzyme was not a part of the reaction.

For Grace, KSC changed in how she prioritized material. She based this upon her prior knowledge from teaching the content, as well as the feedback she had from her data on formative assessments and student interaction. For one class, there was a heavy focus on math as part of the introduction of material because her data indicated that this class struggled with chemical concepts that involved a lot of math. For another class, this was not the issue and she spent more time providing more challenging problems sets.

DISCUSSIONS AND IMPLICATIONS

I will now provide a discussion of the results described previously in in this chapter. Throughout this study, I have sought to collect and analyze data that will produce evidence related to the relationship between the development of new KIPP science teachers' PCK and the influence the teaching cycle of the KFET has had upon it. The collection of data has been structured around three sub-questions, which help to guide the collection of data and assist in clarifying the research question**:**

1. How does implementing the teaching cycle element of the KFET impact the development of the components of new KIPP science teachers' PCK?
2. How does a teacher's "experience in practice" in a KIPP environment impact the development of their PCK?
3. What role does the KFET teaching cycle have on this "idiosyncratic" aspect of a new science teacher's PCK?

Each of the three sub-questions will now be addressed individually based upon the findings of the study. I will provide examples that help to underscore how each participant's PCK was impacted by adhering to the expectations of the teaching cycle of the KFET.

How does implementing the teaching cycle element of the KFET impact the development of the components of new KIPP science teachers' PCK? The development of PCK in a KIPP environment for the participants was not so much a development, but a modification of what they already had as content knowledge and their ability to transform that knowledge to students. I have previously described the teaching experience background of the participants in Chapter Three. Each participant came into the study with more than three years of previous science teaching experience. A large part of the modification for transforming knowledge for all new teachers to KIPP is based on the KFET. This document underscores that at KIPP, "excellent teaching means students learn, grow, and achieve transformative life outcomes" (Ali et al., 2012). It has as its core the ideal of student growth and achievement, and the teaching cycle serves as one of the pillars for supporting this. The teaching cycle carries well-outlined tenets that not so much instruct a teacher in how to accomplish classroom tasks, but describes what a successful classroom would look like when the tenets are implemented. One of the reasons that KIPP implements the framework is the hope that every teacher has the belief that s/he can "become a great teacher and will never truly get to the end of this path because there's so much to learn and so much to do in the act of teaching and learning" (Ali et al., 2012).

For the participants, the process of understanding the teaching cycle of the KFET begins with the new teacher induction process. The induction process has changed significantly over the years in my KIPP region. Seven years ago, when I started the induction process for new teachers, I was simply given a book, encouraged to do my best, and reminded that “all students will learn.” Today, according to the science department chair:

> “New KIPP teachers arrive a few days prior to the start of school, are assigned a mentor, and participate in a yearlong program where there are monthly meetings on class management, content acquisition, and best practices. Just as importantly, they get to interact with other individuals adjusting to the KIPP world. This can also be accomplished at the annual KIPP Summit, where teachers gather for professional development that is designed to reflect on and transform their practice” (Science Department Chair, interview, November 5, 2015).

Teaching is a dynamic process in a KIPP classroom. One of KIPP’s mantras is that “All students will learn.” This empowers the teacher to use any occurrence as a teachable moment. For example, Helen used the latest rap song, a recent episode on a popular television show, and an out-of-the-blue observation from a student as teachable moments. Neither of the participants implemented an off-the-shelf curriculum that was followed where students had to be at a particular point, at a particular time. Yet, each was cognizant of the high-stakes testing that was to come at the end of the semester. At the beginning of each semester, I observed both participants welcome new students on the first day of class with a discussion on how students were expected to perform well on high-stakes testing. This was reiterated in Grace’s class during preparation for Student Learning Outcomes test administered at the end of the semester. This exam is similar to the series of Georgia Milestones Assessment System’s exams. There is currently no Georgia Milestones Assessment exam in chemistry. Grace’s students also had to take practice exams for the American College Testing (ACT) exam. On two occasions I observed her preparing students for this test she informed them of the high expectations of performance on it.

For Helen, during the class review process for the Georgia Milestones Assessment in biology - during the two observations of her class prior to the exam - this level of expectation was discussed. The teaching cycle of the KFET has as part of its beliefs concepts such as: starting with the end in mind, establishing SMART (specific, measurable, achievable, realistic, and timely) aims, and making sure the “what” matched the “how” – an example is where the exit ticket is designed to match the key points of the lesson. I reviewed three sets of lesson plans for each participant and these beliefs were imbedded in their content. The structure of each lesson plan involved completing a do-it-now, followed by introduction to new material, guided practice, independent practice, and then closure with an exit ticket.

An example of this in practice is Grace’s class on understanding units. She began with explaining to students the aim of identifying proper units for measurement and converting between metric units. The do-it-now was completed by providing students a graph and having them answer questions related to interpreting the data on the graphs. During each of the 10 observations I completed of Grace’s class I witnessed students coming up to the front of the class and explaining to the rest of the class answers to a particular assignment. Grace then introduced the concept of metric units, provided examples of how to convert between them, and ended the introduction with a demonstration of how to read graduated instruments – a graduate cylinder and a ruler. Her guided practice involved group-partner-solo – students had the option on how they wanted to work together – to answer questions about metric units, accuracy and precision. For independent practice students took a quiz on the scientific method – covered in the previous class – and completed a worksheet that focused on accuracy, precision, metric units and conversions. The exit ticket involved three problems related to units, conversion and making measurements.

This pattern of instruction was also observed during each of the twenty observations completed during the completion of this study for Helen. During my observation of Helen's class, it began with students entering the class after being greeted by her and students picking up handouts that explicitly indicated the goals of the class and the activities that would be involved in achieving them. During the class related to evolution, the opening discussion began with the aim to analyze and describe the history of evolution. She began the lecture by stating that she, "was not here to prove or disprove your religious views, I am here to speak of the scientific aspects of evolution." Students completed a do-it-now related to spiders and color adaptation. The handouts for the class notes that required students to follow along a PowerPoint presentation and fill in answers to statements related to topics such as where the theory of evolution came from, various attempts to explain the theory of evolution, Darwin's theory of evolution with natural selection, and Darwin's trip on the H.M.S. Beagle. Students then independently completed an evolution survey. The exit ticket involved multiple choice questions related to selecting which animal would survive and reproduce under certain situations. The teaching cycle has as one of its beliefs the concept literacy for everyone. All of Helen's class notes required the students to read content-related material. During one observation, students had to read paragraphs related to evidence of evolution and natural selection at work. While this was a strategy she indicated in her first interview that she embraced because it allowed students, "to ask questions to really incorporate it [content] and it [reading] allows them to showcase what they already know and what they've understood." During her final interview, she indicated that this evolved into more of a check for understanding. Reading assignments were used to demonstrate that students understood the content of the day not what they already knew by answering questions related to reading passages. It was during the review process that reading turned into a measure of what they already knew.

The structure of the classes enabled the participants to constantly change how they carried out PCK components of knowledge of students understanding, knowledge of science curriculum, knowledge of instructional strategies, and knowledge of assessment. Helen's use of the rap songs or the latest television episode as teachable moments is an acknowledgement that students understand material in different ways. Both implemented lesson plans with aims that corresponded to the state standards and allowed students to demonstrate their knowledge of scientific curriculum. Yet both demonstrated a continuing willingness to change their instructional strategies to incorporate aims that had nothing to do with the Georgia Performance Standards. An example is Grace's preparation of students for the ACT - something that had not happened prior to her tenure at KIPP. I observed other examples of PCK development related to a KIPP teacher's autonomy—In the Atlanta KIPP region, this autonomy ranged from something as simple as requesting to visit another teacher's classroom or another school, to implementing changes with curriculum such as problem-based learning (Barrett, Guillory, Hampton & Segure, 2012), to taking a content-related class or attending a national conference, to stopping the class and talking with students about why things were not going as they should.

KIPP teachers' autonomy is driven by their sense of efficacy where the KFET stipulates that the teachers "affect student outcomes." This is best expressed by the banner that hangs in almost all KIPP classrooms and states: "All Students Will Learn." It is this fundamental belief that all students will learn that Helen indicated as the reason that she provides alternative assignments for demonstrating mastery. Her use of the white paper assignment is an example. Students had the option of creating picture books, stories, exams, or any other method that enabled them to demonstrate mastery. This efficacy is an essential component of her PCK development. The implementation of alternative assignments transformed throughout the year based upon her interaction with students and her interest to adjust so that more kids can learn – one of the components of the teaching cycle of the KFET.

Another example of this efficacy in action occurred in Helen's class during Brain Awareness Week which occurred in the second semester class. She brought into her class a researcher from the Georgia Institute of Technology to provide a hands-on demonstration dissecting sheep brains. This session was used as a springboard to discuss the parts of the human brain and how the different structures of the brain work. This was another demonstration for Helen in how she promoted learning by providing a hands-on experience that the students had not had previously in her class. For Grace, there was recognition that students comprehended content when they could relate it to something they understood. During the unit on chemical reactions she had students read a story about romantic relationships. Students then had to relate the five types of chemical reactions to the outcomes of the relationships after some difficult interactions between the characters – for example, couples broke up (decomposition), relationships were formed (synthesis). Students then had to write their own story. Points were awarded by accurately representing all five types of chemical reactions, the story had to flow well and make sense, complete sentences had to be used, so did proper grammar/spelling, it also had to be creative and bonus points were awarded for illustrations.

I have demonstrated in this section how the implementation of the observable behaviors of the teaching cycle of the KFET impacted how the participants transformed knowledge for students in ways that enabled the students to comprehend content. Their efforts to prepare students for high stakes testing in ways that continued to change throughout the observation period, their demonstration of understanding of the curriculum and use of various strategies in educating students, as well as the various assessment methods implemented – each an expectation of the KFET - all demonstrate the impact of the teaching cycle of the KFET on changes to their PCK in transforming knowledge for students.

How does a teacher's "experience in practice" in a KIPP environment impact the development of their PCK? I examined the role of the induction process and the type of professional recognition and development provided to the participants as a way to understand their experience in practice. I will now describe the KIPP induction process and the influence that the KFET has upon it. One of the challenges of hiring a science teacher is finding someone who has a background in science either from job experience (where the person is transitioning from industry or corporate life) or from completing educational training in science education. I have previously described in chapter three the background of the two participants. Both have over three years of science teaching experience, both obtained alternative certification, and both had significant experience teaching in the socioeconomic environment they found at KIPP.

KIPP Implications for Induction Programs During the participants first year at KIPP, there was a greater focus on becoming "KIPPtonized" than on indoctrination into the teaching of science. The assumption was as stated by the science department chair that, "the new KIPP teacher knew content and teaching strategies, but needed an understanding of KIPP culture for a successful first year." KIPP has classroom-management strategies that help alleviate a lot of the disturbances that may be part of a non-KIPP classroom.

KIPP's mission is "to create a respected, influential and national network of public schools that are successful in helping students from educationally underserved communities develop the knowledge, skill, character, and habits needed to succeed in college and the competitive world beyond" (The KIPP Foundation). All beginning teachers must buy into the development of this mission. The classes are primarily filled with minority students who are on the low end of the socioeconomic scale. The desire is to not allow a student's socioeconomic status be an impediment to educational accomplishment. The beginning teacher comes into the KIPP world with the heart to change the lives of these young students.

KIPP's current induction program begins with a history lesson explaining how KIPP began as an idea of two Ivy Leaguers, David Levin and Michael Feinberg, involved in the Teach for America Program in Houston, Texas. They wanted better opportunities for students leaving their classrooms. KIPP's impact has grown from one school with approximately 60 students to now more than 200 schools across the country and more than 80,000 students.

This history lesson is followed by a heavy dose of mission, vision, values and "the data"—which tells the impact of KIPP in transforming the lives of the students that it serves (Appendix G, KIPP by the numbers). It is both inspirational and intimidating. The goal is to get students to and through college. In the Atlanta region, this is accomplished through five organizational values indicated in Table 43.

Table 43:
KIPP Organizational Values (http://www.kippmetroatlanta.org/about-us)

Value	Description
High Expectations	Students, parents, teachers, and staff create a culture of achievement and support, an environment in which students are prepared for the rigors of high school and college
Choice & Commitment	Everyone at KIPP makes a commitment to his or her school, and to one another to put in the time and effort required to achieve success
More Time	With an extended school day, week, and year, students spend more time in school learning and have more opportunities to engage in diverse extracurricular experiences
Power to Lead	The principals of KIPP schools are effective academic and organizational leaders. They are free to innovate, make staffing changes, and swiftly move dollars—allowing them maximum effectiveness in helping students learn
Focus on Results	KIPP schools relentlessly focus on high student performance on standardized tests and other objective measures, as well as emphasize continuous improvement in teaching and learning

These values can be linked to the components of PCK. The descriptions that involve achievement and support, an environment in which students, school, and to one another to put in the time and effort required are aspects of a teachers orientation to teaching science. The value of more time which is described as students spend more time in school learning and have more opportunities to engage in diverse extracurricular can be correlated to knowledge of curriculum and knowledge of instructional strategies. Focus on results has as part of its description the relentless focus on performance on standardized tests and other objective measures which can be a component of knowledge of curriculum and knowledge of instructional strategies.

The induction process for KIPP varies depending on the grade level. For my study the process involved an initial two weeks of KIPPnotizing, where new teachers are taught the KIPP classroom management techniques. This includes a list of hand signals, a mastery tracker, a system of demerits, zest and grit points, a tutorial schedule, and a recognition space. Professional development during these two weeks was focused on the texts *Teach Like a Champion* and *The Skillful Teacher*. Teachers were given instruction on developing the scope and sequence for the course and content development. They were provided with a lesson-plan template and with the KIPP list of non-negotiables – such as arriving on time, adhering to the class schedule, and working hard and being nice.

The induction process also involves a focus on the use of data. KIPP has a laser focus on student performance, especially as students are engaged in high-stakes testing. A portion of the teacher's evaluation is dependent upon students' test performance. As a result, student data from new teachers is scrutinized early and often for impact. During the induction the importance of tools such as benchmark testing, unit tests, quizzes and practice exams are discussed to gain an understanding of student performance as an indication of the student's preparation for the high stakes testing. On assessments such as benchmarks, if a teacher's results are not in line with expectations, there is a team effort to figure out why and what should be done. There is also a team effort in providing and sharing resources across the KIPP network.

One part of the content aspect of a KIPP induction is obtained at the KIPP Summit, an annual gathering of all new and interested KIPP teachers in one location for a weeklong series of workshops and team-building exercises. The summit has transformed from a general "this is how you KIPP" introduction to a content-focused event where teachers and nationally recognized, content-specific experts now participate. Courses for the 2016 event offered science teachers' information on model based inquiry, data driven instruction & academic process monitoring, personalizing science with instructional technology, and building vocabulary for science achievement.

On a national level, KIPP also has implemented the KIPP: Share System, a national online system that links all KIPP teachers. It contains lesson plans and project descriptions, and also serves as a repository for anything created in the KIPP world. It is similar to a Facebook platform where teachers can link across the KIPP network, join communities, and access recommended curriculum. The system is part of a significant effort to share effective classroom management and teaching techniques. During the induction process there are coaches to aid in the difficult process of being KIPPtonized. The strategies are designed to foster the success of a teacher new to the KIPP way of doing things, and will ultimately impact their PCK. Each teacher’s experience is similar in terms of how it is done but unique to the teacher in what they get out of it. For example, the teacher decides what courses to take at the KIPP Summit. During the professional development sessions provided by the school the teacher’s development would be based upon where the coach and the teacher felt would best benefit the teacher.

New-teacher induction also involves spending a lot of time learning about the needs of KIPP students. What KIPP does works (Tuttle et al., 2015). Students in this study took science every day of the week for approximately 90 minutes. An entire year of content occurred in each semester. New teachers were involved in yearlong training sessions that focused on implementing the KFET. This began with gaining an understanding of KIPP’s history, mission, vision, and values, as well as indoctrination into the “culture” of KIPP. The overarching goal was to enable teachers to participate in a plan that encompasses: More time in school (extended day, week, year); consistent and tough-love approach to discipline; focus on all the little things;

making learning fun; willingness to do WHATEVER it takes!; and empowering students to address issues at home and community.

KIPP has built an extensive database on information that tells teachers what should be taught in a classroom. The platform share.kipp.org is a trove of information that KIPP teachers have used for successful implementation of content material. The goal of warehousing this information is to assist in removing "what" should be taught in class and to instead focus more time on "how." This "how" is the transforming of knowledge.

How does one create an environment that supports the mantra that "All students will learn"? The answers begin with sessions on Teach Like a Champion, an indoctrination that focuses on such issues as: classroom procedures, in-class transitions, classroom configuration, and rules, consequences, and rewards. New teachers also are indoctrinated in concepts like Criteria for Success, implementing scopes and sequences, and the backwards design process. All of these efforts center on the KFET. Monthly sessions are held that incorporate some aspect of the framework. Additionally, there are videotaped classrooms sessions where best practices have been observed. Teachers meet as a staff to discuss and dissect these classroom all-stars. There is also a list-serve where routine communication is disseminated among the science teachers.

As part of the Race to the Top funding won by Georgia, KIPP established a KIPP Teachers Fellows Program (Hampton, 2011). This induction program is designed to provide students in the college of education from Georgia State and Mercer universities the opportunity to train in a KIPP Metro Schools environment. It matches the fellow with a veteran teacher in the KIPP system for a year with the intention of the fellow becoming a KIPP teacher at the end of the year.

The ultimate answer to the question posed on how a novice KIPP teacher develops his or her pedagogical response "in practice" to a student's learning needs is unique to each individual educator. The teacher's own experience within the KIPP world in transforming knowledge for the students based upon their knowledge acquisition obtained through the induction process as well as their individual knowledge used in implementing instructional strategies play a role in their PCK development. Teachers have the autonomy to implement what they feel is the most effective tool to transform their knowledge of science and assess the success of this effort. This transformation was observed in the participants' stories written by students, encouraging student participation in science fairs, dissecting sheep brains, attendance in professional development courses, making videos of class routines, and myriad other ideas discovered during the induction process.

Recognition of Professionalism

The experience of a KIPP teacher "in practice" is also impacted by his or her opportunity to develop professionally. The components of PCK are about what a teacher does in a classroom to transform knowledge. My experience within KIPP demonstrated that it is overrun with ambitious, bright-eyed, I-am-going-to-change-the-world individuals. One of the challenges with determining the professional development of teachers in a KIPP system is that many of the teachers lack longevity in the system. Recent data suggests that this is changing. In 2015, 73% of KIPP teachers returned and 7% moved into a non-teaching position at KIPP or teach at another KIPP school (KIPP, 2016). How does KIPP define a veteran teacher? The idea of professionalism revolves around knowledge—not time. The notion that teachers "develop a body of knowledge unique to the members of the teaching profession" (Park & Oliver, 2008, p. 20) is really KIPP's hallmark. It matters little about the age of the individual or the time spent accomplishing something. If it works, share it and you become the professional. KIPP is such a small community that individuals quickly develop a reputation when something of theirs works. What is even better is the willingness to share it—not just with the KIPP community, but also with anyone interested in using the knowledge. The KIPP share.com site, the science list serve, the national KIPP summit, and the weekly staff meetings are all forums by which teachers are capable of demonstrating the "professionalism" that is used to foster student success.

Like most districts, KIPP has consistently tried to develop a system that accurately evaluates teacher effectiveness and how to recognize and reward it. The KIPP Metro Atlanta School system has implemented a tiered system by which teachers are evaluated. Table 44 provides a description of teaching levels for KIPP teacher evaluation:

Table 44:
Tier Teacher Expectation

Tier	Expectation
Novice teacher	Individual who are new to the teaching profession
Developing teacher	Individuals with a couple of years of experience, but new to the KIPP system
Proficient teacher	Individuals who have been in the KIPP system for about five years. This is where the majority of the teachers in the system fall
Advanced teacher	Individuals who have two or more years of extraordinary student performance (not necessarily consecutive) and who also serve in some other function in the school based on their expertise
Master teacher	Individuals who have three or more consecutive years of stellar student performance and who are looked upon as a standard by which others should emulate

The characteristics of the tiered system (Table 45) are an acknowledgment of the increased professionalism that should be demonstrated by successful teachers. It is an effort to move away from rewarding longevity or the attainment of a degree, and an attempt to merge teacher accomplishment with some aspect of student performance. Because KIPP is a data-driven environment, teachers and schools sink or swim based on their ability to fulfill the mission: to equip students with the academic skills, scholarly habits, and character traits necessary to be successful in top-quality colleges and the competitive world beyond.

Table 45:
Characteristics That Define Teacher Professional Tiers

	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
	Developing Teacher	Progressing Teacher	Established Teacher	Advanced Teacher	Master Teacher
Characteristics					
	Developing skills, building knowledge, and confidence	Demonstrates effective teaching and classroom management	Demonstrates highly effective teaching and classroom management contributes to school climate and culture	Demonstrates exceptional teaching and classroom management. Is a strong contributor to school climate and culture	Demonstrates mastery of the teaching craft. Is an exceptional contributor to school climate and culture
		Delivers solid student achievement	Delivers strong student achievement	Delivers very strong student achievement	Constantly delivers exemplary student achievement

There also was an effort to reward teachers in an environment where cash could not be the first option. Due to the economic environment at the time, annual salary increases were halted. The committee came up with suggestions like allowing encouraging attendance at local conferences, creating an environment where teachers felt supported if they needed an alternative schedule, and providing opportunities to take a leadership role on district-wide projects. These measures are currently being used to recognize the continued need for professional development.

Another reward available to accomplished teachers and recognition of professionalism is the opportunity to move up the administrative pathway. The national KIPP organization supports two highly coveted fellowships.

The Fisher Fellowship supports an individual for a year while s/he goes through a required process to found and lead a KIPP school. It is “designed to provide in-depth support and insight into the process and best practices involved in school leadership – including topics as varied as charter authorization, facilities improvement, student and teacher recruitment, curriculum development, and community outreach” ("KIPP School Leader Fellowships" - KIPP Public Charter Schools. N.p., n.d. Web. 10 Nov. 2013).

The Miles Fellowship is designed for individuals who currently serve as grade-level chairs, department chairs, or lead teachers. “As part of the Miles Family Fellowship, fellows are expected to actively participate in the yearlong developmental process and proactively pursue their own development through engagement and commitment to the learning process” ("KIPP School Leader Fellowships." - KIPP Public Charter Schools. N.p., n.d. Web.10 Nov. 2013).

What role does the KFET teaching cycle have on this “idiosyncratic” aspect of a new science teacher’s PCK? New teacher enactment of the other elements of the KFET have a greater impact on specific components of a teacher’s PCK development while the teaching cycle impacts the development of all the components of PCK. An analysis of the data for rival explanations and deviant cases enabled me to draw this conclusion. It is in this aspect that the “idiosyncratic” nature of PCK is can be determined. Park & Oliver (2008, p. 18) suggests that a teacher's PCK is idiosyncratic because it is "continuously changing and reconstructing as it becomes an established aspect of their achieved PCK." KIPP teachers are never told that a specific set of instructional strategies ought to be implemented or that specific assessments must be used. The only expectation is that a teacher implements some form of an assessment—the type and purpose of which are completely up to them. However, a component of their assessment criteria must include benchmark testing in order to diagnose students' comprehension prior to the round of high-stakes testing.

Another aspect of this "idiosyncratic" nature of PCK occurs when a teacher enters into the KIPP system and begins the induction process. Typically, it involves the new teachers arriving on campus a few days prior to the returning teachers starting. For my participants, this involved a round of KIPPnotizing, some professional development, and team building. They are introduced to the KFET in its entirety. The teacher is then assigned a coach, given a class, and the year starts.

Throughout the year, the participants and the coach met periodically for O3s, formative observations, and mid-year and end-of-year observations. One of the hallmarks of KIPP is that the teacher is given the autonomy to conduct the class as she sees fit. Throughout the study, it became obvious through an analysis of rival explanations and deviant cases that there was an enactment of certain observable behaviors of the KFET by the participants that influenced their PCK development that were not observable behaviors of the teaching cycle element of the KFET. An example of research data that has led to this observation was obtained during an interview with the science department chair. In it he specifically states that in the first year of a new KIPP teacher other elements of the KFET are focused on because, "we expect the initial interview process to convince us that the teacher is knowledgeable of content and how to convey it. The most important element of the KFET for us initially is that the teacher is able to relate to the students and this is found in the KFET element classroom culture" (Personal communication, November 11, 2015). Each of the five elements of the KFET has been described in detail in Chapter 2. I will describe elsewhere the impact of the teaching cycle element of the KFET on the development of a new KIPP science teacher's PCK. I will now describe how the remaining four KFET elements impact specific components of PCK:

Self and others. The element self and others of the KFET has competencies of self-awareness, cultural competence, and professionalism. This aspect of the KFET involves the teacher consistently and independently reflecting upon her practice and data, using a multitude of strategies to make the most efficient use of her time and energy, building culturally relevant material into lesson plans, and upholding professional responsibilities

Reflection upon processes and data has been included in various studies related to PCK. Ertmer & Newby (1996) suggested that developing PCK is about adding knowledge, and partly about figuring ways to integrate and use that knowledge in strategic, self-regulated, and reflective ways. Schön (1983) described how "reflection-on-action" is done after a teacher has completed a particular task. With this process, teachers realize the need for a modification of their practice upon reflection.

As part of the data collection for this study, the participants often were asked to be reflective on why a particular process occurred or what was involved in process decisions. After each class Helen and Grace stated that they would reflect on the class and modify the next class's lesson by either going into more detail where questions were raised by students or when the content was not comprehended as indicated by the exit tickets. Helen reflected on her different use of data in preparing students for the Milestone exams. She adjusted her process to posting individual student mastery of a particular standard rather than performance in class. Grace's reflection on use of data resulted in her seeking out her coach to address student performance on exams. This resulted in her modifying her practice in creating exams. She also was concerned about the students' reliance on her for the notes that were expected to be taken in class. Part of her reflection was thinking about how to wean students off depending on her cues to know what notes should be taken.

Both participants routinely implemented different strategies for efficient use of time and energy. This ranged from classroom count downs, to use of timers, to warnings that a change in class was about to occur—from lecture to lab for, example. Each class was structured in a similar manner. It followed the agenda that was written on the board for each class. The structure of which is a KIPPism. Classes began with the teacher meeting the students at the door. Each class had a do-it-now for five to 10 minutes. The agenda listed on the board dictated how the class time was going to be spent. At the end of class, there was discussion of the homework, followed by an exit ticket that was submitted prior to the student leaving the class. The teachers often walked around the room during times of student independent work to keep students focused or provide assistance where needed.

Each teacher built culturally relevant material into lesson plans. This was important to both participants because of their beliefs that the students see themselves as being scientists and capable of going forward to pursue science as a career option. There were bulletin boards highlighting scientific accomplishments from persons of their culture. Students' work was placed in prominent places in the room.

Beliefs and character. This element of KFET impacts the participants' Orientation to Teaching Science more than any other component of PCK. The competency and behaviors of this element both involve the idea of the teacher having a growth mindset and a sense of accountability. KIPP believes that these observable behaviors impact who the teacher thinks she is, her impact on the relationships with others, her classroom environment, how she teaches, and what she knows. During the course of the study, the participant's beliefs and character as measured by the interviews and observations remained constant. Helen stated that her vision for the class was:

> "…to incorporate a sense of curiosity about the world around us and show students that biology is more than just a science class. My goal is to motivate and inspire students to ask the question "why" about various concerns or questions that they may have about the world around them. Students will achieve this vision by connecting their lives with the study of biology while also becoming scientific literate citizens. With these skills, my students will walk out of my classroom feeling confident that they can solve any problem they are presented with along with tackling some of the major problems that exist in today's world, such as a cure for HIV or how to design an unborn child" (Helen, interview, August 21, 2015).

There were a number of instances where Helen put this belief into place. Most often during lectures, Helen used examples that related back to some current event, or there would be comments made by students that Helen would give time to in order to foster the "why" questions – no matter how farfetched. An example occurred during an interaction related to the characteristics of living things. One student wanted to know if a study that he had heard about in which a human head was placed onto a robot were true. As part of the resolution to the question, Helen challenged the student to find more information on the issue over the weekend and report back to the class. In another example, Helen would consistently tell students that “you are on fire today” as a means of implementing her belief of building students’ confidence.

Grace’s belief was that “…students best learn science by seeing and doing, as well as by making mistakes. The hands-on experiences and having to problem solve their way through courses really helps them develop methods of scientific thought and reasoning more than just memorization would” (Grace, interview, July 30, 2015). She ran her class on this belief.

Other examples of the participants demonstrating their belief and character through observable behaviors in the class included building relationship with students by listening to music that they wanted to hear, setting up a board that provided students with information about their life and background, setting up bulletin board honoring the students, holding students accountable for breaches of integrity or behavior.

I have described how teachers’ orientation to teaching science is built upon their beliefs associated with their conceptions of science teaching and learning, including beliefs about the role of the teacher, the learner, how students learn science, and how to teach in ways that make science attractive and comprehensible. I also have described the observable behaviors associated with the beliefs and character of the KFET. I have made an effort to connect the orientation to teaching science to the teaching cycle of the KFET. However, analysis of data from this study indicates there is a much stronger link between the KFET element beliefs and character to the PCK component orientation of teaching science than to the teaching cycle observable behaviors of the KFET.

Classroom culture. The KFET element classroom culture has as the competencies of classroom climate, management, discipline, and joy factor. The science department chair felt the focus for first-year KIPP science teachers should be on the classroom culture. The focus involved making the classroom environment a safe place where students are willing to take on changes and risk failure; making students feel known, loved, and valued; creating the right physical environment for learning; implementing efficient behavioral and academic systems' managing student behavior; effective discipline; and exuding a love of teaching and learning.

The classroom culture is one of the aspects that separate a KIPP classroom from other public school classrooms. Other processes that differentiate a KIPP classroom were discussed previously and included such actions as more time in school, consistent and tough-love approach to discipline, and a willingness to do whatever it takes.

Indoctrination into the KIPP culture begins during the new-teacher induction process. The process focuses on such issues as understanding the KFET, classroom discipline, mastery grading, and the five key features expected of each classroom: accessibility, raised hands, classroom engagement, academic posture, and clear systems and procedures.

I will go into more detail on mastery grading. This system provides specific, timely, and actionable feedback on assessments that require re-teaching and/or remediation if less than 75% of students demonstrate mastery; cultivates a culture of student achievement and ownership; and accurately evaluates student mastery. Teachers are provided instruction on when they should move to new material – when 75% of students attain 80% mastery on formative assessments. They are instructed on what type of reviews should take place based upon student passing rates: spiral review: 80% or more, remediation: 75% or 79%, and re-teaching: 74% or less.

Table 46 indicates a description of the purpose as well as do's and don'ts associated with each type of review.

Table 46:
Mastery Grading Criteria

Review Type	***Performance***	***Purpose***	***Do's***	***Don'ts's***
Spiral Review	80% or more	To review mastered material in a way that connects and provides foundation for future material; to keep past material fresh and relevant so students retain information over time.	Do Now's, Extension activities, Homework, tutorial materials, Review packets and activities	When students have NOT initially mastered the material, to introduce new material
Remediation	75% or 79%	To provide support when there is a sizable group of scholars who need support and it is more that can be comfortably served through tutorial alone.	Small groups, split-class format, differentiated, tutorial, online platforms (USA Test Prep, etc.…)	Move on, provide independent work with no teacher follow-up, support, or re-assessment.
		Data from your exit ticket or formative assessment usually shows that most scholars earned 50%, but there are key misconceptions that hinder mastery		
Re-teaching	74% or less	To strategically re-teach a lesson to address misconceptions,	Re-present information 1-2 days after assessment, use assessment questions to help clarify misunderstanding, use new instructional material, give another FA to reassess mastery	Simply correct test questions whole group and move on, invite over 30% of your students to tutorial and move on, re-.teach without reassessing mastery
		To reintroduce information in a new and more accessible way,		
		To teach a topic in a more in-depth way, or		
		To include a topic that was not addressed in order to increase student understanding, and therefore mastery.		

Teachers also are provided KIPP-defined effective strategies for the class, such as timely grading (zero to two days of formative assessment); the make-up work policy (students have the same amount of instructional days to make up work as they missed); required classwork and/or homework assignments (ensures that students have completed sufficient prerequisite material to fairly attempt mastery); and the retake policy (students are allowed to have more than one retake to attain mastery, though it does not have to be unlimited – this is based upon teacher discretion).

To foster a place where students feel loved and valued, teachers first organize a bulletin board that tells their educational story – where they went to college, what they studied, what extracurricular activities they were involved in. On her first day, Helen discussed with students her vision that "science is all around us." She explained her goals for the class, discussed the norms, explained her consequence matrix for disciplinary actions, outlined what was expected during the first five minutes of class, and reviewed the syllabus. Students completed a questionnaire that asked about their interests/hobbies, things that teachers do that bother them, what makes them feel open and comfortable in class, anything they would like the teacher to know, and their goals for the year. She would then use this information during the course of the semester to incorporate their responses into components of the lecture.

The classroom culture component of the KFET impacts the PCK component of knowledge of students' understanding in science due to it including such aspects as motivation, diversity in ability and developmental levels, and need. The PCK component knowledge of assessment in science learning would also be impacted by the teacher's classroom culture. An example of this at KIPP would involve implementing the master grading policy. The teacher would need to be aware of different methods by which learning can be assessed. During this study, it was demonstrated by Helen implementing the white paper assignments, or Grace having students write stories of relationships to demonstrate the different types of chemical reactions.

The teachers addressed issues of motivation by participating in discussions on why students were at KIPP. Such issues involved examples like the wait list for students wanting to gain a spot in classes, the strong focus on high school graduation and college placement, and performance on such high-stakes testing at the American College Testing (ACT) program. For both teachers, class time was devoted to taking practice ACT exams and including vocabulary terms related to the ACT in their lesson plans. Developing assessment items indicates how a teacher's knowledge of assessment is impacted. Student assessment played a major role in the mastery grading criteria through the use of classroom extension activities, small group assignments, tutorials, use of online platforms (for example USA Test Prep or StudyIsland), and review packets.

Knowledge. The KFET element, knowledge, has as its competency and behavior the notion of content knowledge. The expectation is that the teacher: knows the material well enough to create questions that teach and assess students and delivers instruction that reflects an understanding of the content and concepts of the discipline, constantly connecting lessons to previous and future lessons.

While there have been other studies that explored the relationship between subject matter content knowledge and PCK (Ball, et al., 2008; Baumert, J., Kunter, M., Blum, W., Brunner, M., Voss, T., Jordan, A., & ... Tsai, Y., 2010; Jüttner, Boone, Park, & Neuhaus, 2012; Luft, Dubois, Nixon, & Campball, 2015), I have purposefully not used this approach in completing this study. In an evaluation of studies that related the relationship between a teacher's content knowledge and PCK, van Driel, Berry, and Meirink (2015) suggested that content knowledge and PCK are separate types of teacher knowledge and that few studies have looked only at PCK. I acknowledge the critical role content knowledge plays in the success of a teacher in the classroom. This element would impact the component of PCK for knowledge of science curriculum and knowledge of assessments. In order to display knowledge of content for the purpose of creating questions that teaches and assesses students, a teacher would have to have a fundamental understanding of the content. For the purposes of this study, I wanted the focus to be solely on aspects of PCK. Further studies related to the interaction of content knowledge, PCK, and the KFET is a suggestion for future work.

I have described the other four elements of the KFET and their greater impact on *certain* components of new KIPP teachers' PCK development. My results suggest that the teaching cycle element of the KFET has the greatest impact on *all* of the components of PCK. For example, the data provided a strong link between the KFET element beliefs and character and the PCK component orientation to teaching science. The results of the study did not provide strong links between the KFET element beliefs and character and the other PCK components.

Summary

The teaching cycle of the KFET has 13 observable behaviors (more than any other element) that were used to determine the impact on the new KIPP teachers' PCK development. Results presented indicate the teaching cycle of the KFET has observable behaviors impacting each of the five components of PCK, but not all at the same strength. The components of PCK have links to specific elements of the KFET that are stronger than others.

CHAPTER 5

Research Findings, Implications, and Summary

I will now describe the research findings that I have made related to the data obtained during this study. These findings will be followed by implications on the development of KIPP science teachers' PCK. I will then suggest future research opportunities and conclude with a summary of the conclusions that can be drawn from this study.

The development of the new teacher's understanding of the Teaching Cycle of the KFET is not focused on by coaches during the first year of employment at KIPP. According to the science department chair, choosing what element of the KFET to focus on is a three-step process that begins with a formative evaluation of all teachers on the elements of the KFET. The KFET stipulates specific criteria be used to complete the evaluation of a specific behavior. For example, some behavior rankings are based on lesson plans, some use observations, and some use assessments. The type of professional development provided is based on program developed by the science department chair called the Choose Your Own Adventure Professional Development. The science department chair indicated that data from this formative evaluation of all teachers is then filtered from highest performing element of the KFET to the lowest performing element of the KFET for all of the teachers in the school. The lowest element of the KFET for the school is then targeted to develop professional sessions around it. The first session revolves around instructional strategies. It was noticed during observations by the science department chair that teachers' instructions were not clear and teachers were not holding students accountable for the instructions that were provided.

The second process involves individual teachers, and the decision of what to focus on is based upon the O3 discussions between the teachers and their coaches. Sometime during the week, the coach observes the classroom and takes literal notes of what is going on in the classroom. A brief example is provided in Figure 11.

Pop-in (Optional) - Collected Evidence
for Grace by SDC

Source 5/5activities	Time Tagged	Notes	Tags	Observer	Shared All | None
Classroom Observation Text	2:12 pm August 3, 2015	T - I need eyes up in front in 5, mouths closed in 4, 3 still waiting on eyes, 2, and 1. Great way to include behavioral criteria for success in your countdown to remind students what your expectations are when you are on one.	3.2a 3.2b	SDC	
Classroom Observation	2:14 pm August 3, 2015	T - ok. I need someone to share with us their Do Now. S - five different students share their responses (one students snap for students sharing response). This is good culture. How do we get kids to do more of this throughout the rest of the period? Let's talk about "risk culture."	3.1a	SDC	
Classroom Observation	2:17 pm August 3, 2015	T - I like how you guys were eager to shout out each other out. So we want to use something called bright spots to shout each other. So let's do two-claps for all that participated during the Do Now. 1-2. I didn't have everyone that time so let's try that again. I want us to norm on 100%. Two claps for participating 1-2. Very good. Very good! Encourage 100% participation 100% of the time. Keep pushing this idea everyday all the time.	3.2b 3.3a	SDC	
Classroom Observation	2:17 pm August 3, 2015	T - Ok can I get a strong reader to read key point number one.		SDC	

Figure 11: Literal Notes from Classroom Observations

The coach (the department chair) then synthesizes the teachers' actions that caused students' observed behavior and, from that, analysis growth goals are established for the individual teacher. The literal notes are provided to the teacher and a discussion is held between the coach and teacher about things that the teacher did great on (glows) and things the teacher should push themselves on (grows). The teacher then has the opportunity to either agree or disagree agree with what the coach has observed. An example of the debriefing is provided in

Figure 12.

Pop-in (Optional) - Post-Observation Conference
for Grace by SDC

Glows (+):

- SOCS - I love when you countdown you give What-to-Do instruction as well. Your instructions were sequential, observable, concrete, and specific enough for students to follow them with ease. This shows that you have a clear idea of what you want from students after you give instructions. Great way to include behavioral criteria for success in your countdown to remind students what your expectations are when you are on one.
- Stop and Scan/Do it Again - I saw you stop and scan when you were listening for "Ame." When students see you looking for your expectations then they know you mean business are more inclined to follow instructions the first time given.
- 100% - Every time you gave instructions you had at least 26 out of 27 students following your instructions. This means that your instructions were super clear and that you are holding students to those same instructions.

Grows (-):

- Strong Voice - Let's work on your strong voice. Strong voice helps enhance student engagement and is a great model for students replicate when they are sharing answers aloud and in whole-class format.

Figure 12: Debriefing Post Observation Notes

Next, steps are developed on what areas to grow on. This is then looked for in the next cycle and the teacher's progress on this area for growth is tracked.

The science department chair indicated that the priority for new science teacher development in the O3s is given to the KFET element of classroom culture. He stated "… that if teachers are utilizing classroom culture moves, they would be able to facilitate the lesson plans and materials that they have designed for the class. It impacts the other KFET observable behaviors more directly than the other elements of the KFET" (Personal communication, November 11, 2015). The focus also involves making certain that 100% of the students are on task 100% of the time.

The third process for this is a procedure that is titled *Looking at Student Work Protocol*. This procedure was developed from looking at other charter schools and adds a video component that allows other teachers to peek into each other's classroom, as well provides warm and cool feedback that indicates areas to grow in or strategies to use. Interdisciplinary content teams are put together to observe the videos and provide the feedback.

The science department chair indicated that observable behaviors of the teaching cycle of the KFET are not focused on during the O3s until sometime in the second or third year at KIPP. The reason is that during the hiring process, teachers are screened in part based upon how they carry out their teaching functions in class. The participants in this study had extensive prior experience in the classroom. Issues related to the teaching cycle were not an immediate concern on the part of the science department chair. As a result, the participants initially tended to focus on the KFET element that related to classroom culture. Their efforts to bond with the students utilized a lot of the soft people skills to build relationships. The participants built this classroom culture by examples, such as placing pictures of their life outside of KIPP in their rooms, building reward and recognition boards, and standing at the door to greet students as they walked into the class.

The number of PCK/teaching cycle incidents exhibited by new teachers increased from first observation to the last. Tabulating the number of instances PCK components observed in the participant's classroom was done through the enumerative approach. The components of PCK were itemized in Appendix C. My review of field notes was used to count when the participants exhibited one of the components. This enabled me to tabulate both the participants' experience in practice, as well as the idiosyncratic aspect of their teaching. The tally was first done evaluating the instances of PCK documented in the field notes taken during a classroom observation. When clarification of notes was needed, the audio recording of the class was used. The goal was to document the number of observable incidences of PCK over time. Table 23 (chapter 4, page 143) is an enumeration of the number of incidences observed early in the semester verses late in the semester.

The data from this enumerative process suggests that the participants demonstrated more instances of the PCK component knowledge of instructional strategies (188) and fewest incidences of orientation to teaching science (9). This trend also holds for both of the participants and suggests that the teachers exhibited their efficacy and implemented a number of different strategies to convey content. While knowledge of instructional strategies had the greatest number of incidences, the PCK component knowledge of science curriculum had the greatest percentage of increase at 69%. This suggests that the greatest growth in PCK occurred in the participants' knowledge of science curriculum. Another trend in the data is a constant increase in the number of incidents of PCK from the first classroom observation to the last, suggesting that the longer the participant was in a KIPP system the more incidents of PCK were observed. For Grace, there was a 42% increase in the number of incidents, even though she was involved in half of the study. Helen had an increase of 57% in the number of incidents.

The teacher's developing understanding of the KFET impacts the development of her PCK, but the KFET rubric is not sensitive enough to detect these changes. A major component of the KFET that sets it apart from other teacher frameworks is the rubric used to score teachers based upon their performance. As discussed previously, the rubric divided each of the observable behaviors of the KFET into five tiers that indicate characteristics of accomplishment as seen during an observation across the range from novice teacher to master teacher. Appendix A provides a detailed explanation of the rubric along with what criteria is required to rank a teacher at a certain tier for a specific KFET behavior. I have previously (Figure 7) described the connections that I have drawn between the observable behaviors of the teaching cycle of the KFET and the components of PCK. A part of the strategy used in determining the impact of the teaching cycle of the KFET on the development of a new KIPP science teacher's PCK was comparing the rubric rankings provided by the participants, the science department chair, and myself.

One of the limitations of this approach involves specific criteria that a statistical analysis of the data would demand. This includes such criteria as a larger sample size, more data points, and greater variation in the rankings. Based on discussions with the University of Georgia Statistical Consulting Center (Ross and Chen, personal communication, October, 12, 2016), a statistical test that could be used for ferreting out significant changes in the data simply does not apply here due to the limitations of the study. The number of participants was based upon the number of new KIPP science teachers that met our participation criteria. In this instance, there were only two in the entire region. One left prior to the completion of the study. The rankings using the rubric associated with the teaching cycle of the KFET were completed by three individuals. This did not provide enough diversity in the results to detect a statistically significant difference in the population.

There is an impact on a new KIPP science teacher's PCK by the implementation of the observable behaviors associated with the teaching cycle element of the KFET. In completing this study, I have implemented a number of strategies in which I have made a connection between the observable behaviors of the teaching cycle of the KFET and the components of PCK. Each has associated with it data obtained throughout this study. Each of these strategies has played a role in my ability to make connections between the impact of the teaching cycle of the KFET on the development of new science teachers' PCK. They include aligning the observable behaviors of the teaching cycle of the KFET with the components of PCK; observing teachers' behaviors in their classrooms and documenting incidences of PCK and teaching cycle observable behaviors; completing a ranking of KFET observable behaviors related to the teaching cycle of the KFET; completing both formal and informal interviews related to the participants' PCK; and obtaining classroom artifacts and memos that support the participants' KFET and PCK.

At the beginning of this study, it was important to gain an understanding of the participants' PCK to establishment a baseline. This was accomplished through the formal interview and through observations at the beginning of the semester. Gaining this understanding was also the only way to determine if their PCK had changed. It also was important to have instructors who were experienced so that they walked in with a strong idea of how their classes would run. This allowed maturation as an instructor to not be a major factor in evaluating change. This afforded me the confidence to relate change to their PCK to what occurred in the first year at KIPP with their experience within KIPP.

The observable behaviors expected by the teaching cycle of the KFET are not specific in how a teacher is to carry out these expectations in their classrooms. The observable behaviors serve as a barometer of their competency at accomplishing what is expected of a KIPP teacher. KIPP teachers are indoctrinated with this during their induction process. While the O3s may not focus specifically on this in the first year, it is still a component of the teacher's yearly evaluation. It is, therefore, in the teacher's best interest to demonstrate a level of competency in observable behaviors that are defined by the teaching cycle of the KFET.

Throughout this study, I observed instances of both participants striving to demonstrate the behaviors expected of the teaching cycle of the KFET. These efforts have been similar to what Park and Oliver (2008) describe as "idiosyncratic." Each teacher's change in teaching cycle observable behaviors was a result of different experiences and knowledge gained in their classrooms. On some level, each of the three competencies of the teaching cycle of the KFET

(Plan, Teach, Get Better So More Kids Learn) were impacted to differing degrees and at different times throughout the study. In a similar fashion, the component of PCK that I aligned with each specific observable behaviors of the teaching cycle of the KFET also changed.

An example of this early in the study occurred with Grace. She indicated that her initial approach to summative assessments was based upon what had worked for her in the past. She had taught the content successfully and had exams that indicated previous students had mastered the content. Leading up to her first summative assessment, all of her formative data had indicated her previous approach would work for her at KIPP. The first summative assessment yielded disappointing results from the students. She met with her coach to try and figure out what she could do differently. Two changes in the structure of her assessment led to improved student performance. By "chunking" similar material together in the assessment (for example, all questions in an exam section are related to each other by similar content) and scaling the material (for example, having low-level Bloom's Taxonomy questions in the beginning of the exam) in a way that students gained confidence in answering easier questions first, the students began demonstrating the level of success that the formative data predicted.

This effort was driven by the teaching cycle behavior describing expectations to assess and adjust so more students learn. Grace changed how she planned her assessments so that they were "appropriately spiraled, scaffolded, and differentiated." The knowledge of the assessment component for PCK was impacted in this instance.

For Helen, the most significant change for her occurred in her use of data, which impacted a number of areas associated with the teaching cycle of the KFET. Performance data from diagnostic scores, exit-ticket scores, quiz data scores, and unit assessments made her realize that students were not mastering the content. This prompted her to break down the standards to provide a more foundational level of instruction; for example, a greater emphasis on using vocabulary. She also gave students who could handle a more rigorous workload independent case studies to complete. This led to a concept she started at KIPP called a white paper review assignment, where students created white papers and used them as study guides. Data from the first semester convinced her to change the order in which certain units were taught so that there was a better buildup of students' prior knowledge. The use of data also impacted how her tutorials were done. The structure of the class changed in the second semester to have tutorials that were standards-driven. This involved using student trackers, a tool students used to determine which standards they were deficient on – a new concept for Helen. Specific standards were taught at certain tutorials, and students came to tutorial on days where the deficient standards were being taught.

All of these behaviors implemented by Helen demonstrated a significant change in the competencies associated with the teaching cycle element of KFET. These experiences in practice that she had in her classroom led to changes in her PCK. Her orientation to how students learned led her to alter the way she felt science teaching should be taught. Her knowledge of student understanding was altered by realizing that the class had to be differentiated due to the students' ability to master the class content. Her knowledge of science curriculum changed in how the tutorials became focused on specific standards. Her knowledge of instructional strategies changed in how she restructured the class during the second semester. And finally, her knowledge of assessment changed in her use of white paper assignments to help students in their review process. All these changes are substantiated with data that I have obtained and described from a triangulation approach to answering the research question.

Implications for Future Research

The purpose of this study was to establish a linkage between the use of the teaching cycle of the KFET and development of the PCK components of new KIPP science teachers. While there were limitations to the study, such as the number of participants and the variability of the KFET rubric, the study also leaves a number of questions that can be answered with future research.

Examining PCK development among new teachers in other types of schools. As previously stated, KIPP is a national network of public charter schools that prides itself on the unique culture that exists in its classrooms. Observable behaviors such as the KFET that define what KIPP considers as excellent teaching, the focus on getting students to and through college, an environment that fosters teacher autonomy, a focus on classroom management that is unique to KIPP, and the effort to extend both the day and the number of days that students are in school distinguish the KIPP experience from other educational experiences. A future study can examine how PCK is developed in a KIPP world verses its development in another school environment.

Focusing on changes in PCK as a teacher matures in a KIPP System. KIPP hires a variety of instructors with different levels of experience. While I used teachers who were experienced in their craft, an area of future research could look at how a teacher's PCK changes the longer they are in the KIPP system. My study demonstrated that specific elements of the KFET are focused on by the teacher's coaches in their first year of working at KIPP. The science department chair indicated that the teaching cycle element of the KFET is not focused on until the second or third year of employment. What impact does longevity in a KIPP system have on the development of a teacher's PCK is not answered with this study. I did observe that there was a difference in Grace's and Helen's PCK from the beginning of the school year to the end. This was demonstrated by the number of instances of PCK that was enumerated. Would this increase in the number of instances hold up over time?

Determining the difference in the implementation of the KFET in elementary, middle, and high school, and the impact on PCK. As a national public charter school network, there are now 200 KIPP schools serving nearly 80,000 students. In many regions, a student could enter a KIPP school in kindergarten and graduate from a KIPP high school. The KFET is implemented across KIPP nation. All teachers are evaluated on the elements of the KFET. A research question could examine how the KFET impacts PCK in the elementary, middle, and high schools that comprise KIPP.

Examining the impact of all of the KFET elements on development of PCK. This study made an effort to focus as much as possible on the competency of the teaching cycle of the KFET. There are four other elements that were not aligned to the components of PCK. While the study did find other components of PCK were impacted by specific elements of KFET, this was not the main focus of the study. This effort would take considerably more time and personnel than what was available to complete this study.

Expanding the pool of participants to be statistically significant. This study was a qualitative effort to determine the impact of the teaching cycle element of the KFET on the development of the PCK for a teacher new to KIPP. One of the statistical limitations involved having only two participants. There are more than 5,000 teachers who make up KIPP nation. Expanding the study to look at a larger pool of participants could provide greater statistical insight into the findings observed in this study.

Adapting the Teaching Cycle of KFET to incorporate specific components of PCK. Finally, a suggestion that comes from an analysis of the KFET with the components of PCK is to incorporate these components into the evaluation of the elements of the KFET. The KFET is routinely evaluated for its effectiveness in accomplishing its task – evaluating the fidelity of KIPP teachers to what KIPP defines as excellent teaching. While the KFET is a tool used nationally by KIPP, each region has the autonomy to adapt it to its specific interest. I have previously indicated the extensive number of resources that is used by KIPP to improve the KFET. Each year, KIPP evaluates the framework to determine what is relevant and changes the framework when it is deemed necessary. This process is done on both a national and regional level. Incorporating components of PCK into the framework links another body of extensive research to the process and improves KIPP's ability to achieve excellent teaching.

Summary

This study examined the impact of the KFET on the development of new KIPP science teachers' PCK. The KFET serves as the main tool by which KIPP holds all of its teachers accountable. It is the standard by which KIPP defines excellent teaching. To date, there has been no study that has examined the impact of the KFET on the PCK of new KIPP science teachers. KIPP has grown from an idea between two teachers with 60 students to now 200 schools and nearly 80,000 students. The majority of these students participate in the National School Lunch Program, where a requirement is that the family's income is at or near a percent of the poverty level. It is important to understand what impact the KFET has in providing an excellent education to these students. From the moment a teacher walks into the door at KIPP, the KIPPtonizing process begins. It involves the induction program, being assigned a coach, understanding the time commitments, and embracing the KFET. All of these factors play a role in KIPP's belief that all students will learn. There is also a commitment to support students from kindergarten to college graduation.

A triangulated approach was taken to complete the study. Observations, interviews, and various artifacts were used in this process. To increase the validity of the study, member checks, peer debriefing, prolonged engagement, persistent observations, and audit trails were implemented. To avoid bias, I have made this an inductive study so that—by keeping an open mind from the start—I would limit the collection of data that only served my purpose and some self-fulfilling-prophecy bias.

The results demonstrated that new teacher enactment of the other elements of KFET has a greater impact on specific components of a teacher's PCK development, while the teaching cycle impacts the development of all the components of PCK; the development of the new teacher's understanding of the Teaching Cycle of the KFET is not focused on by coaches during the first year of employment at KIPP; the number of PCK/teaching cycle incidents exhibited by new teachers increased over time; the teacher's developing understanding of KFET impacts the development of their PCK, but the KFET rubric is not sensitive enough to detect these changes; and that the observable behaviors of the teaching cycle element of the KFET impact a new KIPP science teachers' PCK. I also have provided suggestions for future research related to the interaction of KIPP, PCK, and the KFET.

If we are to work towards resolving Bechtel's challenge of students of color becoming scientists and my wish for a KIPP student to win the Nobel Prize in chemistry, there must be an improvement in the preparation of high school science teachers. Before students can become scientists, they must first succeed in science in secondary education, then find success in college, and to do that, they need excellent science teachers. It is important to understand the relationship between the KFET and a teacher's PCK if only because so much is depending upon the teacher's success.

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Appendix

A KIPP: Framework for Excellent Teaching


SELF AND OTHERS
BELIEFS AND CHARACTER
KNOWLEDGE
STUDENT GROWTH AND ACHIEVEMENT
CLASSROOM CULTURE
THE TEACHING CYCLE
KIPP FRAMEWORK FOR
EXCELLENT TEACHING
KFET VERSION 2.0, SUMMER 2012
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TEACHER PATHWAYS RUBRIC | 2015 2016

KIPP: Metro Atlanta Schools

KIPP Framework For Excellent Teaching (KFET) 3.0 2015-16, KIPP Metro Atlanta Schools

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KIPP

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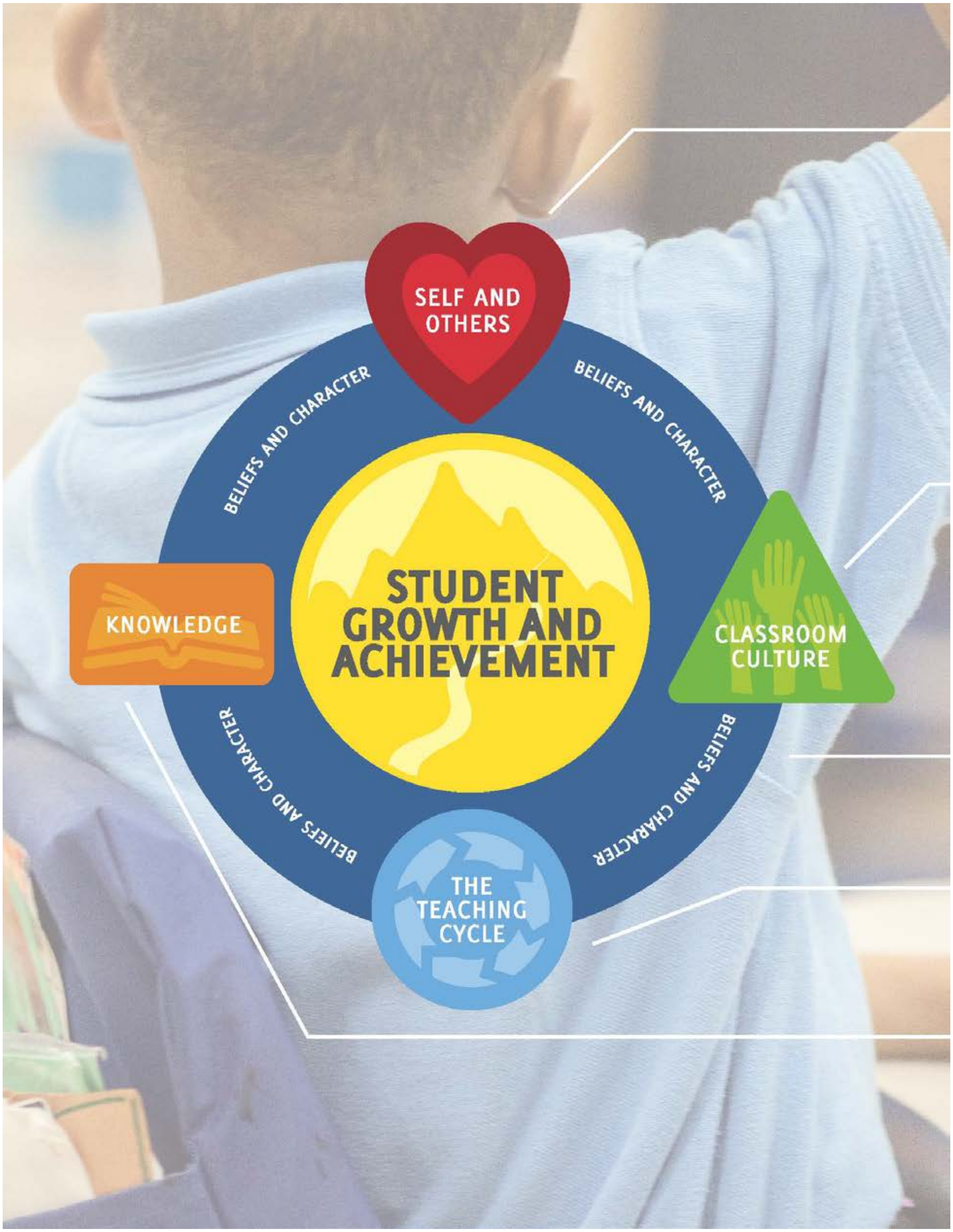
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BELIEFS AND CHARACTER
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◊ BEHAVIOR

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Cultural Competence
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◊ BEHAVIOR

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Management and Discipline
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- 100%
- Warm and Demanding

Joy Factor

◊ ELEMENT
Beliefs and Character

◊ COMPETENCY

Growth Mindset and Accountability

◊ BEHAVIOR

Growth Mindset and Accountability

◊ ELEMENT
The Teaching Cycle

◊ COMPETENCY

Plan
Teach
Get Better so More Kids Learn

◊ BEHAVIOR

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- SMART Aim
- The "What" Matching the "How"
- Vocabulary
- Reading & Writing Strategies
- Differentiation

Teach
- Clarity
- Questioning
- Rigor
- Urgent Patience

Get Better so More Kids Learn
- Assess
- CFU
- Track and Analyze Data

◊ ELEMENT
Knowledge

◊ COMPETENCY

Content Knowledge

◊ BEHAVIOR

Content Knowledge

Introduction

As we enter the 2015-16 school year, KIPP Metro Atlanta Schools is releasing the most up-to-date version of the KIPP Framework for Excellent Teaching Rubric (KFET 3.0).

If you used the previous versions of this rubric, you will notice a few changes in KFET 3.0. While the five elements – Self and Others, Beliefs and Character, Classroom Culture, Teaching Cycle, and Knowledge – and the "sticky language" of the behaviors have remained the same, the names of competencies and the numbers of behaviors have shifted. The changes were made based upon the rapidly growing body of knowledge from policy, practice, and research of teacher observation and evaluation, as well as feedback from KIPP Metro Atlanta Schools' teachers and instructional leadership teams.

KFET Changes

We believe these changes will support our instructional managers and teachers by offering cohesion and adding clarity to our definition of excellent teaching.

Most notably:

- The number of behaviors has been reduced from 51 to 27.
- The number of competencies has been reduced to 11 and renamed in more cohesive language.
- Footnotes describing how to assess cut points between tiers have been added to each behavior. For some, the footnotes flesh out differences between tiers; other times, they explain how to think about the behavior holistically.
- Resources for teachers and instructional leaders are also available for most behaviors.
- Modified versions of the rubric exist for the following groups of teachers: Physical Education, Fine Arts, and Special Education.

Thanks

We would like to thank the following organizations (amongst others), as well as our internal rubric revision team, our Fine Arts and Physical Education Working Groups, and our Special Education Working Group for contributing to the creation of KFET 3.0:

- Achievement First (AF Essentials Observation Rubric)
- Charlotte Danielson (The Framework for Teaching Reflecting Teaching to Support CCSS Learning: The Six Clusters)
- District of Columbia Public Schools (IMPACT Model)
- Houston Independent School District
- Mastery Public Charter Schools Teacher Observation and Evaluation Model
- Teach For America (Teaching as Leadership Rubric)
- The New Teacher Project (TNTP Core Teaching Rubric)
- The Marzano Teacher Evaluation Model
- YES Prep Public Schools (Teaching Excellence Rubric)

Teacher Leader · Level 5

What things can count for a "teacher leader" at a Level 5?

The Teacher Pathways Teacher Manager Working Group came together in the winter of 2015 and created a research-based list for possible examples of what would contribute toward a teacher being rated a Level 5.

Level 5 Criteria

In order for the teacher to be considered a Level 5, s/he must meet all the criteria of a Level 5, plus demonstrate "active teacher leadership." The following behaviors are examples of active teacher leadership:

- Presents a professional development session on a certain behavior/behaviors to their department, school, region, or an outside conference
- Opens his/her classroom for filming of selected behaviors for the Excellence in Teaching Library
- Officially or unofficially mentors another teacher/teachers (e.g. provides resources)
- Is an exemplar for observations (either within his/her school or across the region) of certain behaviors and has teachers observe his/her classroom
- Organizes a grade-level or school-wide event (e.g. one that focuses on parental involvement, the curriculum, etc.)
- Participates in a regional or school working group or task force (e.g. Special Education Working Group, science and social studies curriculum writer, etc.)
- Applies for, and receives, a grant

Self and Others

Excellent teaching requires understanding of oneself, one's connection to others, and a growth mindset that allows the teacher to take ownership of the success of all KIPPsters.

1.1A Self-Awareness and Self-Adjustment

SHARPENS THE SAW

Doesn't settle or sit · Grows

method of data collection
O3s

● developing

Teacher generally identifies areas of strength or growth inaccurately.

●● progressing

With **support**, the teacher reflects upon his/her practice and data to identify areas of strength and areas of growth.

●●● established

Teacher **consistently and independently** reflects upon his/her practice and data, and can **generally identify** his/her areas of strength and areas of growth, OR seeks feedback in **key** areas.

With **some** support, the teacher can execute a **basic** plan of action (most likely put in place by his/her manager) with **measurable outcomes** and make adjustments based upon student outcomes and manager feedback.

●●●● advanced

Teacher frequently reflects upon his/her practice and data, and can **accurately self-identify** areas of strength and areas of growth, OR seeks feedback in key areas.

With **some** support, the teacher can execute a basic plan of action (most likely put in place by his/her manager) AND is **proactive** about finding other resources to support his/her development.

●●●●● master

Teacher **very frequently** or **always** reflects upon his/her practice and data, and can **accurately self-identify** his/her areas of strength and areas of growth, OR seeks feedback in key areas.

Teacher **proactively** creates a **specific and measurable** plan of action with **appropriate immediate** and/or **long-term goals** and executes the plan, constantly **self-monitoring** and **adjusting** based upon student outcomes.

Consistently serves as an active teacher leader.

1.1A footnotes

at a LEVEL 1

The teacher might pick some areas of strength and growth on the KFET rubric, but s/he misaligns to the areas of growth that the data supports and/or his/her coach identifies.

at a LEVEL 2

With support from manager, the teacher can reflect upon his/her practice in order to identify areas of strength and areas of growth that align with data points from observations.

At a Level 2, however, the teacher is inconsistent in executing an action plan to make measurable growth in his/her development areas.

at a LEVEL 3

The teacher can accurately reflect on his/her areas of strength and areas of growth (the manager might add other data gathered during observations, etc.), and the areas that the manager identified generally align with what the teacher has identified. For example, the teacher might pick one-to-two areas in which s/he would like to develop, and the manager would also push to add one more. Additionally, at a Level 3, the teacher consistently executes the development plan that s/he and his/her manager have identified (e.g. area of development is around routines and systems, and the action item for the week is to observe another teacher's classroom and read a chapter from a relevant book).

at a LEVEL 4

The teacher meets the criteria of a Level 3 teacher, but also does an additional action like independently seek out another teacher to observe, take a Coursera course, etc.

at a LEVEL 5

The teacher not only accurately identifies areas of strength or areas of growth, but also is extremely proactive in identifying short-term and long-term goals and finding resources to support his/her growth.

Self and Others

1.1B Self-Awareness and Self-Adjustment

OXYGEN MASK

Manages time, energy, and attitude. Renews physically, emotionally, and mentally, and shows grit.

method of data collection
O3s & Observations

● developing

Does not consistently maintain energy.

●● progressing

With **support**, can name when s/he will lose or has lost energy and motivation **during key points** of the school year, and with **some** success, can implement a limited number of time-management strategies to maintain energy, motivation, and a positive attitude.

●●● established

Consistently anticipates when s/he will lose energy and motivation **during key points** of the school year.

Implements a **limited** number of time-management strategies and is **generally** successful at maintaining energy, motivation, and attitude.

●●●● advanced

Always or almost always uses a multitude of strategies in order to make the most efficient use of his/her time and energy throughout the day, week, semester, and over the course of the school year.

Consistently strikes the right balance to ensure physical, emotional, and mental recovery, and maintains a positive attitude while demonstrating grit.

●●●●● master

Always or almost always uses a multitude of strategies in order to make the most efficient use of his/her time and energy throughout the day, week, semester, and over the course of the school year.

Consistently strikes the right balance to ensure physical, emotional, and mental recovery, and maintains a positive attitude while demonstrating grit.

Serves as a model for rest and renewal, and encourages others, when appropriate.

1.1B footnotes

- This section (especially at a Level 4 and a Level 5) is not stating that one won't be tired; rather that s/he can instead maintain energy through hard parts in the day, week, month, or year. Maintaining energy looks different for each person – for some, it would be ensuring consistent sleep and/or exercise, for others it could be mindfully scheduling vacations during school breaks to rest and recharge.

resources

- Heyck-Merlin, Maya. *The Together Teacher: Plan Ahead, Get Organized, and Save Time!* 2012.
- Peterson, Christopher and Martin Seligman. *Character Strengths and Virtues: A Handbook and Classification*. 2004.
- Rath, Tom. *Eat Move Sleep: How Small Choices Lead to Big Changes*. 2014.
- ---. *Are You Fully Charged?: The 3 Keys to Energizing Your Work and Life*. 2015.
- Stack, Laura. *What to Do When There's Too Much to Do: Reduce Tasks, Increase Results, and Save 90 Minutes a Day*. 2012.
- ---. *Leave the Office Earlier: The Productivity Pro Shows You How to Do More in Less Time...and Feel Great About It*. 2004.

Self and Others

1.2 Cultural Competence

KNOW YOURSELF AND YOUR STUDENTS.

Considers cultural connections and differences between self, students, and colleagues when communicating in general, as well as when planning and executing lessons.

method of data collection

Lesson Plans & Unit Plans

developing

Does not build in culturally relevant material.

progressing

Sometimes builds culturally relevant material into lesson plans.

established

Consistently builds culturally relevant material and techniques into lesson plans.

advanced

Almost always builds culturally relevant material and techniques into lesson plans.

master

Always considers the culture of students, families, and colleagues when crafting lesson plans with culturally relevant materials and while interacting with stakeholders **on a daily basis**.

Leads dialogue at the school, regional, or national level that helps to **transform** individuals, the school community, or other schools toward becoming more culturally competent.

1.2 footnotes

- Cultural competence includes aspects of students' lives such as gender, race, age, and socio-economic status.
- Examples of culturally relevant materials include using students' interests to drive content, including students as examples in class, selecting differentiated texts based upon students' interests, incorporating aspects of students' neighborhood/city, etc.
- For this behavior, "sometimes" is one day a week, "consistently" is two-to-three times a week, "almost always" is four days a week, and a Level 5 is defined as including culturally relevant material every day.

resources

- Ladson-Billings, Gloria. "But That's Just Good Teaching! The Case for Culturally Relevant Pedagogy." *Theory into Practice* 34. Summer 1995. 159-165.
- Perry, Theresa, Claude Steele, Asa Hilliard III. *Young, Gifted, and Black: Promoting High Achievement Among African-American Students*. 2004.
- Saphier, John, Mary Ann Haley-Speca, Robert Gower. *The Skillful Teacher: Building Your Teaching Skills*. 2008. 351-352.

Self and Others

1.3 PROFESSIONALISM

Honors that teaching is our chosen profession and that our students and their families put a tremendous amount of faith in us as individuals.

method of data collection
Lesson Plans and O3s

• developing

Rarely upholds professional responsibilities.

•• progressing

Upholds **some** professional responsibilities, but has **more than four** instances in which it interferes with performance.

••• established

Professionalism **rarely (except for two-to-three times)** interferes with performance during the school year.

•••• advanced

Professionalism **rarely, if ever (one time or less)**, interferes with performance.

••••• master

Almost always upholds professional responsibilities, with exceptions only due to extenuating circumstances.

Models professionalism for others, holds others accountable, and/or mentors others in professionalism, when appropriate.

1.3 footnotes

- Responsibilities include, but are not limited to, the following: attendance, on-time arrival, following school rules and procedures (i.e. dress code, grading, deadlines, duties, timely communication), self-control, grit, and respect.
- **Respect** is a feeling or understanding that someone or something is important, serious, etc., and should be treated in an appropriate way. All stakeholders (students, parents, staff, etc.) should be treated with respect.
- **Self-Control** is the capacity to regulate thoughts, feelings, or behaviors when they conflict with valued goals. For example, the teacher remains calm even when criticized or otherwise provoked, allows others to speak without interruption, is polite to others, keeps temper in check, etc.
- **Grit** is defined as perseverance and passion for long-term goals. It means that a teacher finishes whatever s/he began, tries very hard even after experiencing failure, stays committed to goals, keeps working hard even during difficult times, etc.

resources

- Covey, Stephen. *The 7 Habits of Highly Effective People: Powerful Lessons in Personal Change*. 1989.
- Lemov, Doug. "Emotional Constancy." Technique 61 in *Teach Like a Champion 2.0: 62 Techniques that Put Students on the Path to College*. 2014. 439-441.
- Mischel, Walter. *The Marshmallow Test: Mastering Self Control*. 2014.
- Patterson, Kerry, et al. *Crucial Conversations: Tools for Talking When Stakes are High*. 2002.
- Individual school handbooks

Beliefs and Character

An excellent KIPP teacher is committed to KIPP's mission.

2.1 GROWTH MINDSET & ACCOUNTABILITY

All children can learn.

method of data collection

Observations & Student Surveys

● developing	**Attempts to** communicate, through words and actions, that all students can learn.	**Few (less than 60%)** students report that their teacher cares about them.
●● progressing	**Attempts to** communicate, through words and actions, that all students can learn.	**Some (61-85%)** students report that their teacher cares about them.
●●● established	**Regularly** communicates, through words and actions, that all students can learn.	**Most (86-95%)** students can give evidence that their teacher cares about them.
●●●● advanced	**Consistently** communicates, through words and actions, that all students can learn.	**Most (96-99%)** students can give evidence that their teacher cares about them.
●●●●● master	**Consistently** communicates, through words and actions, that all students can learn, and creates or seizes organic opportunities to **influence his/her peers** to do the same.	**All (100%)** students can give evidence that their teacher cares about them. **Consistently** serves as an active teacher leader.

2.1 footnotes

- The "student outcomes" criteria weigh more heavily than the "teacher input" criteria. For example, if on the student satisfaction survey only 33% of students report that their teacher cares about them even though the teacher is regularly communicating that s/he cares, then the teacher would be rated a Level 2.
- This data comes from the mid-year student surveys, but this question may be re-administered in a locally given survey if the teacher or coach so chooses.
- The survey question reads: "I believe that my teacher [Teacher's Name] truly cares about me and is willing to do whatever it takes for me."
- This behavior also links closely to "PEOPLE FIRST" (3.1b).

resources

- Dweck, Carol: *The Power of Believing that You can Improve*. Filmed November 2014. TED video, 10:20. http://www.ted.com/talks/carol_dweck_the_power_of_believing_that_you_can_improve?language=en.
- Florio, Nicolette. "Carol Dweck on Fixed Mindset vs. Growth Mindset." *Examined Existence*. http://examinedexistence.com/carol-dweck-on-fixed-mindset-vs-growth-mindset/.

Classroom Culture

In an excellent classroom culture, the teacher focuses on countless tangible and intangible details in the space to create an environment where students are joyfully engaged, meaningfully on-task, and feel ownership for their individual and collective successes in college and in life.

3.1A Classroom Climate

RISK CULTURE

Insists students take risks, make and learn from mistakes, and admit confusion.

● method of data collection
● Observations

● developing

The classroom environment is not safe for **most** students, such that students are frequently unwilling to take on challenges and risk failure.

●● progressing

The classroom environment is generally safe for **some** students, such that students are willing to take on challenges and risk failure, but there are **usually** exceptions.

●●● established

The classroom environment is generally safe for **most** students, such that students are willing to take on challenges and risk failure, but there are **some** exceptions.

●●●● advanced

The classroom environment is safe for **almost all** students, such that students are willing to take on challenges and risk failure.

●●●●● master

The classroom environment is safe for **all** students, such that students are willing to take on challenges and risk failure.

Consistently serves as an active teacher leader.

3.1A footnotes

at a LEVEL 1

Most students might be reluctant to answer questions or take on challenging assignments, students might generally hesitate to ask the teacher for help even when they need it, or students might frequently discourage the work of their peers or criticize classmates who give incorrect answers.

at a LEVEL 2

While some students might eagerly respond to challenges and not respond negatively when a peer answers a question incorrectly (evidenced by tracking, giving positive reinforcement, etc.), some students might demonstrate reluctance or occasionally respond negatively when a classmate gives an incorrect answer.

at a LEVEL 3

While many students might eagerly respond to challenges and not respond negatively when a peer answers a question incorrectly (evidenced by tracking, giving positive reinforcement, etc.), some students might demonstrate reluctance or occasionally respond negatively when a classmate gives an incorrect answer.

at a LEVEL 4

Almost all students are eager to ask questions, feel comfortable asking the teacher for help, feel comfortable engaging in constructive feedback with their classmates, and do not respond negatively when a peer answers a question incorrectly (evidenced by tracking, giving positive reinforcement, etc.).

at a LEVEL 5

All students are eager to ask questions, feel comfortable asking the teacher for help, feel comfortable engaging in constructive feedback with their classmates, and do not ever respond negatively when a peer answers a question incorrectly (evidenced by tracking, giving positive reinforcement, etc.).

resources

- Saphier, John. "Discipline." Chapter 8 in *The Skillful Teacher: Building Your Teaching Skills*. 2008. 115-139. (Note: This chapter focuses on building community and dealing with resistant students).
- ---. "Classroom Climate." Chapter 14 in *The Skillful Teacher*. 328-354.

Classroom Culture

3.1B Classroom Climate

PEOPLE FIRST

Treats students as people first, and works to make them feel known, loved, and valued.

method of data collection

Observations & Student Surveys

developing

Attempts to be fair and respectful towards **some** students, families, and colleagues, and builds relationships with **limited** success.

Some students **(less than 60%)** indicate that they feel their teacher cares about them.

progressing

The teacher has a positive rapport with **some** students, as demonstrated by displays of positive affect, evidence of relationship building, and expressions of interest in students' thoughts and opinions.

Some students **(61-85%)** indicate that they feel their teacher cares about them.

established

The teacher has a positive rapport with **some** students, as demonstrated by displays of positive affect, evidence of relationship building, and expressions of interest in students' thoughts and opinions.

Some students **(86-95%)** indicate that they feel their teacher cares about them.

advanced

The teacher has a positive rapport with **most** students, as demonstrated by displays of positive affect, evidence of relationship building, and expressions of interest in students' thoughts and opinions. There is also evidence that the teacher has strong, individualized relationships with some students in the class.

For example, the teacher might demonstrate personal knowledge of students' lives, interests, and preferences.

Most (96-99%) students indicate that they feel their teacher cares about them.

master

The teacher has a positive rapport with **all** students, as demonstrated by displays of positive affect, evidence of relationship building, and expressions of interest in students' thoughts and opinions. There is also evidence that the teacher has strong, individualized relationships with some students in the class.

For example, the teacher might demonstrate personal knowledge of students' lives, interests, and preferences.

All (100%) students indicate that they feel their teacher cares about them.

Consistently serves as an active teacher leader.

3.1B footnotes

- Observers should consider the specific point in the school year when assessing this behavior. For example, in September the teacher might be in the early stages of building individualized relationships with students, or the teacher might be establishing a culture of offering unsolicited praise with students who were not previously accustomed to engaging with classmates in that way.
- The data for the "student outcomes" portion may be collected through the mid-year regional survey OR a survey given at the school level. For example, if a teacher has a development goal around this behavior, a coach may choose to assess students at other checkpoints to measure growth.
- The question reads: "I believe that my teacher [Teacher's Name] truly cares about me and is willing to do whatever it takes for me."
- The "student outcomes" criteria weigh more heavily than the "teacher input" criteria. For example, if on the student satisfaction survey only 33% of students report that their teacher cares about them even though the teacher is regularly communicating that s/he cares, then the teacher would be rated a Level 2.
- This behavior also links closely to "GROWTH MINDSET AND ACCOUNTABILITY" (2.1) due to the "student outcomes" portion – the results of the student mid-year survey tie to both behaviors.

resources

- Saphier, John. "Discipline." Chapter 8 in *The Skillful Teacher: Building Your Teaching Skills*. 2008. 115-139. (Note: This chapter focuses on building community).
- ---. "Personal Relationship Building." Chapter 13 in *The Skillful Teacher.* 317-327.

Classroom Culture

3.1C Classroom Climate

THE HAPPY PLACE

The physical environment contains seating arrangements that encourage teacher-to-student and peer-to-peer learning and rich print materials to stimulate learning.

method of data collection

Observations

● developing

Classroom is cluttered or disorganized.

The room lacks relevant content materials and/or the display of student work.

Classroom arrangement inhibits interactions.

●● progressing

The space **is somewhat clean and organized**.

The room lacks relevant content materials and/or the display of student work.

Classroom is **arranged neatly** but does not encourage varied interaction.

●●● established

The space is generally clean and organized, and it contains **work specific to content** (e.g. word walls, anchor charts).

The room **contains materials** to increase academic access to content, as well as materials for student reference (e.g. dictionaries, other appropriate reference books, anchor charts, manipulatives, and models).

Classroom is arranged neatly and encourages **some variations of interactions** between teachers and students.

●●●● advanced

The space is almost always clean and organized to promote student achievement. The room includes examples of **recent exemplary** student academic work, as well as work specific to content (e.g. word walls, anchor charts).

The room contains materials to increase academic access to content, as well as materials for student reference (e.g. dictionaries, other appropriate reference books, anchor charts, manipulatives, and models).

Classroom is arranged to meet curricular goals and allows for varied **teacher-to-student** and **student-to-student** interactions (i.e. can easily switch from independent, to partner, to group work).

●●●●● master

The space is always clean and organized to promote student achievement. The room includes examples of recent exemplary student academic work, as well as work specific to content (e.g. word walls, anchor charts).

The room contains materials to increase academic access to content, as well as materials for student reference (e.g. dictionaries, other appropriate reference books, anchor charts, manipulatives, and models).

Classroom is arranged to meet curricular goals and allows for varied teacher-to-student and student-to-student interactions.

Teacher's room serves as a role model for others.

3.1C footnotes

- To obtain a certain level, the teacher must meet all of the associated criteria.
- At a Level 3, the classroom may be arranged in a manner that encourages some varied interactions between teachers and students. For example, desks may be in neat rows, but they can easily be transformed for partner or group work. At a Level 4, the classroom is predisposed to varied types of interactions (e.g. the desks are already in partners or groups, there are different stations set up around the room).
- If a coach observes towards the end of the year, please take into consideration whether a teacher has removed items from the classroom and/or walls due to standardized testing.

resources

- Saphier, John. "Space." Chapter 5 in *The Skillful Teacher: Building Your Teaching Skills*. 2008. 40-49.

Classroom Culture

3.2A Management and Discipline

WELL-OILED MACHINE

Designs and executes efficient behavioral and academic systems.

method of data collection

Lesson Plans & Observations

● developing

Most key moments of class are missing clear procedures and/or routines.

Less than 60% of students execute procedures that the teacher attempts to implement, and/or much instructional time is wasted either redirecting behavior, giving consequences, or stopping students to redeliver directions during transitions.

●● progressing

Develops procedures and/or routines for **some key moments** that attempt to maximize instructional time.

60-85% of students execute procedures, though there is still some time wasted.

●●● established

Designs procedures and/or routines that maximize instructional time at **most** key moments in a class.

Most (86-95%) students execute procedures smoothly with little prompting/redirection from the teacher.

●●●● advanced

Designs procedures and/or routines that maximize instructional time for students at **most** key moments in a class.

Most (96-99%) students execute procedures with little-to-no prompting/redirection from the teacher.

●●●●● master

Develops procedures and/or routines that address **all possible** inefficiencies, maximizing instructional time.

All (100%) students execute procedures with little-to-no prompting from the teacher.

Consistently serves as an active teacher leader.

3.2A footnotes

- There are two main things to look for in terms of "teacher input:" 1) Routines or systems for key moments in a class, and 2) Clarity of those routines and systems, as executed by the students.
- Key moments include entry and exit routines, passing in/out materials, transitions between portions of the lesson, getting into and out of groups, sharpening pencils, etc.
- At a Level 3, for example, routines and systems are in place at most key moments in a class. Transitions between activities are efficient and smooth with minimal disruption and most (85-96%) students follow procedures without prompting (though, at a Level 3 there may still be some students who need prompting).
- Because the "student outcomes" criteria is the ultimate goal for this row, they weigh more heavily than the "teacher input" criteria. For example, if the teacher develops procedures that address most possible inefficiencies (Level 3 or Level 4), that maximize instructional time for almost all students (Level 4), but only 86-95% of students can execute with little-to-no prompting, then the teacher would be rated a Level 3.
- Additionally, the observer and teacher should take note of the specific point in the school year in which the observation occurs. For example, at the beginning of the year or semester, an observer would expect to see more prompting by the teacher, but this should decrease and the score may increase quickly over the course of the year (or semester, in some cases).
- When planning systems and routines, the teacher should take into consideration the developmental stage of their students.

resources

- Lemov, Doug. "Strategic Investment: From Procedure to Routine." Technique 49 in *Teach Like a Champion 2.0: 62 Techniques that Put Students on the Path to College*. 2014. 365-372.
- Saphier, John. "Routines." Chapter 7 in *The Skillful Teacher: Building Your Teaching Skills*. 2008. 68-71.
- Wood, Chip. *Yardsticks: Children in the Classroom Ages 4-14*. 2007.

Classroom Culture

3.2B Management and Discipline

100%

Aware of student behavior in the classroom and adjusts accordingly, providing specific, concrete, observable, and sequential directions to drive towards the student outcome of 100% of the students meeting 100% of the expectations 100% of the time.

method of data collection
Observations

● developing

Is **generally unaware** of student behavior in the classroom.

Attempts to set and reinforce clear expectations with 'What to Do' statements with **limited success** in class.

Significant instructional time is lost due to interruptions.

Less than 60% of students, on average, are on-task during the lesson.

●● progressing

Sometimes is aware of what is happening in the classroom and **attempts to** adjust to get students on task.

Some instructional time is lost due to disruptions and misbehaviors.

Sets and reinforces clear expectations with 'What to Do' statements that are **somewhat** specific, concrete, sequential, and measurable at some **key** moments in the class.

61-85% of students, on average, are on-task during the lesson.

●●● established

Regularly is aware of what is happening in the classroom and adjusts with **some** success.

Sets and reinforces clear expectations with 'What to Do' statements that are **generally** specific, concrete, sequential, and measurable at **most** key moments in the class.

Minimal instructional time is lost due to minor disruptions/misbehaviors.

86-95% of students, on average, are on-task during the lesson.

●●●● advanced

Very frequently or always is aware of what is happening in the classroom and adjusts accordingly.

Little-to-no instructional time is lost due to minor disruptions/misbehaviors.

Sets and reinforces clear expectations with **efficient** 'What to Do' statements that are specific, concrete, sequential, and measurable at **almost all** key moments in the class.

96-99% of students, on average, are on-task during the lesson.

●●●●● master

Very frequently or always is aware of what is happening in the classroom and **adjusts without compromising learning time**.

Sets and reinforces clear expectations with **highly efficient** 'What to Do' statements that are specific, concrete, sequential, and measurable **consistently throughout** the class.

100% of students, on average, are on-task during the lesson.

Consistently serves as an active teacher leader.

3.2B footnotes

- Since the "student outcomes" criteria is the ultimate goal for this behavior, it carries more weight than the "teacher input" criteria. For example, if a teacher is regularly scanning and implementing 100% strategies (a Level 3) and generally giving clear 'What to Do' statements, but only 61-85% of the students are on task, then the teacher would be rated a Level 2.
- After scanning, the following techniques, among others, could be used to get students back on-task: positive group correction, anonymous individual correction, private individual correction, or a consequence.
- "On-task" may be measured in multiple ways, but the most common way is for an observer to set a timer and count the number of students on-task at regular intervals – the recommendation is every five minutes throughout the observation period – and then take the average.
- "On task" student behavior includes, but is not limited to, the following: complying when a teacher gives a direction, following instructions, and working consistently during independent, partner or group work time.
- "Off task" student behavior includes, but is not limited to, the following: not following instructions when given, sleeping, focusing on other things (e.g. digging through purse, applying lip gloss or lotion), talking to other students when not instructed to do so, and walking around the classroom without permission.

resources

- Lemov, Doug. "Radar/Be Seen Looking." Technique 51 in *Teach Like a Champion 2.0: 62 Techniques that Put Students on the Path to College*. 2014. 381-386.
- ---. "Make Compliance Visible." Technique 52 in *Teach Like a Champion 2.0*. 393-395.
- ---. "Least Invasive Intervention." Technique 53 in *Teach Like a Champion 2.0*. 395-402.
- ---. "Firm, Calm, Finesse." Technique 54 in *Teach Like a Champion 2.0*. 402-405.
- ---. "Art of the Consequence." Technique 55 in *Teach Like a Champion 2.0*. 406-412.
- ---. "What to Do." Technique 57 in *Teach Like a Champion 2.0*. 417-420.
- Saphier, John. "Discipline." Chapter 8 in *The Skillful Teacher: Building Your Teaching Skills*. 2008. 89-112.
- ---. "Attention." Chapter 3 in *The Skillful Teacher*. 19-31.

Classroom Culture

3.2C Management and Discipline

WARM AND DEMANDING

Uses a calm, firm, and convincing tone when addressing inappropriate behavior.

method of data collection
Observations

● developing

Constantly uses indirect, defensive, or aggressive language with students and employs body language that is defensive, aggressive, or distant.

●● progressing

Attempts to use a warm and demanding tone with students but may sometimes use **negative language** when addressing student behavior.

●●● established

Uses a warm and demanding tone with students through word choice that is specific, clear, and free of negative language, and **rarely** shows signs of stress when addressing student behavior.

Teacher uses **more** positive than negative comments.

Maintains **confident** and **assertive** body language.

●●●● advanced

Is **almost always** authentically positive, modeling "warm-demanding," and holds high expectations while his/her tone is **almost always** specific, clear, and free of negative language; **never** showing signs of stress.

Teacher uses **three times as many** positive as negative comments.

Maintains confident and assertive body language.

●●●●● master

Is almost always authentically positive, modeling "warm-demanding," and holds high expectations while his/her tone is almost always positive, upbeat, and urgent; never showing signs of stress.

Teacher uses **three times as many** positive as negative comments.

Maintains confident and assertive body language.

Teacher serves as a **role model** to others in the building for his/her "warm-demanding" tone.

3.2C footnotes

- Negative language includes, but is not limited to, the following: threats (e.g. "Stop talking or I will..."), put-downs (e.g. "When are you ever going to learn?"), etc.
- To obtain a certain level, the teacher must meet all of the associated criteria.

resources

- Lemov, Doug. "Positive Framing." Technique 58 in *Teach Like a Champion 2.0: 62 Techniques that Put Students on the Path to College*. 2014. 426-433.
- ---. "Precise Praise." Technique 59 in *Teach Like a Champion 2.0*. 433-438.
- ---. "Warm/Strict." Technique 60 in *Teach Like a Champion 2.0*. 438-439.
- ---. "Emotional Constancy." Technique 61 in *Teach Like a Champion 2.0*. 439-442.
- Shindler, John. *Transformative Classroom Management: Positive Strategies to Engage All Students and Promote a Psychology of Success*. 2009.

Classroom Culture

3.3 Joy

LOVE OF THE GAME

method of data collection
Observations

Exudes a love of teaching and learning through facial expressions, tone and actions; smiles and laughs regularly; brings humor and zest to the work of teaching and learning; and creates opportunities in the day for students to smile, laugh, and be expressive.

● developing

Attempts to demonstrate joy through facial expressions, tone, laughter, and actions.

●● progressing

Sometimes demonstrates joy through facial expressions, tone, laughter, and actions.

There are **one-to-two** authentic **moments of joy and/or enthusiasm** from teachers and students each class period.

●●● established

Regularly demonstrates joy through facial expressions, tone, laughter, and actions.

There are a **few (2-3)** authentic moments of joy and/or enthusiasm from teacher and students during each class period.

●●●● advanced

Almost always demonstrates joy through facial expressions, tone, laughter, and actions.

There are **four-to-five** authentic moments of shared joy and/or enthusiasm from teacher and students each class period.

●●●●● master

Almost always demonstrates joy through facial expressions, tone, laughter, and actions.

There are **constant (more than 6)** authentic moments of joy and/or enthusiasm from teacher and students during each class period.

Teacher serves as a **role model** for nurturing the love of learning.

3.2C footnotes

- Joy may look different in primary, middle, and high school. It may also look different depending on the personality of the teacher. For example, in primary school it might include developmentally appropriate "wiggle breaks," jokes, chants, or cheers; in high school it might look like more jokes about content (while still including chants, cheers, etc., depending on teacher preference).
- Each of the criteria in this behavior carries equal weight. For example, if the teacher smiles several times throughout class, but there isn't at least one moment of shared joy, then the teacher would be rated a Level 1.
- The authentic moments of joy and/or enthusiasm may take place between the teacher and one student, a group of students, and/or the entire class.

resources

- Lemov, Doug. "Joy Factor." Technique 57 in *Teach Like a Champion 2.0: 62 Techniques that Put Students on the Path to College*. 2014. 426-433.

The Teaching Cycle

Excellent teaching means planning and executing rigorous, engaging lessons that fit into a logical scope and sequence, as well as using student data to assess mastery of objectives and movement towards big goals for student achievement and growth.

4.1A Plan

END IN MIND

Backwards plan.

- method of data collection
- Lesson Plans

● developing

Demonstrates **attempt** to use the regional or school curriculum resources OR **does not create** a scope and sequence.

●● progressing

Consistently uses the regional or school curriculum resources **OR** demonstrates an **attempt** to create a scope and sequence.

●●● established

Consistently uses the regional or school curriculum resources **OR** a teacher-created scope and sequence to plan **logical units** with objectives.

●●●● advanced

Uses student data to modify the regional or school curriculum resources **OR** a teacher-created scope and sequence.

Allocates time **appropriately** based on the content to be taught, and plans for **contingencies, remediation, and enrichment**.

●●●●● master

Uses student data to modify the regional or school curriculum resources **OR** a teacher-created scope and sequence.

Allocates time appropriately based on the content to be taught, and plans for **contingencies, remediation, and enrichment**.

Consistently serves as an active teacher leader.

4.1A footnotes

- At the primary- and middle-school levels, MOST subjects have a set scope and sequence that teachers may use and modify based upon their individual student data.
- At the high-school level (or for primary and middle school subjects that do not have a scope and sequence), teachers might be responsible for the creation of their own scope and sequence.

resources

- Lemov, Doug. "Begin with the End." Technique 6 in *Teach Like a Champion Field Guide: A Practical Resource to Make the 49 Techniques Your Own*. 2012. 73-81.
- ---. "Begin with the End." Technique 19 in *Teach Like a Champion 2.0: 62 Techniques that Put Students on the Path to College*. 2014. 133-136.
- Saphier, John. "Curriculm Design." Chapter 15 in *The Skillful Teacher: Building Your Teaching Skills*. 2008. 357-370.
- Wiggins, Grant, and Jay McTighe. *The Understanding by Design Guide to Creating High-Quality Units*. 2011.

The Teaching Cycle

4.1B Plan

SMART AIM

Plans a daily objective/aim that is achievable, rigorous, and measurable.

- method of data collection
- Lesson Plans & Unit Plans

● developing

Attempts to write aims that are achievable, rigorous, and measurable, and is successful **0-50%** of the time.

●● progressing

Aims are achievable, rigorous, and measurable **51-75%** of the time.

●●● established

Aims are achievable, rigorous, and measurable **76-85%** of the time; they include what students **need to know** and **should be able to do**.

Aims are always **backwards planned** within a unit.

●●●● advanced

Aims are **frequently (86-95% of the time)** achievable, rigorous, and measurable; they include what students need to know and should be able to do.

Aims are always backwards planned within a unit and **generally** scaffolded based on **student data**.

●●●●● master

Aims are **frequently (96-100% of the time)** achievable, rigorous, and measurable; they include what students need to know and should be able to do.

Aims are **always** backwards planned within a unit and always appropriately adjusted based on student data so that there is **no frustration or wasted time**.

Consistently serves as an active teacher leader.

4.1B footnotes

- While an individual aim can be measured as SMART or not (i.e. Was today's aim a SMART AIM?), this row should be measured from a sampling of objectives over time.
- Each of the criteria in this behavior carries equal weight. For example, if a teacher has aims on four of five days that are achievable, rigorous, and measurable (a Level 3), but does not backwards plan within a unit, then s/he would be rated a Level 2.

resources

- Lemov, Doug. "Four M's." Technique 7 in *Teach Like a Champion Field Guide: A Practical Resource to Make the 49 Techniques Your Own*. 2012. 82-89.
- ---. "4M's." Technique 17 in *Teach Like a Champion 2.0: 62 Techniques that Put Students on the Path to College*. 2014. 137-140.
- ---. "Begin with the End." Technique 19 in *Teach Like a Champion 2.0*. 133-136.
- Saphier, John. "Objectives." Chapter 16 in *The Skillful Teacher: Building Your Teaching Skills*. 2008. 371-394.

The Teaching Cycle

4.1C Plan

THE "WHAT" MATCHING THE "HOW"

Establishes clear criteria for success for students and aligns each component of the lesson to the aim.

method of data collection
- Lesson Plans

● developing

Key points and exit ticket are **not aligned** with content and/or cognition of the aim.

●● progressing

Key points and exit ticket are **aligned** with content of the aim, but may not be aligned to cognition level of the aim.

●●● established

The **key points and exit ticket or CFS** are aligned to content **and** cognition of the aim.

●●●● advanced

All components of the lesson align to content and cognition of the aim.

●●●●● master

All components of the lesson align to content and cognition of the aim.

Consistently serves as an **active teacher leader**.

4.1C footnotes

- At a Level 3, the exit ticket and/or CFS (i.e. the method in which the teacher gauges student mastery) AND the key points align to the content and cognition of the aim. If less than this aligns, then the teacher would be rated a Level 1 or Level 2.
- At a Level 2, the content of the lesson is reflected in the aim and the learning activities, but the cognition levels do not match. For example, if an aim calls for the students to analyze a text, but the students are only doing the cognitive work of identifying, then the cognitive levels do not align.
- At a Level 4, ALL components of the lesson align to the objective, including, but not limited to, the following: the hook, key points in the INM, guided practice and independent practice, and closure.
- The only difference between a Level 4 and a Level 5 is if the teacher is a teacher leader.
- Also note that in some discovery lessons such as constructivist math or science labs, these portions might look different. However, each portion should still be driving towards the SMART aim. The only exception in the lesson cycle (about the content which should be carefully considered) would be a spiral review.

resources

- Lemov, Doug. "Shortest Path." Technique 7 in *Teach Like a Champion Field Guide: A Practical Resource to Make the 49 Techniques Your Own*. 2012. 92-96.
- ---. "Post It." Technique 18 in *Teach Like a Champion 2.0: 62 Techniques that Put Students on the Path to College*. 2014. 140-142.

The Teaching Cycle

4.1D Plan

LITERACY FOR EVERYONE

Vocabulary

method of data collection
Lesson Plans, Unit Plans & Observations

developing

Does not attempt to teach vocabulary **OR** the vocabulary is not age-appropriate or subject-specific.

progressing

Models and **teaches** using age-appropriate and subject-specific vocabulary.

Students **do not consistently** use academic vocabulary when writing and speaking.

established

Models, teaches, and **holds students accountable for learning and using** age-appropriate and subject-specific vocabulary.

Students **consistently** use academic vocabulary when writing and speaking.

advanced

Models, teaches, and holds students accountable for learning and using age-appropriate and subject-specific vocabulary.

Students **almost always** use academic vocabulary when writing and speaking.

master

Models, teaches, and holds students accountable for learning and using age-appropriate and subject-specific vocabulary.

Students **almost always** use academic vocabulary when writing and speaking.

Consistently serves as an active teacher leader.

4.1D footnotes

- In ELA, vocabulary should primarily consist of high-utility academic terms found in many texts, in addition to cross-curricular terms and ELA-specific content terms. In other content areas, vocabulary should primarily consist of domain-specific academic terms.
- Each of the criteria in this behavior carries equal weight.
- At a Level 1, the teacher makes no attempt to teach vocabulary in class, and there is no evidence (in lesson/unit plans, word walls, or conversation during the lesson) that vocabulary is being taught.
- At a Level 2, students are not consistently using academic vocabulary words that are age-appropriate or subject-specific, but there is evidence that vocabulary is being taught. For example, this may look like students consistently using the word "number" instead of "digit" in a math lesson without correction from the teacher, although there might be instances in which students misuse vocabulary words.
- At a Level 3, students are consistently using academic vocabulary when speaking and writing, although there might be some exceptions during class. Additionally, teachers hold students accountable when they do not use the correct words.
- At a Level 4, students almost always use academic vocabulary when speaking and writing. The only exception is if there is a small amount of students who are individually struggling with the content (this might vary based upon class size, etc.).
- At a Level 5, the teacher meets all the criteria for a Level 4, and also serves as a teacher leader.

resources

- Beck, Isabel L., Margaret G. McKeown, and Linda Kucan. *Creating Robust Vocabulary: Frequently Asked Questions and Extended Examples (Solving Problems in Teaching of Literacy)*. 2008.
- ---. *Bringing Words to Life, Second Edition: Robust Vocabulary Instruction*. 2013.
- Marzano, Robert J., and Debra J. Pickering. *Building Academic Vocabulary: Teacher's Manual*. 2005.
- Marzano, Robert J. "The Art and Science of Teaching / Six Steps to Better Vocabulary Instruction." *Teaching for the 21st Century* 67. September 2009. 83-84.

The Teaching Cycle

4.1E Plan

LITERACY FOR EVERYONE

Reading and text-based writing strategies

method of data collection
Lesson Plans, Unit Plans & Observations

developing

When looking at the unit plan and lesson plans, written and oral responses **rarely** (0-25%) require students to draw evidence or information from the text to support analysis, reflection, and/or research.

Few (0-50%) students are able to master the key points from the text.

progressing

When looking at the unit plan and lesson plans, written and oral responses **sometimes** (26-50%) require students to draw evidence or information from the text to support analysis, reflection, and/or research.

Some (51-75%) students are able to master the key points from the text.

established

When looking at the unit plan and lesson plans, written and oral responses **regularly** (51-75%) require students to draw evidence or information from the text to support analysis, reflection, and/or research.

Most (76-85%) students are able to master the key points from the text.

advanced

When looking at the unit plan and lesson plans, written and oral responses **almost always** (76-85%) require students to draw evidence or information from the text to support analysis, reflection, and/or research.

Almost all (86-95%) students are able to master the key points from the text.

master

When looking at the unit plan and lesson plan, written and oral responses **almost always** (>86%) require students to draw evidence or information from the text to support analysis, reflection, and/or research.

Almost all or all (96-100%) students are able to master the key points from the text.

Consistently serves as an active teacher leader.

4.1E footnotes

- Complex texts will vary by content area. For math, this may mean that students engage with multi-step word problems. In science and social studies, this may also include reading nonfiction texts or primary resources related to the content.
- The percentages listed on the previous page refer to the number of days that students are required to do close reading or text-based writing.
- "Student outcomes" criteria directly mirror the student outcomes for "CLARITY" (4.2A). Hone in on this during lessons which specifically use reading comprehension or text-based writing as the criteria for success.
- Each of the criteria in this behavior carries equal weight. For example, if 86% of students master the objective (e.g. text-based writing prompt) for the day, but the teacher only does this one time during a six-week unit, then the teacher would be rated a Level 1. Conversely, if the teacher embeds reading or text-based writing into his/her lessons 60% of the time, but 90% of students master the lesson, the teacher would be rated a Level 3.
- Samples of student work can be submitted in the portfolio to help determine the rating.

resources

- AdLit.org. "Classroom Strategies." http://www.adlit.org/strategy_library/.
- Common Core State Standards Initiative. "College and Career Readiness Anchor Standards for Writing." http://www.corestandards.org/ELA-Literacy/CCRA/W/.
- ---. "Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects." http://www.corestandards.org/assets/Appendix_C.pdf.
- Farr, Steven, and Teach For America. "Building Comprehension Through Pre-, During-, and Post-Reading Strategies." Chapter 4 in *Teaching As Leadership: The Highly Effective Teacher's Guide to Closing the Achievment Gap*. 2010. 59-76.
- Harvey, Stephanie. "Nonfiction Inquiry: Using Real Reading and Writing to Explore the World." *Language Arts* 80. September 2002. 12-22.

The Teaching Cycle

4.1F Plan

DIFFERENTIATION

Pre-teaches, re-teaches, and extends as needed.

- method of data collection
- Lesson Plans

● developing

In reflection, s/he accurately explains the main ideas behind differentiating plans based on student diagnostic data and/or goals of the individualized education plans, if applicable.

OR

Does not attempt to differentiate plans.

●● progressing

Designs plans so that s/he can offer support to **individual students** while the whole class is working.

●●● established

Designs plans and **accountability systems** to initiate **various forms** of **structured differentiation** (e.g. teacher rotating among established student groupings).

●●●● advanced

Designs efficient plans and accountability systems to initiate **flexible differentiation** (e.g. students in varied groups, students working independently).

●●●●● master

Designs efficient plans and accountability systems to initiate flexible differentiation (e.g. students in varied groups, students working independently).

Consistently serves as an active teacher leader.

4.1F footnotes

- Differentiation can be achieved through differentiating for content, process, product, or environment.

resources

- Wilmette Public Schools District 39. "Differentiated Instruction." http://www.wilmette39.org/index.php?Itemid=232.

The Teaching Cycle

4.2A Teach

CLARITY

Delivers content in a well-organized, clear, accessible manner, highlighting key points. Proactively addresses students' misconceptions.

method of data collection

Observations & Student Work

● developing

Sometimes, with **limited** success, delivers content in an accessible manner.

Few (0-50%) students are able to master the key points from the lesson.

●● progressing

Sometimes delivers content in a well-organized and correct manner.

Some (51-75%) students are able to master the key points from the lesson.

●●● established

Regularly delivers content in a well-organized, clear, accessible manner, with a focus on key points.

Most students (76-85%) are able to master the key points from the lesson.

●●●● advanced

Very frequently or always delivers content in a well-organized, clear, and accessible manner, illuminating key points in a **memorable** way.

Almost all students (86-95%) are able to master the key points from the lesson.

●●●●● master

Very frequently or always delivers content in a well-organized, clear, and accessible manner, illuminating key points in a **memorable** way.

All or almost all (96-100%) students are able to master the key points from the lesson.

Assists other teachers within his/her content area in helping to break down the key points in their lessons.

4.2A footnotes

- The observer should look for the "teacher input" during the framing of the lesson and for key points during the INM (or other comparable part of the lesson if the teacher is not using the I/We/You lesson format). However, the "student outcomes" criteria weighs more heavily than the "teacher inputs" criteria. Thus, if a teacher delivered content in a "memorable" way, but only 76% of the students mastered the objective, the teacher would be rated a Level 3.
- The observer should collect student data either during the lesson or at the end of the lesson to gauge the percentage of students who mastered the key points.

resources

- Lemov, Doug. "Plan for Error." Technique 7 in *Teach Like a Champion 2.0: 62 Techniques that Put Students on the Path to College*. 2014. 60-64.
- Saphier, John. "Clarity." Chapter 9 in *The Skillful Teacher: Building Your Teaching Skills*. 2008. 173-208.
- ---. "Principles of Learning." Chapter 10 in *The Skillful Teacher*. 2008. 220-239. (Note: Specifically the part on critical attributes).
- ---. "Decision 8: Anticipating Confusions." Chapter 17 in *The Skillful Teacher*. 2008. 404. (Note: See also pages 171-173).

The Teaching Cycle

4.2B Teach

QUESTIONING

Incorporates higher-order questions from Bloom's Taxonomy and provides supports, when necessary, to get students to high-quality responses.

method of data collection
Observations & Unit Plans

● developing
The level of questions asked by the teacher is low and results in **low intellectual engagement** of students.

●● progressing
The level of questions asked by the teacher incorporates some higher-order questions from Bloom's and results in moments of **moderate intellectual engagement** by students.

●●● established
The level of questions asked by the teacher incorporates some higher-order questions from Bloom's and results in **consistent intellectual engagement** by students.

●●●● advanced
The level of questions asked by the teacher incorporates some higher-order questions from Bloom's and results in a highly **engaging classroom** for students.

●●●●● master
The level of questions asked by the teacher and students incorporates higher-order questions from Bloom's and results in a highly engaging classroom for students.

Consistently serves as an active teacher leader.

4.2B footnotes

at a LEVEL 1

Teacher questions are rapid-fire with a single correct answer and do not invite deep student thinking. All discussion is between the teacher and individual students. Students are not invited to speak directly to one another. Teacher does not ask students to explain their thinking.

at a LEVEL 2

Teacher questions are rapid-fire with a single correct answer and do not invite deep student thinking. Teacher attempts to provide wait time to formulate ideas. Teacher does not ask students to explain their thinking.

at a LEVEL 3

Teacher questions are a mix of those with a single correct answer and others inviting student thinking. Teacher provides wait time for students to formulate ideas and has some success. Teacher invites students to respond directly to each other's ideas, but few students do so. Teacher asks students to explain their reasoning and cite specific evidence, and students correctly answer the question with some success.

at a LEVEL 4

Many of the teacher's questions are open-ended or have multiple answers, inviting students to think; when low-level questions are used, they provide scaffolding for new learning. Wait-time is used productively. Students engage in thoughtful reflection during discussion. Students direct their comments to one another during full-class discussions. Students are asked to explain their reasoning and cite specific evidence, and students correctly answer the question with high levels of success.

at a LEVEL 5

Teacher serves as a teacher leader. Students initiate higher-order questions. Students extend the discussion, enriching it and inviting comments from their classmates. Students build on each other's ideas and make conjectures/connections aimed at deepening understanding.

resources

- Bloom, B. S. *Taxonomy of Educational Objectives, Handbook I: The Cognitive Domain*. 1956.
- Lemov, Doug. "Right is Right." Technique 2 in *Teach Like a Champion Field Guide: A Practical Resource to Make the 49 Techniques Your Own*. 2012. 22-36.
- ---. "Stretch It." Technique 13 in *Teach Like a Champion Field Guide*. 2012. 108-155.
- ---. "Stretch It." Technique 3 in *Teach Like a Champion 2.0: 62 Techniques that Put Students on the Path to College*. 2014. 37-51.
- ---. "Right is Right." Technique 12 in *Teach Like a Champion 2.0*. 100-107.
- ---. "Format Matters." Technique 14 in *Teach Like a Champion 2.0*. 116-122.
- Saphier, John. "Clarity." Chapter 9 in *The Skillful Teacher: Building Your Teacher Skills*. 2008. 204-214. (Note: Specifically the information about questioning).

The Teaching Cycle

4.2C Teach

RIGOR

Uses a variety of strategies to increase the thinking, writing, analyzing, and talking done by students.

method of data collection
Observations, Lesson and Unit Plan Review & Student Work

● developing

Teacher provides **no** opportunities for students to engage in work that requires higher-level thinking skills.

Students do not employ higher-level thinking skills during the lesson.

●● progressing

Teacher **attempts to provide** opportunities for students to engage in work that requires higher-level thinking skills.

Students **do not** employ higher-level thinking skills during the lesson.

●●● established

Teacher uses instructional tasks that require students to use higher-level thinking skills.

Students **employ** higher-level thinking skills during the lesson but may not do so in a way substantially connected with the mastery of the lesson objectives.

●●●● advanced

Teacher uses a **variety** of instructional strategies to develop students' higher-level thinking skills.*

Teacher **embeds** higher-level thinking skills into the lesson objective so that mastery of the objective requires students to meaningfully employ higher-level thinking skills.

Students **employ** higher-level thinking skills to engage with lesson concepts, questions, and tasks, and to demonstrate understanding of the lesson's objectives.**

●●●●● master

Teacher uses a **variety** of instructional strategies to develop students' higher-level thinking skills.*

Teacher **embeds** higher-level thinking skills into the lesson objective so that mastery of the objective requires students to meaningfully employ higher-level thinking skills.

Students **employ** higher-level thinking skills to engage with lesson concepts, questions, and tasks, and to demonstrate understanding of the lesson's objectives.**

Students synthesize diverse perspectives or points of view during the lesson.

Students communicate their thinking and reasoning processes, and encourage their peers to do the same, when appropriate.

Consistently serves as an active teacher leader.

4.2C footnotes

- *Examples of instructional tasks requiring higher-level thinking skills include: solving problems with predictable and non-predictable solutions, noticing patterns and finding relationships, generating hypotheses, planning tasks to address problems, generating reasonable arguments and explanations, predicting outcomes, assessing progress toward goals, communicating about learning, and engaging in advanced-level reading and writing tasks.
- **Examples of higher-level thinking skills include: reflecting on learning, generating new insights, asking questions, making decisions; and analyzing, classifying, comparing, evaluating, explaining, summarizing, synthesizing, and solving problems. Teachers are encouraged to refer to Bloom's Taxonomy to support their understanding of higher- and lower-order cognitive skills and their application.
- Higher-level thinking skills include anything over the application level of Bloom's.

resources

- Lemov, Doug. Techniques 32-44 in *Teach Like a Champion 2.0: 62 Techniques that Put Students on the Path to College*. 2014. 234-349.
- Lemov, Doug, Aja Settles, and Julianna Worrell. *Great Habits, Great Readers: A Practical Guide for K-4 Reading in the Light of Common Core*. 2013.
- Krumme, Gunter. "Major Categories in the Taxonomy of Educational Objectives (Bloom 1956)." http://www.krummefamily.org/guides/bloom.html.
- Saphier, John. "Clarity." Chapter 9 in *The Skillful Teacher: Building Your Teaching Skills*. 2008. 186-190, 194-202. (Note: Specifically the parts about making cognitive connections and making students' thinking visible).

The Teaching Cycle

4.2D Teach

URGENT PATIENCE

Sets, communicates, and keeps pace during class in order to maximize instructional time.

method of data collection
Observation

developing

Does not create an agenda for the lesson **OR** creates an agenda but only loosely follows it.

progressing

Creates an agenda and follows content and pacing of it **faithfully**, regardless of circumstances.

May use some time-keeping strategies.

established

Follows lesson plans faithfully, while **flexibly making adjustments** based on in-the-moment circumstances, as necessary.

Sets clear expectations for how long activities will take at **key points** throughout lesson, and uses time-keeping strategies to keep pace.

advanced

Seizes opportunities to **purposefully transform** lesson plans, as necessary, in order to move closer toward goals.

Consistently uses **appropriate** time-keeping strategies in order to **maximize** instructional time throughout the lesson.

master

Seizes opportunities to purposefully transform lesson plans, as necessary, in order to move closer toward goals.

Consistently uses **appropriate** time-keeping strategies to **maximize** instructional time throughout the lesson.

Consistently serves as an active teacher leader.

4.2C footnotes

- Examples of time-keeping strategies may include timers, songs, time reminders, countdowns, etc.
- At a Level 1, the teacher may create an agenda but only loosely follows it. An example of this would be having a "Do Now" that is scheduled for 10 minutes, but it goes for 25 minutes. Another example would be if the teacher does not get to a key component of the lesson, such as the independent practice.
- The root cause of not being able to follow the lesson plan may vary. For example, it could be due to student behavior and interruptions or not incorrectly estimating how long different components of the lesson will take.
- A teacher should not be penalized for extenuating circumstances (e.g. a fire drill or a schedule change).
- Each of the criteria in this behavior carries equal weight, so a teacher needs to meet each of them in order to attain a level. For example, if a teacher sets clear expectations for how long activities will take at key points in the lesson, but doesn't make adjustments after doing a CFU where s/he picks up on a student misunderstanding, then that teacher would be rated a Level 2.

resources

- Lemov, Doug. "Change the Pace." Technique 27 in *Teach Like a Champion 2.0: 62 Techniques that Put Students on the Path to College*. 2014. 201-210.
- ---. "Brighten Lines." Technique 28 in *Teach Like a Champion 2.0*. 211-213.
- ---. "All Hands." Technique 29 in *Teach Like a Champion 2.0*. 214-219.
- ---. "Work the Clock." Technique 30 in *Teach Like a Champion 2.0*. 220-224.
- ---. "Every Minute Matters." Technique 31 in *Teach Like a Champion 2.0*. 224-230.
- ---. "Pacing Reflection and Useful Tools." In *Teach Like a Champion 2.0*. 231-232.

The Teaching Cycle

4.3A Assess and Adjust so More Students Learn

ASSESS

Assesses all students against each lesson's learning objectives to inform daily teaching (e.g. exit tickets, class work). Plans unit assessments and weekly/bi-weekly assessments that are appropriately spiraled, scaffolded, and differentiated. Adapts, accommodates, and modifies assessments for students with special needs.

method of data collection

Observations, Lesson Plans & Unit Plans

● developing

To inform teaching, s/he **attempts to** assess all students against each lesson's learning objectives by using daily, weekly/bi-weekly, or unit assessments.

●● progressing

To inform teaching, s/he **sometimes** assesses all students against each lesson's learning objectives by using daily, weekly/bi-weekly, or unit assessments.

Sometimes modifies assessments for students with special needs

●●● established

To inform teaching, s/he **regularly** assesses all students against each lesson's learning objectives by using daily, weekly/bi-weekly, **and** unit assessments.

Regularly modifies assessments for students with special needs.

●●●● advanced

To inform daily teaching, s/he **almost always** assesses all students against each lesson's learning objectives by using daily, weekly/bi-weekly, and unit assessments.

Teacher **almost always** modifies assessments for students with special needs (i.e. appropriate rigor and aligned with IEP goals).

●●●●● master

To inform daily teaching, s/he **always** assesses all students against each lesson's learning objectives by using daily, weekly/bi-weekly, and unit assessments.

Teacher **always** modifies assessments for students with special needs (i.e. appropriate rigor and aligned with IEP goals).

Consistently serves as an active teacher leader.

4.3A footnotes

- Each of the criteria in this behavior carries equal weight, so a teacher needs to meet each of them in order to attain a level.
- At a Level 1 and Level 2, the teacher incorporates some, but not all, forms of assessment (daily, weekly/bi-weekly, and unit).
- At a Level 3, Level 4, and Level 5, the teacher incorporates all forms of assessment (daily, weekly/bi-weekly, and unit).
- "Regularly" means 76-85% of the time; "almost always" means 86-99% of the time, and "always" means 100% of the time.
- Modifications include reducing the length of assessments, number of answer choices, scope of content covered, etc.

resources

- Saphier, Jon. "Assessment." Chapter 19 in *The Skillful Teacher: Building Your Teaching Skills*. 2008. 431.

The Teaching Cycle

4.3B Assess and Adjust so More Students Learn

CFU

Gets an accurate pulse on student understanding and immediately uses the data from CFUs to correct misconceptions and determines whether to re-teach the entire class, target a smaller group, or support individual students.

● method of data collection

● Observations & Lesson Plans

● developing

The teacher **never** gets an accurate "pulse" at key moments because the CFU does not provide information about the depth of understanding for the students assessed, when appropriate.*

●● progressing

The teacher **rarely** gets an accurate "pulse" at key moments because the CFU does not provide information about the depth of understanding for the students assessed, when appropriate.*

Based on the data collected, the teacher **attempts** to reteach.

●●● established

The teacher **sometimes** gets an accurate "pulse" at key moments by using one or more checks that provide information about the depth of understanding for the students assessed, when appropriate.*

The teacher **sometimes** re-teaches effectively, when appropriate, such as cases in which most of the class demonstrates a misunderstanding or an individual student demonstrates a significant misunderstanding.**

●●●● advanced

The teacher **almost always** gets an accurate "pulse" at key moments by using one or more checks that gather information about the depth of understanding for a range of students, when appropriate.* For example, the teacher calls on both volunteers and non-volunteers, strategically checks with students at various levels of proficiency after a whole class check, or uses methods such as exit slips or whiteboards to provide information about a range of students.

The teacher **always** re-teaches effectively, when appropriate, such as cases in which most of the class demonstrates a misunderstanding or an individual student demonstrates a significant misunderstanding.** For example, the teacher might use a different approach to present a concept, or re-explain a problematic step or unclear academic vocabulary, and then return to the student(s) who surfaced the original misunderstanding.

●●●●● master

The teacher **always** gets an accurate "pulse" at key moments by using one or more checks that gather information about the depth of understanding for a range of students, when appropriate.* For example, the teacher calls on both volunteers and non-volunteers, strategically checks with students at various levels of proficiency after a whole class check, or uses methods such as exit slips or whiteboards to provide information about a range of students.

The teacher **always** re-teaches effectively, when appropriate, such as in cases in which most of the class demonstrates a misunderstanding or an individual student demonstrates a significant misunderstanding.** For example, the teacher might use a different approach to present a concept, or re-explain a problematic step or unclear academic vocabulary, and then return to the student(s) who surfaced the original misunderstanding.

The teacher also anticipates common misunderstandings (e.g., by offering a misunderstanding as a correct answer to see how students respond) or recognizes a student response as a common misunderstanding and shares it with the class to lead all students to a more complete understanding.†

Consistently serves as an active teacher leader.

4.3B footnotes

- A **key moment** is when checking is necessary to inform instruction going forward, such as after each key point, before transitions between lesson activities, or partway through the independent practice.
- *For some lessons, checking the "pulse" of the class may not be appropriate. For example, if students spend the majority of the observation working on individual essays while the teacher conferences with a few students, it may not be necessary for the teacher to check the understanding of the entire class. In these cases, observers should assess how deeply and effectively the teacher checks for the understanding of the students with whom s/he is working.
- **There are many factors that determine whether it is appropriate to scaffold or re-teach, including pacing, the extent of a student's misunderstanding, the importance of the concept, and the number of students who have a particular misunderstanding. If the misunderstanding is significant or shared by many students, scaffolding may be an inefficient or ineffective way to address it. For example, if students have a significant conceptual misunderstanding that would limit their ability to move toward mastery, the teacher may need to re-teach the concept to certain students or to the whole class.
- †In some cases, the teacher might anticipate misunderstandings so effectively that no misunderstandings surface during the lesson. Evidence of this level of anticipation should be credited as highly effective practice in this behavior. Also, this practice can be tied to "CLARITY" (4.2A).
- Observers should debrief lessons with teachers to discuss how s/he utilized CFUs to inform re-teaching.
- Each of the criteria in this behavior carries equal weight, so a teacher needs to meet each of them in order to attain a level.
- The teacher does not necessarily have to check with every student in order to gauge the understanding of the class (i.e. get the "pulse"). For example, as long as the teacher calls both on students who raise their hands and on those who do not, a series of questions posed to the entire class can enable the teacher to get the "pulse" of the class. Or, if the teacher checks the understanding of a number of students, finds that most of them did not understand some part of the lesson, and immediately re-teaches that part to the entire class, this should count as effectively getting the "pulse" of the class because the teacher gained enough information to be able to adjust subsequent instruction.

resources

- Lemov, Doug. "Gathering Data on Student Mastery." *Teach Like a Champion 2.0: 62 Techniques That Put Students on the Path to College*. (2014). 27-55.
- Saphier, Jon. "Clarity." Chapter 9 in *The Skillful Teacher: Building Your Teaching Skills*. 2008. 190-202.

The Teaching Cycle

4.3C Assess and Adjust so More Students Learn

Track and Analyze Assessment Data

Tracks and analyzes assessment data regularly to drive short- and long-term planning, re-teaching, and differentiation. Accurately predicts level of student mastery in advance of exit tickets, student practice, weekly/biweekly assessments, unit assessments, etc.

● method of data collection

● Observations, Lesson Plans & O3's

● developing

Does not track data OR does not create a feasible action plan.

●● progressing

Tracks and analyzes assessment data on a regular basis (i.e. interims, benchmarks, and trimester assessments).

Creates an action plan that is **feasible**, but the plan might not be the most efficient way to re-teach concepts.

●●● established

Tracks and analyzes assessment data on a regular basis (i.e. interims, benchmarks, and trimester assessments).

Creates an action plan that **prioritizes key levers**, including changing short- and long-term planning, re-teaching, and differentiation, and **implements** the action plan.

●●●● advanced

Tracks data on a regular basis **beyond staff-initiated**, formal interactions.

Creates an action plan that is **implemented independently**, including changing short- and long-term planning, re-teaching, and differentiation, and **implements** the action plan with **fidelity**.

●●●●● master

Tracks data **continuously** (e.g. unit tests, quizzes, daily exit tickets, etc.).

Consistently gauges what is **most impactful** to **implement independently**, including changing short- and long-term planning, re-teaching, and differentiation, and **pursues contingencies** if the initial solution is ineffective.

Consistently serves as an active teacher leader.

resources

- Bambrick-Santoyo, Paul. *Driven by Data: A Practical Guide to Improve Instruction*. 2010.

Knowledge

Teaching is an art and a science. As the artists and scientists, we are responsible for building our understanding of child development, pedagogy, and content. We are responsible for knowing what we are teaching and how it fits into a PreK-16 continuum.

5.1 Content Knowledge

Knows the essential content, concepts, and big ideas of the discipline well enough to create questions that teach and assess them.

- method of data collection
- Observations, O3s, Lesson Plans & Unit Plans

● developing

Teacher does not have a basic understanding of the content.

●● progressing

Delivery of instruction and assessments **sometimes** reflects basic understanding of content and concepts of the discipline.

●●● established

Delivery of instruction and assessments reflects a **basic** understanding of content and concepts of the discipline.

●●●● advanced

Delivery of instruction and assessments **almost always** reflects a **strong** understanding of content and concepts of the discipline, constantly connecting lessons to previous and future lessons.

●●●●● master

Delivery of instruction and assessments **always** reflects a **deep** understanding of the content and concepts of the discipline, constantly connecting lessons to previous and future lessons.

Consistently serves as an active teacher leader.

5.1 footnotes

at a LEVEL 1

The teacher might be new to the grade level or discipline and is learning the content.

at a LEVEL 2

The teacher has some understanding of the content, but cannot pick out the unit's big ideas. S/he might also struggle with breaking the unit into aims and/or picking out the key points for each lesson.

at a LEVEL 3

The teacher has a basic understanding of the content and concepts of the discipline. When looking at unit plans, the teacher is able to identify the key content and big ideas. At the lesson level, the teacher has an understanding of strong aims for the unit and how to scaffold them, as well as the key points for each lesson. However, what holds a teacher back from becoming a Level 4 is things such as not anticipating the misconceptions that students have about certain key points, not knowing the discipline above the level of the standards (i.e. if a student asks a tricky question and the teacher does not have a response), etc.

at a LEVEL 4

The teacher has a deep understanding of his/her content. This is evident in that the teacher knows the content that comes before and after his/her grade level(s). Additionally, the teacher can identify the misconceptions that students might have about the content and proactively plans lessons to clarify the misconceptions.

at a LEVEL 5

The teacher meets all the criteria for a Level 4 and also serves as an active teacher leader.


HONOR yourself and others

KIPP Framework For Excellent Teaching (KFET) 3.0 2015-16, KIPP Metro Atlanta Schools

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Appendix B

B Artifacts Obtained During Observations

Appendix B
Artifacts Obtained During Observation

	90 Minute Observations:	Unit AIM									
Grace											
	Grace Observation Notes 8_13_2015	Atomic Orbital Diagrams & Mini Lab	Class Field Notes	Audio File	Do It Now: How Many Protons, Electrons, Neutrons	Mini Lab Activity	Independent Activity Identify Atoms	Exit Ticket: Identifying Atoms and Atomic Orbital Diagrams			
	Grace Observation Notes 9_02_2015	Summarize Atomic Properties and Periodic Trends	Class Field Notes	Audio File	Do It Now: Valence Electrons and Oxidation Numbers	Quiz on electronic trends	Graphing Periodic Trends				
	Grace Observation Notes 9_14_2015	Naming Ionic Compounds	Class Field Notes	Audio File	Do It Now: Classify Compounds as Ionic or Covalent	Quiz on electronic trends	Independent Practice: Naming Ionic Compounds	Exit Ticket: 5 Problems Related to Naming Compounds	Notes for Naming Ionic Compounds	Weekly for DIN Completion	
	Grace Observation Notes 9_21_2015	Predict Name and Formula of Compounds	Class Field Notes	Audio File	Do It Now: Write the name of the covalent compounds	Celebration of Knowledge: IUPAC Nomenclature of Covalent Compounds	Independent Practice: Naming Hydrocarbons		Notes for Naming Hydrocarbons	Weekly for DIN Completion	
	Grace Observation Notes 9_23_2015	Predict Name and Formula of Compounds	Class Field Notes	Audio File	Do It Now: Write the name or formula for the following	Project Rubric: How To Name Chemical Compounds					
	Grace Observation Notes 10_01_2015	Identify the Types of Chemical Reactions	Class Field Notes	Audio File	Do It Now: What Type of Reaction Is Represented In The Following	Mini Project: Story And Chemical Equation Challenge	Group Work: Mathematical Equations Challenge				
	Grace Observation Notes 10_16_2015	Balance Chemical Reactions	Class Field Notes	Audio File	Do It Now: Balance the Following Equations	Balancing Equations Worksheet					
	Grace Observation Notes 10_30_2015	Calculate the Molar Mass of a Compound	Class Field Notes	Audio File	Do It Now: Make the Following Conversions	Class Notes on Molar Mass	Independent Practice: Molar Mass	Exit Ticket: Molar Mass			
	Grace Observation Notes 11_18_2015	Use Stoichiometric Calculations in a Lab Setting	Class Field Notes	Audio File	Do It Now: Calculate Amount of KCl Needed for a Solution	Stoichiometry In Action: Pre-Lab Activity	Stoichiometry In Action: Lab Protocol	Stoichiometry In Action: Data & Analysis	Unit 3b Exam		
	Grace Observation Notes 12_02_2015	Explain the Different States of Matter	Class Field Notes	Audio File	Do It Now: Answer and Explain States of Matter	Class Notes on States of Matter	Independent Practice: States of Matter	Exit Ticket: States of Matter	States of Matter Classification Practice	Celebration of Knowledge: Equilibrium, Reaction Rates and Dissolution	Rate of Dissolution: Lab Activity
	Grace 12_10_2015	SLO Review			Chemistry SLO Review: Interactive Notebook	SLO Review: Interactive Notebook Grading Rubric					
Helen											
	Helen Observation Notes 8_27_2015	Explain What Makes Something Living	Class Field Notes	Audio File	Do It Now: Mr. H. CRAIG - What are the characteristics of living things.						
	Helen Observation Notes 9_03_2015	Explain and Differentiate the Two Types of Transport	Class Field Notes	Audio File	Do It Now: Open ended questions on cell Transportation						
	Helen Observation Notes 9_09_2015	Explain and Differentiate the Two Types of Cell Processes Photosynthesis and Cell Respiration	Class Field Notes	Audio File	Do It Now: Reading assignment for living organisms	Class Notes on Cells and Unit 2 Qualifiers to Take Unit 2 Test	Classifying Organisms: Mini Lab Activity	Photosynthesis Worksheet	Unit 2 Weekly Calendar	White Activity: Poster Assignment	
	Helen Observation Notes 9_21_2015	Codominance, incomplete dominance, multiple allele, Punnett square	Class Field Notes	Audio File	Do It Now Cell: Reproductions and Genetics	Class Notes on Genetics	Quiz on Cell Transport	Independent Practice: Bikini Bottom Genetics: Incomplete and Codominance	Homework 7 Genetic Questions	Exit Ticket with Extra Credit on Genetics	
	Helen Observation Notes 9_30_2015	Compare Asexual vs. Sexual Reproduction	Class Field Notes	Audio File	Do It Now: The Great Divide	Class Notes on Cell Division	Independent Practice: Genetic Dominance	Genetic Unit Review Sheet	Unit 3 Quiz on Cell Reproduction		
	Helen Observation Notes 10_16_2015	Explain the Process of Mutations	Class Field Notes	Audio File	Do It Now: Cell Mutation	Class Notes on Biotechnology	Partner Practice: Genes	Independent Practice I: Genes	Independent Practice II: Agree or Disagree Talk-n-Turn	Homework: White Paper Assignment	Genetics Quiz

Appendix B

Artifacts Obtained During Observation

Helen Observation Notes 10_29_2015	Explain Evolution	Class Field Notes	Audio File	Do It Now: Darwin's Natural Selection Review	Reinforcement and Study Guide: Natural Selection and the Evidence for Evolution	Homework Evolution Practice Quiz						
Helen Observation Notes 11_18_2015	Population Ecology	Class Field Notes	Audio File	Do It Now: The Ups and Downs of Population Growth	Class Notes on Population Growth	EOC Milestone Practice	Partner Practice: Exponential Growth and Carrying Capacity	Independent Practice: Vocabulary Assignment	Homework: White Paper Assignment Human Impact on the Environment	Exit Ticket Ecological Succession		
Helen Class Activity 11_18_2015	Food Chains and Webs - What's for Dinner	Class Field Notes		Food Chain Questions	Food Chain Worksheet	Food Chain Quiz	Food Chain Quiz II	Food Chain Vocabulary Match				
Helen Milestone Preparation Assignments Thanksgiving work 11_23_2015	Diagnostic for Georgia Milestone	Class Field Notes		Pretest for Georgia EOCT Biology								
Helen Observation Notes 12_02_2015	Cell Energy and Cell Transport	Class Field Notes	Audio File	Do It Now: Mitosis	Quiz: Multiple Choice Questions on Plant Cells	Partner Practice: Organic Molecules and	Worksheet: Comparing Mitosis and Meiosis	KAC Research Symposium Rubric				
Helen Observation Notes 1_05_2016	Explain Class Rules and Procedures	Class Field Notes	Audio File	Do It Now: Imagine A Class Without Rules, Policies, or Procedures	Biology Course Scope and Sequence	Student Information Sheet	January Class Calendar	Class Notes: Rules	Save Same Inquiry Lab Write-Up	Exit Ticket: Name One Rule or Procedure That Must Be Followed Daily		
Helen Observation Notes 1_19_2016	Explain Cell Energy	Class Field Notes	Audio File	Do It Now: Reading Passage for Living Cells	Class Notes on Cells	Partner Practice: Cellular Processes	Partner Practice: Compare and Contrast	Worksheet: Photosynthesis	Cell Energy Quiz			
Helen Observation Notes 2_03_2016	Explain Enzymes	Class Field Notes	Audio File	Do It Now: Enzymes Function	Class Notes: Factors that Effect Enzyme Activity	Amoeba Sisters Video Recap Enzymes	Independent Practice: Enzymes and Substrates	Elaborate: Write Open Ended Questions and Graph on Yeast Cells	EOCT Practice: Enzyme Controlled Reactions	Homework: What Do Enzymes Do		
Helen Observation Notes 2_04_2016	Explain Enzymes	Class Field Notes	Audio File	Do It Now: Macromolecules and Monomers	Class Notes: Macromolecules and Monomers	Independent Practice: Biochemistry Study Guide						
Helen Observation Notes 3_11_2016	Binomial Nomenclature	Class Field Notes	Audio File	Do It Now: Classifying Organisms	Class Notes: Viruses and Nerve Cells	Partner Practice: Binomial Nomenclature	Partner Practice II: Agree or Disagree	Independent Practice: Classification Using Binomial Nomenclature	Exit Ticket : Classification	Homework: Open Ended Questions on Neurons		
Helen Observation Notes 3_15_2016	Learn About the Brain and Dissect One	Class Field Notes	Audio File	Do It Now: Identify Similarities an Differences in Brains	Sheep Brain Dissection Handout							
Helen Observation Notes 3_22_2016	Analyze and Describe the History of Evolution	Class Field Notes	Audio File	Do It Now: Adaptation	Class Notes: History on Theory of Evolution	Partner Practice: Compare Homologous, Analogous and Vestigial Structures	Handout: What is Evolution	Vocabulary: Mutation, Evolution, Fitness and Darwin	Evolution: Personal Word Wall	Handout: Evidence for Evolution	Handout: Speciation	Handou Theory Natura Selectio
Helen Observation Notes 5_10_2016	Preparing for Georgia Milestones Exam	Class Field Notes	Audio File	Do It Now: Pointers on Completing the Exam								

Appendix B

Photos and Artifiacts

Photos	Subject	Person	Item	Email Date
Photos	Artifact	Grace	Chemical Reaction Project/Lab Supplies	Sun 11/29/2015 8:41 AM
Photos	Artifact	Grace	Stellar Scientist/Periodic Table Project/Data Spot Student Performance/Board Set up/Personal Board	Sun 11/29/2015 8:40 AM
Photos	Artifact	Grace/Helen	Room Student Work	Fri 3/25/2016 9:33 AM
Photos	Artifact	Grace/Helen	Atoms/Room	Fri 3/25/2016 9:29 AM
Photos	Artifact	Helen	Cells Project	Wed 11/18/2015 10:05 PM
Photos	Artifact	Helen	Prokaryotic Vs Eukaryotic Cells	Wed 11/18/2015 10:05 PM
Photos	Artifact	Helen	Performance Data/ Project Cells	Sun 11/29/2015 8:41 AM
Photos	Classroom	Helen	Students use of Technology/Board Presentation	Mon 2/15/2016 8:11 PM
Photos	Artifact	Helen	White Paper Assignment Cell Energy	Mon 2/15/2016 8:11 PM
Photos	Artifact	Helen	Study Guide Cell Organelles	Mon 2/15/2016 8:11 PM
Photos	Artifact	Helen	Seating Chart/Fill in Your Future	Mon 2/15/2016 8:10 PM
Photos	Video	Helen	Dissect Sheep Brain	Tue 3/15/2016 8:37 PM
Photos	Classroom	Helen	Classroom Set up for dissection/Seating Assignments/Dissection kits	Tue 3/15/2016 8:36 PM
Photos	Classroom	Helen	Students getting sheep brains/desk work	Tue 3/15/2016 8:35 PM
Photos	Classroom	Helen	Students Dissecting/Class Presentation	Tue 3/15/2016 8:34 PM
Photos	Milestone Data	Helen	Mastery Tracker & Tutorial Schedule	Wed 3/23/2016 4:51 PM
Photos	Artifact	Helen	Word Wall/Guided Notes	Thu 3/24/2016 11:53 AM
Photos	Artifact	Helen	Seating Chart/ Completed	Mon 5/16/2016 1:34 PM
Photos	Artifact	Helen	Consequence Matric	Mon 5/16/2016 1:34 PM
Photos	Artifact	Helen	Student Individual Evaluation	Mon 5/16/2016 1:34 PM
Photos	Artifact	Helen	Completed Mastery Tracker & Tutorial Schedule	Mon 5/16/2016 1:34 PM
Photos	Artifact	Helen	Mastery Tracker	Mon 5/16/2016 1:34 PM
Photos	Artifact	Helen	Mastery Tracker Tutorial Schedule	Mon 5/16/2016 1:34 PM
Photos	Artifact	Helen	Mastery Tracker	Mon 5/16/2016 1:34 PM
Photos	Artifact	Helen	Student Goals	Mon 5/16/2016 1:34 PM
Photos	Artifact	Helen	Helen Board	Sun 3/27/2016 9:33 AM

Appendix B

Photos and Artifiacts

Student Work	Artifact	Helen	Cell Unit Review	
Student Work	Artifact	Helen	Prokaryotes Vs Eukaryotes	
Student Work	Artifact	Helen	Study Guide for Final Exam	
Student Work	Artifact	Helen	Ecology Outline	
Student Work	Artifact	Helen	Review Sheet for Final Exam (High Performer)	
Student Work	Artifact	Helen	Review Sheet for Final Exam (Low Performer)	
Student Work	Artifact	Helen	20 Questions from Student	
Student Work	Artifact	Helen	Creative Study Guide	
Student Work	Artifact	Helen	Study Guide Low Performer	
SDC Dept. Chair Observations				
	Grace		Literal Notes	8_3_2015
	Grace		Debrief	8_3_2015
	Helen		Observation	8_10_2015
	Helen		Quick Observation	8_10_2015
	Grace		Debrief	9_1_2015
	Grace		Literal Notes	9_1_2015
	Helen		Debrief	9_2_2015
	Helen		Observation	9_2_2015
	Helen		Debrief	9_14_2015
	Helen		Observation	9_14_2015
	Grace		Debrief	9_30_2015
	Grace		Observation	9_30_2015
	Grace		Lesson Plans	8_10_2015
	Grace		Lesson Plans	8_17_2015
	Grace		Lesson Plans	8_24_2015
	Helen		Lesson Plans	8_3_2015
	Helen		Lesson Plans	8_10_2015
	Helen		Lesson Plans	8_17_2015
	Grace		Formative KFET Ratings	
	Helen		Formative KFET Ratings	
	Grace		Mid Year	
	Helen		Mid Year	
	Helen		End of Year	
	Helen		Debrief	11_25_2015
	Helen		Observation	8_2015
	Grace		Debrief	11_24_2015

Appendix B
Photos and Artifiacts

K. Rigby	Induction Program	New Teacher Induction PowerPoint Presentation New Teacher Induction Training Handouts Teaching Cycle Interactive Handout Teacher Training Better Lessons Induction Schedule KSFA_Teach Like a Champion Guide Curriculum Documents_8th Grade Science Criteria for Success Part One Criteria for Success Part Two

Appendix B			
Memos			
Memos			
		Date	Topic
	Grace	Fri 7/172015 10:31 AM	Invitation to participate in study
		Mon 7/20/2015 7:48 AM	Agreement to participate in the study
		Tue 7/21/2015 3:21 PM	Setting up meeting time to sign consent form
		Wed 7/29/2015 12:59 PM	Setting up meeting time to complete first interview
		Thu 8/6/2015 4:05 PM	Schedule of classes
		Wed 8/12/2015 4:03 PM	Agreement for first observation
		Thu 8/13/2015 11:31 AM	Request for Orbital Diagram used in class
		Mon 8/31/2015 3:59 PM	Agreement for second observation
		Fri 9/4/15 3:19 PM	Response to on teacher induction/class star & actions/copies of class documents
		Mon 9/14/2015 9:23 AM	Negeotiating Agreement for third observation
		Mon 9/21/2015 8:08 AM	Classes on different scheules
		Mon 9/21, 2015 5:23 PM	Response to retake of quiz policy/professional development/ KIPP Summit/copy of exam
		Tue 9/29/2015 4:24 PM	Explination of what is going on in class for next visit
		Fri 10/2/2015 8:39 AM	Perception on how the lesson went/were lesson came from/modifications made/copy of types of chemical rxns and rubric
		Thu 10/22/2015 10:32 AM	Discussion of Scope and Sequence
		Fri 11/6/2015 1:15 PM	Discussion of mentor/chage in knowledge of student's learning/structure and operation of class
		Tue 11/24/2015 2:27 PM	Winter break work/Unit exam/next semester's students
		Wed 12/2/2015 8:13 AM	When to come by and what is occuring in the class
		Tue 12/08/2015 11:34 AM	Discussion of GA Milestones exam/End of year review material.
		Wed 12/16/2015 5:44 PM	Notice that will no longer be at KAC
		Fri 12/18/2015 9:50 AM	Copy of Teaching Cycle KFET evaluation
	Helen		
		Fri 8/7/2015 at 7:55 AM	Request to participate in research study
		Fri 8/7/2015 1:40 PM	Agreement to participate in study
		Thur 8/27/2015 11:11 AM	Class handouts Characteristics of Life Quiz and Notes
		Fri 9/4/2015 9:08 AM	Questions on Mastery Block/KIPP Teacher Induction/Cell Transport quiz and notes/Flash cards
		Thu 9/10/2015 9:36 AM	Attendance at Mastery Block
		Wed 9/9/2015 7:44 PM	Role of Ms. Smith - Teacher's Aid
		Wed 9/16/2015 10:52 AM	Can not visit due to testing
		Thur 9/24/2015 7:39 PM	Utit test on Cells/Key/Retake policy/Professional Development/KIPP Summit Attendance
		Thu 10/1/2015 3:35 PM	Activities to Address Learning Difficulties/Role of Ms. Steele
		Thu 10/15/2015 4:50 PM	Changing of Quarter New Students
		Wed 10/28/2015 7:29 AM	Scope and Sequence/current pace in the class
		Fri 10/30/2015 10:42 AM	Evaluation for White Paper Assignment for Evolution Unit
		Mon 11/2/2015 12:13 PM	Past student wanting to tell me about college acceptance
		Wed 11/18/2015 9:20 AM	Response to question on student learning needs/how class has changed
		Mon 11/23/2015 10:09 AM	Thanksgiving HW/Pizza Study Party on 11/21/15 for struggling students
		Tue 1/5/2016 11:30 AM	Copy of Scope and Sequence
		Tue 1/5/2016 2:03 PM	Ms. Steele and IEP
		Wed 3/9/2016 8:07 PM	Professional Development
		Fri 1/29/2016 10:36 AM	Copy of Macromolecule Quiz
		Wed 4/17/2016 9:16 PM	Copy of Day 1 EOC Review, EOC Vocabulary Quiz#1, EOC Vocabulary Quiz Day 2, Cell Division Cell Organelles, and Cell Transport Review

Appendix B

Memos

SDC	Fri 7/17/2015 2:40 AM	Introduction to Grace
	Sun 11/1/2015 2:56 PM	Meeting with SDC for Interview
	Fri 12/4/2015 4:07 PM	Participation in Science Symposium
	Fri 4/15/2016 8:41 AM	Observation Debrief/Lesson Plans/18 Documents
	Fri 4/15/2016 8:40 AM	KFET Evaluation for Deason and Erman by SDC
D_Howland	Wed 7/08/2015 at 10:12 AM	Request to meet with staff regarding participating in research project
	Mon 7/13/2015 10:33 PM	Response granting staff participation
	Tue 7/14/2015 8:52 PM	Biology Teacher Offer
K. Rigby	Fri 1/24/2014 6:35 PM	Agreement to meet about research project
	Mon 5/12/2014 2:12 PM	Providing updated version of KFET
	Tue 8/26/2014 4:24 PM	Background of KFET
	Mon 6/1/2015 5:16 PM	Solicitation of Participants
	Wed 6/17/2015 3:04 PM	Request to Ms. Bond for Participants
	Fri 6/26/2015 3:00 PM	Request for summary of what the commitment on the part of the school and teacher would be
	Tue 7/7/2015 2:44 PM	Idenitification of study participants by A. Bond
	Thu 9/17/2015 3:04 PM	Update on study status
E. Canosa	Wed 8/5/2015 9:18 AM	Decision to not participate in the study
IRB	Wed 6/17/2015 1:06 PM	IRB Approval
KIPP National	Wed 11/13/2013 1:01 PM	Documents in support of completing research with KIPP to Caroline Galindo
	Mon 1/6/2014 3:57 PM	Approval to complete research study with KIPP from Caroline Galindo

Appendix B

Interviews

Grace			
	Initial Interview	Audio/Transcript	7/30/2015
	Exit Interview	Completed	3/25/2016
Helen	Initial Interview	Audio/Transcript	8/21/2015
	Exit Interview	Scheduled for 5/2015	
SDC	Initial Interview	Audio/Transcript	11/5/2015
	2nd Interview	Audio/Transcript	4/25/2016

Appendix C

C Classroom Observation Tool

PCK Evidence Reporting Table

Date:__________ Class/Block:__________ Content:__________

Orientations to Teaching Science

Science Teaching and Learning	Role of Teacher	
	Role of Learner	
	How Students Learn Science	
	Attractive & Comprehensible	
Nature of Science	Ontological Beliefs	
	Epistemological Beliefs	
Goals of Science	Learning Science	
	Learning to do Science	
	Learning About Science	

K of Instructional Strategies and Representation

Types of Activities	# of Activities
Inquiry - Based Lab	
Hands -On	
Demonst-ration	
Simulation	
Problem Solving	
Investiga-tion	
Other	

Types of Language Devices		# of Language Devices
Explanation	Metaphors	
	Analogies	
	Similes	
Examples	Related	
	Similar Situation	
	Dissimilar Situation	
Narratives	Stories/ Anecdotes	
	Biography	
Illustration		
Mnemonic Devices		
Questioning	Recall/Factual Questions	
	Attention Focusing Questions	
	Problem Posing Questions	
	Action Questions	
	Reasoning Questions	
	Comparison Question	
Argument	Logic	
	Induction	
	Deduction	

Types of Content Elaboration	# of Content Elaboration
Depth Beyond the Intended Goal of Text (Topic Knowledge)	
Breadth Beyond the Intended Goal of Text (Domain Knowledge)	
Flexibility Beyond the Viewpoint of Text	

Knowledge of Students

Item	# of Incidents
Minscon-ceptions	
Learning Difficulty	
Motivation/ Interest	
Need	
Diversity	
Background	

Knowledge of Curriculum

Item	# of Incidents
Knowledge of Vertical Curriculum	
Knowledge of Horizontal Curriculum	
Curricular Saliency	

Knowledge of Assessment

		# of Incidents
Types of Assessment	Diagonstic	
	Formative	
	Summative	
Knowledge of Assessment Methods		
Knowledge of Students Learning Goals Important to Assess in a Given Unit		

Appendix D

D Interview Questions

Below represents interview questions that will be asked of the study participants in two forty-five minute interviews. The questions will serve as one method in determining what impact the teaching cycle element of the KIPP: Framework for Excellent Teaching (KFET) has on the development of new KIPP science teacher's Pedagogical Content Knowledge (PCK).
Teacher Background:

1. What is your highest level of education?
2. What is/are your degree(s) in?
3. What subjects are you teaching?
4. What grade level are you teaching?
5. Do you serve any other role in this school?
6. What experience have you had in teaching science?
7. How long have you been teaching your current content area?

Questions for Orientations to teaching science: (Associated with Beliefs and Character)

KFET
Behavior

4.2c

1. What impact has the teaching cycle of KFET had on your teaching experience?
2. What role does being at KIPP play in your class instruction?
3. What is your teaching philosophy? How do you intend to interact with students?
4. When you are creating your lesson plan, how do you decide which aspects of the subject matter, the curriculum, students understanding will be incorporated into it? What do you take into consideration during the lesson planning?
5. How do you plan to assess your students' mastery of content? Please provide relevant examples.
6. Explain the role that student assessment data plays in student learning.

Appendix D

D Interview Questions

Questions related to Knowledge of Student's Understanding in Science: (How does a teacher know about what students know of a topic and how will he/she discover areas of likely difficulty?)

KFET
Behaviors

4.1b	4.2a	4.3a
4.1c	4.2b	4.3a
4.1e	4.2c	4.3b
4.1f	4.2d	

1. How will you determine student prior knowledge? Please provide relevant examples.
2. What role does a student's conceptions of science play in the learning process?
3. Provide examples of differentiation that will be implemented to address leaning difficulties?
4. What role does a student's learning style play in education?
5. How would you determine the role that student data plays on preparation of your lesson cycles.

Appendix D

D Interview Questions

Questions related to Knowledge of Science Curriculum: (What is the teacher's understanding of the importance of topics relative to the curriculum as a whole.)

KFET
Behaviors

4.1a	4.1e	4.2c
4.1b	4.1f	4.2d
4.1c	4.2a	4.3a
4.1d	4.2b	4.3c

1. How do you determine the components of your scope and sequence? Please provide relevant examples.
2. On what grounds would you decide to modify a lesson? What strategy goes into modifying it prior to administering it? Is this based on experience with this particular lesson or prior experience with teaching it? would need modifying?
3. What are your thoughts on the need to cover the curriculum and ensuring that content is mastered?
4. What would you consider as a science student's yearlong goals for growth and achievement related to the content of this course?
5. How do you determine the criteria for success and how will you know when it has been met? Please provide relevant examples.
6. How will lessons be structured to be as clear and accessible to all learners? Please provide relevant examples.
7. How will you connect what students already understand about content prior to the introduction of new material? Please provide relevant examples.

Appendix D

D Interview Questions

Questions related to Knowledge of Instructional Strategies and Representations for Teaching Science: (How will the teacher implement subject-specific strategies and topic specific strategies?)

KFET
Behaviors

4.1a	4.1e	4.2c
4.1b	4.1f	4.2d
4.1c	4.2a	4.3a
4.1d	4.2b	4.3b
		4.3c

1. What strategies will be implemented to ensure that science content for a specific strand in your curriculum is understood by the students?
2. Provide examples of how you will establish different learning objectives for students?
3. What methods will be used to convey specific objectives?
4. How will you determine when to use inquiry-oriented instruction? Please provide relevant examples.
5. What process will be used to transition between your lesson cycles?
6. What strategies will be implemented to identify mastery of content and how will they be differentiated?
7. How will you ensure that students have the opportunity to think, speak, and write in class? Please provide relevant examples.
8. How will you balance the class being teacher-led verses independent thinking/talking done by students? Please provide relevant examples.
9. What strategies will be implemented to move the class at the expected pace?
10. What type of adjustments would be considered to balance periods of active/passive engagement?

Appendix D

D Interview Questions

Questions related to Knowledge of Assessment of Science Learning: (How would a teacher know what to access and what is the best means of assessment?)

KFET
Behaviors

4.1c	4.2b	4.3a
4.1d	4.2c	4.3b
4.1f	4.2d	4.3c

1. What process is used to break goals into up into components where student's accomplishment can be effectively assessed and facilitated through a long range plan for instruction? Measurable and manageable means?
2. What activities will be used to manage and track student progress?
3. How will you use formative and summative assessments? Please provide relevant examples.
4. What role will diagnostics such as benchmark testing, summative/formative assessments play in your planning?
5. How will you ensure that assessments are appropriately spiraled, scuffled and differentiated? Please provide relevant examples.
6. How will students with special needs be accommodated? Please provide relevant examples.
7. How will the assessment data be used to drive long-term planning, re-teaching, and differentiation? Please provide relevant examples.
8. What strategies will be implemented related to conveying the criteria for success?
9. What strategies will be used so that student work is graded and promptly returned?

Appendix E

E Example of an Exit Ticket

Name:___________________________ Date:_____________________________

Exit Ticket: Classification

The table below provides classification information for four different mammals:

Scientific Classification of Four Mammals

Classification Level	Mammal 1	Mammal 2	Mammal 3	Mammal 4
Order	Rodentia	Lagomorpha	Rodentia	Rodentia
Family	Castoridae	Leporidae	Sciuridae	Sciuridae
Genus	Castor	Sylvilagus	Sciurus	Sciurus
Species	Canadenis	Floridanus	Niger	carolinensis

___1. Using the table above, which of these mammals are most closely related to each other?

a. 1 and 2 b. 1 and 3 c. 2 and 4 d. 3 and 4

Comparison of Hemoglobin of Humans to Other Organisms

Organism	Amino Acid Differences	Organism	Amino Acid Differences
Human beta Chain	0	Mouse	27
Gorilla	1	Kangaroo	38
Rhesus Monkey	8	Chicken	45
Dog	15	Frog	67
Cow	25	Soy Bean	124

2. Based on the data in the chart above which organisms share the most recent common ancestor?

a. Human and kangaroo b. Gorilla and rhesus monkey
c. Cow and mouse d. Human and soy bean

3. A cladogram shows

a. Which kingdom is the most diverse. b. How to name a species.
c. Change over time. d. Evolutionary relationships.

4. An organism is MOST closely related to another organism that is in the same ____?

a. Family, but a different genus. b. Class, but a different order.
b. Kingdom, but a different phylum. d. Genus, but a different species.

Appendix F

F Teaching Cycle KFET Tier Rankings

		Helen			Grace	
		Formative Assessment 1			Formative Assessment 1	
	KFET Behavior	SDC	Hampton		SDC	Hampton
Plan						
	a. End In Mind	3	3		3	4
	b. Smart Aim	3	3		4	3
	c. The What Matching the How	3	3		4	3
	d. Vocabulary	3	3		3	3
	e. Reading and Writing Strategies	3	3		3	3
	f. Differentiation	2	3		3	3
Teach						
	a. Clarity	3	3		3	3
	b. Questioning	3	3		3	3
	c. Rigor	3	3		3	3
	d. Urgent Practice	2	3		3	3
Get Better So More Kids Learn						
	a. Access	3	3		3	3
	b. CFU	3	3		3	3
	c. Track and Analyze Data	2	3		3	3

			Helen			Grace	
		Mid-Year Assessment 1			Mid-Year Assessment 1		
	KFET Behavior	Helen	SDC	Hampton	Grace	SDC	Hampton
Plan							
	a. End In Mind	3	3	3	3	3	4
	b. Smart Aim	3	3	3	3	4	3
	c. The What Matching the How	3	3	3	3	4	3
	d. Vocabulary	3	3	3	3	3	3
	e. Reading and Writing Strategies	3	3	3	3	3	3
	f. Differentiation	2	2	3	2	3	3
Teach							
	a. Clarity	3	2	3	3	3	4
	b. Questioning	3	3	3	3	3	4
	c. Rigor	3	3	3	3	3	4
	d. Urgent Practice	2	2	3	3	3	3
Get Better So More Kids Learn							
	a. Access	3	3	3	3	3	4
	b. CFU	3	3	3	3	3	3
	c. Track and Analyze Data	3	2	3	3	3	4

			Helen	
		End-of-Year Assessment 1		
	KFET Behavior	Helen	SDC	Hampton
Plan				
	a. End In Mind	4	4	4
	b. Smart Aim	4	4	3
	c. The What Matching the How	3	3	4
	d. Vocabulary	4	4	4
	e. Reading and Writing Strategies	3	4	4
	f. Differentiation	3	2	3
Teach				
	a. Clarity	4	3	3
	b. Questioning	4	3	4
	c. Rigor	3	3	3
	d. Urgent Practice	3	2	3
Get Better So More Kids Learn				
	a. Access	4	3	4
	b. CFU	4	3	4
	c. Track and Analyze Data	3	3	4

Appendix G

G KIPP By The Numbers

Number of Students in network		70,000
Number of Schools in network		183
% of students by race		
	African-American	57
	Latino	39
	White	2
	Asian	1
% students eligible for federal free or reduced price lunch		88
% students that receive special education services		10
% students designated as English language learners		17
% students retruning to KIPP		89
% middle students growth over 4 yars of middle school in reading		13+
% middle students growth over 4 yars of middle school in math		19+
% Grades K-8 that meet/exceed national average reading		64
% Grades K-8 that meet/exceed national average math		73
% Grades 3-8 outperforming local districts reading		64
% Grades 3-8 outperforming local districts math		63
% Grades 3-8 outperforming states reading		32
% Grades 3-8 outperforming states math		44
% High School students outperforming district:		
	English	83
	Math	58
	Science	64
	Social Studies	100
% High School students outperforming state		
	English	48
	Math	33
	Science	57
	Social Studies	100
% High School seniors taking advanced placement courses		68
% High School seniors scoring 3 or higher on at least one advanced placement cours		37
% High School seniors taking ACT or SAT exam		98
	Avg ACT score	19
	Avg SAT score	1382
% Students who graduate from college		
	KIPP average	94
	Low-income average	74
	U.S. average	91

Appendix G

KIPP By The Numbers

% Students who start college		
	KIPP average	81
	Low-income average	45
	U.S. average	64
% Students earning a four-year college degree		
	KIPP average	44
	Low-income average	9
	U.S. average	34