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**NATIONAL BOARD CERTIFICATION AS PROFESSIONAL DEVELOPMENT:
WHAT ARE TEACHERS LEARNING?**

**An Empirical Investigation of the Learning Outcomes from the National Board for
Professional Teaching Standards' Certification Process**

Volume I

By

David Scott Lustick

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ABSTRACT

NATIONAL BOARD CERTIFICATION AS PROFESSIONAL DEVELOPMENT: WHAT ARE TEACHERS LEARNING?

**An Empirical Investigation of the Learning Outcomes from the National Board for
Professional Teaching Standards' Certification Process**

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This study investigated the National Board for Professional Teaching Standards' (NBPTS) assessment process in order to identify, quantify, and substantiate possible learning outcomes from the participants. One hundred and twenty candidates for the Adolescent and Young Adult Science (AYA Science) Certificate were studied over a 2-year period using the recurrent institutional cycle research design. This quasi-experimental methodology allowed for the collection of both cross-sectional and longitudinal data insuring a good measure of internal validity regarding observed changes both between and within group means. Multiple assessors scored transcripts of structured interviews with each teacher using the NBPTS' assessment framework according to the 13 standards accomplished science teaching. The scores (aggregated to the group level) provided the quantitative evidence of teacher learning in this study. Significant changes in mean scores from pre to post are reported at the overall, standard group, and individual standard levels. Findings suggest that the intervention had an overall effect size of .475 upon candidates' understanding of science teaching related knowledge. More specifically, most learning was associated with the standards of Scientific Inquiry and Assessment. The results support the hypothesis that the certification process is an

effective standards based professional learning opportunity. The learning outcomes discussed in this report (including the identification of Dynamic, Technical, and Deferred Learning categories) should inform debate between educational stakeholders regarding the financial and ideological support of National Board certification as a means of improving teacher quality, provide suggestions for the improvement of the assessment process, and contribute insight into the current divisive state of science education in public education.

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To Doreen, whose love, patience, and understanding make all things possible.

To Dakota, Avalon, and Troy for teaching me about the important things in life.

To Mom and Dad, for a strong foundation all down the line.

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PREFACE

Three years ago, my oldest son was in 2nd grade. One cold winter evening around the dinner table, he shared a story with the whole family about what happened at school earlier in the day. He said they learned about the different types of jobs grown-ups have.

“When it was my turn, I told everyone that my Daddy is writing a book.”

“I am?” asked.

“Yes. You work downstairs every day writing your book.”

“What kind of book?” I asked.

“It’s your autobiography,” he answered.

I had never considered the research and writing that occupied my time in my basement ‘office’ as anything other than interesting work. But, my son saw it as something more interesting. To him, it was the story of my life. I was so struck with his perception of what ‘Daddy’s does’ while pursuing a Ph.D., that the conversation has stayed with me throughout this process.

This work in some respects is my ‘autobiography’. It is the story of how a researcher tries to find an answer to a question that has both personal and professional value. In the most difficult and trying moments through this long process, my son’s idea that it was a story, helped me stay on task and committed to finding an answer.

An autobiography is not an episode of one’s life, but rather strives to capture some of the essence of what made a particular life special. For me, teaching has always been part of how I define myself. Since elementary school, I worked to teach others. When teaching became my chosen career, the classroom was like a second home for me.

Through the blur of day-to-day challenges trying to teach students about the world through the lens of science, I discovered the creative and often spontaneous power of purpose in the work of a teacher. I excelled at the practice. I pushed the boundaries of curriculum and technology. While preparing lessons, I would review textbooks and lab manuals to try and find the best vehicle for bringing about learning with my classes of students for that particular year. Often, I would think, “Is this the best way to teach this idea/concept/lesson/laboratory?” My dissatisfaction with the status quo curriculum or pre packaged labs resulted in my creating new approaches for my students. Sometimes they were successful and sometimes not. But with each attempt to improve, my reflective practice became richer in scope, more effective for my students, and (for a time) more interesting for me.

After seven years of this type of intensive teaching, I found myself getting stale, worn down, and maybe a little depressed. What once had been new had become tired. What once was a challenge had become routine. I was feeling the beginnings of the notorious ‘teacher burnout’. I had witnessed colleagues in New York City suffer for years with advanced stages of the affliction. I remember one teacher in particular who used to come to work, walk into the teacher’s lounge and announce for all to hear: “673 days 15 hours until retirement.” I knew I had to avoid this syndrome at all costs. With the threat of burnout hanging over my career, I heard President Clinton’s State of the Union Address in 1997. It turned out to be a life-changing event.

During the speech, he said the following about teachers:

To have the best schools, we must have the best teachers. Most of us in this chamber would not be here tonight without the help of those teachers. I know that I wouldn't be here. For years, many of our educators, led by North Carolina's Governor Jim Hunt and the National Board for

Professional Teaching Standards, have worked very hard to establish nationally accepted credentials for excellence in teaching. Just 500 of these teachers have been certified since 1995. My budget will enable 100,000 more to seek national certification as master teachers. We should reward and recognize our best teachers. And as we reward them, we should quickly and fairly remove those few who don't measure up, and we should challenge more of our finest young people to consider teaching as a career.

-President William Clinton
1997 State of the Union Address
February 4, 1997

His words rang in my head like a bell. 'Reward and recognize our best teachers' and 'credentials for excellence in teaching' piqued my interest and curiosity. What was the 'National Board for Professional Teaching Standards'? I took the President's words as a direct challenge to be one of those 100,000 teachers. In his plan to address the needs of schools, President Clinton described his ideas as a "Call to Action for American Education". I took that phrase in a literal sense: my president was calling on me to be one of those 100,000 master teachers. It was the first time in my life that a political figure had inspired me to do more with my life. I felt it was my duty as a good American to try and achieve what the President found important. The next day I investigated the National Board for Professional Teaching Standards through the brand new Internet. I read the five core propositions and thought, "This is me. This is my kind of teaching." Within a month, I was preparing for certification and lobbying my administration for support. The next year, I successfully completed the certification process and became a National Board certified Teacher in Adolescent and Young Adult Science.

The experience proved a high water mark in my teaching career. I put my entire heart, soul, and mind into it. I had the unusual experience of pursuing National Board certification while teaching in an American School in Sao Paulo, Brazil. Despite the

intense isolation from others in my National Board certification cohort, I made connections with resource personnel on line. In addition, I was able to solicit valuable assistance from some of my colleagues, students, and parents as I attempted to construct the entries of the portfolio. For the assessment center exercises, I had to fly from Sao Paulo to Miami, Florida to take the two day computerized 'assessment exercises'.

After months of requests and lobbying for financial support to cover the costs associated with National Board certification, my administration finally agreed to pay for half my travel expenses to Miami. All other costs associated with the certificate, the \$300 registration fee, \$1700 certification fee, hotel, food, etc. were my responsibility. I would also not enjoy any benefit to my salary or any financial gain if successful in my attempts for the coveted National certification.

For reasons that remain a mystery to me, my administration was not enthusiastic about my independent efforts to pursue the 'new' form of certification. Likewise, my colleagues who were for the most part supportive and helpful, did not understand, appreciate, or necessarily approve of my ambitions. I felt that some of the teachers viewed National Board certification as a threat to the egalitarian model of what they viewed the teaching profession to be. From this perspective, anyone who was 'crazy' enough to pursue a career as a teacher should be given equal respect for the sacrifice. Whether they were effective in the classroom was secondary to the choice they made to dedicate their lives to helping young people learn. They were not in education for the money. They were not in education for the prestige. They were not teachers for the paperwork and requirements of the administration.

National Board threatens this particular model of the teaching profession. It sends a message that deciding to be a teacher is not the distinguishing factor, but rather, how effective one is at bringing about learning in the classroom becomes the primary consideration. In other words, some teachers may be “better” than others and National Board certification provided the first systematic means for verifying this assertion. Such an approach to the profession of teaching is extremely threatening to a generation of educators raised in the union dominated egalitarian view of teaching.

Teachers demonstrated this kind of apprehension by questioning why I was doing what I was doing. Why would anyone want to work so hard on something that seemed so unnecessary? Why would I want to prove that I was somehow better than everyone else? Why couldn't I be satisfied with the intrinsic rewards from the students I taught and their parents? Some teachers thought that they too could be successful with National Board certification if they wanted to commit as much time and effort as it seemed to require and they had the financial ability to cover all the costs. Just because I was paying for this experience and putting in all the additional hours of work after school and on weekends did not mean that I was a better teacher than someone who chose not to accept the extra responsibilities. For most teachers it seemed that National Board certification was an exercise in vanity. If successful, the experience would only benefit the ego of the candidate and not translate into anything meaningful for the teacher, students, or the school as a whole.

I must admit that at the beginning of the experience, these ideas may very well have applied to me. I did want to prove to my community (as well as myself) that I was an accomplished teacher as judged by an outside authority. Maybe I felt that I was not

receiving the respect that I was due. Maybe the intrinsic rewards were not enough to validate the amount of work and time I put into my teaching. Maybe I was dissatisfied with the egalitarian model because it equated me with others who I was sure were far inferior at bringing about learning in the classroom.

I remember one teacher in particular who was an experienced teacher with a Ph.D. in Chemistry. His content knowledge was far superior to me in every respect, but he knew relatively little about how to teach that content to a diverse group of learners. It was true that for the high achievers, his traditional direct approach to instruction was quite effective as evidenced by the standardized test scores at the end of the year, but to the majority of average achievers, his pedagogy left much to be desired¹. I knew this because many of them would come to my office hours for extra help because they knew I would employ different strategies and approaches to address their needs.

My colleague, though intelligent and experienced, was at a loss as to how to help these struggling students. To be fair, some of my higher end students would seek him out during his office hours because I could not answer their advanced content questions to their satisfaction. However, we were hired to teach high school science not college and the needs of a secondary student go beyond just advanced content. I knew I was more effective than my traditional teaching counterpart at helping the majority of students not only appreciate and enjoy the experience of chemistry, but also succeed at learning the required concepts.

My knowledgeable colleague would probably find the National Board certification experience mostly foreign ideas and nearly impossible to do successfully.

¹ Coincidentally, my students did just as well if not better on the same exams. So regardless of teaching philosophy, both teachers facilitated excellent results.

He had no appreciation of the students as resources in the learning equation. He did not value the power of collaboration in learning nor in providing innovative and meaningful assessments. As is true with many traditional educators in science, he relied on lectures, note taking, didactic ‘discussions’ (Q & A with the students asking questions and the teacher giving answers), and assessments based on memorization and problem solving ability.

In many respects, I saw myself as a mirror opposite of this approach to teaching. For me, teaching and learning was a collaborative and an evolving process. Assessment could be memorization and problem solving, but it could also be open-ended and authentic. Students’ ideas of natural phenomenon were assets to be mined in class not obstacles to be overcome. After reading the National Board’s standards of accomplished science teaching, I knew that the standards described my approach to teaching and learning and not my esteemed colleague. The National Board’s Standards documents were the first to articulate and speak directly to my abilities and values as a science educator. Faced with colleagues whose approach to teaching was exclusive and fixed and my own feelings of becoming burned out and not respected by my immediate peers, National Board certification provided me with an opportunity to address both of these issues at once. Little did I know that its impact on me both professionally and personally would go far beyond these motivating factors.

If my decision to pursue National Board certification started out as an exercise in vanity, it ended as professional learning experience whose reverberations are still being felt today. The idea that the process would only benefit me and not my students became blatantly false. I knew that my intense and honest efforts at a critical self-reflection had

changed some of my approaches to teaching and reaffirmed others. For example, I gained a new appreciation for the learning experience as seen through the eyes of different students. For some, learning science was ‘second nature’ and for others it was like pulling teeth. Appreciating how painful and difficult learning can sometimes be, enabled me to anticipate problems with individual learners before they became big and weighty issues. I also learned about the value of parents as a resource in a student’s successful learning experience. Prior to certification, I saw parents at their worst as a nuisance and at their best as a hedge with student discipline problems. However, after certification, I saw every parent as having a unique child with a different set of priorities and values. Addressing those differences allowed me to develop more prosperous and appreciably better relationships with those parents and their students.

In my actual daily practice however, I think I learned the most. After analyzing videotapes of my work, I quickly realized that I talked more than I listened. I missed important comments and questions between students. I was too easily drawn into the ‘sage on the stage’ role of teacher. Finally, what I thought was ‘wait time’ was really more like a one second pause. There is nothing more humbling than watching a videotape of one’s teaching for the first time. The reality of the videotape confronts directly one’s own self-image as a teacher. The disconnect between perception and reality is quite disturbing. What I had thought was pretty good work proved to be awful and what I had considered awful, turned out to be not so bad. The videotape analysis forever changed me as a teacher and a person. Every time I stepped into a classroom, I was reminded of those horrible images I was forced to confront in the videotape. I was determined to address every identified weakness and turn it into strength.

After I achieved certification, I began thinking seriously about why I found the experience such a profound and productive professional development. When I arrived at Michigan State University to pursue a Ph.D. in Curriculum, Teaching & Educational Policy, I quickly discovered in the literature that there were many teachers who had had similar experiences with National Board certification and had written about it in journals and magazines. An idea began to form that the mounting anecdotal evidence might constitute a legitimate phenomenon worthy of investigation. The literature had great breadth, but relatively little depth. When asked what they learned by going through National Board certification, the typical answer was an unfulfilling “I’m more reflective” type of response. Very few pieces went into any kind of detail about what “more reflective” might actually mean. If I had been asked what I learned, I would have found it difficult to answer too. Not because I didn’t learn anything, but because I had learned so much it was impossible to sort out the complex nature of the learning and prioritize what was learned and its impact upon practice. I wanted to know what I learned and what others learned and the best way to do that was through research.

The study presented here is my attempt to answer the question “What are teachers learning by going through the certification process?” The value of this research is not just for the educational policy community and the National Board both of whom have a vested interest in using whatever outcomes are identified from the study for political and systemic gain, but for me. On a very personal level I wanted to understand my experience more thoroughly and be able to discuss learning outcomes beyond the ‘more reflective’ rhetoric. If the research could answer some of my own questions, it might help science

teachers decide whether or not to pursue Board certification and other candidates understand and describe their own experiences more thoroughly.

The decision to pursue an empirical approach to this question was based upon two factors: 1) the policy community's desire for information based upon empirical studies and 2) the unique opportunity to attempt to measure outcomes using the National Board's own rubrics and scoring procedures. However, there was an innate problem: investigator bias. How could I pursue this research as Principal Investigator and not be an influencing force in the results? Several alternative possibilities for resolving the conflict presented themselves to me. First, I could abandon the project and do my dissertation on something where the appearance of bias would not be as much of an issue and I could be more 'objective'. Second, I could work into the design and budget a second researcher who would be responsible for either all the interviews, all the scoring, or management of data thereby insulating myself and allowing the different aspects of data collection and assessment to be blind to each other and to me. Third, I could compromise and do both interviewing and scoring and implement a series of measures to protect against bias. I opted for the third option for a variety of reasons including practical, technical, and financial. In this third option, the other two assessors were blind to the status (pre or post, gender, cohort, etc) of each transcript they scored.

As I did this work on how and what others might be learning, I was constantly aware at every step what it was that I might be learning. I was conscious of my role in the process and how my ideas and perceptions were shaping and were shaped by the events I experienced. I approached this project with an intellectual curiosity and professional honesty. What if anything would the data reveal concerning what might be

learned from the process of certification? Was my experience common or uncommon? How would demonstrated professional knowledge among candidates change from before to after certification? When I began this investigation, I did not know the answers to these questions. Now, I have a much better understanding. My learning is documented in this work. If this is my 'autobiography', then the work presented here represents only the first chapter. I consider my ongoing efforts to achieve knowledge and understanding as a 'work in progress' requiring many more years and a career of study.

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CHAPTER 1: INTRODUCTION

*“Life is for learning.”
-Joni Mitchell*

Situating and Stating the Problem

Teaching is a complex endeavor (Lampert, 1985; Lortie, 1975). The process of teaching and learning can be thought of as a practice of ‘human improvement’ involving the unpredictable and uncertain nature of people (Cohen, 1988). As difficult a challenge as education presents, its role in fostering a strong, democratic and prosperous society is undeniably important (NCEE, 1983; NCTAF, 1996). The high value placed upon teaching and learning is reflected in policy initiatives aimed at strengthening the current system of education. Efforts to improve and better understand what works best at improving teaching and learning lie at the forefront of the current political and educational agendas. In an address to an audience of Minnesota education stakeholders in March of 2002, President George W. Bush unveiled his plan for education reform titled, “No Child Left Behind” (Bush, 2002). The plan focuses on a theme of improving teacher quality. In his comments, the President said:

My administration is supporting teachers in getting the training they need to raise educational standards...This is the greatest federal commitment to quality teachers and principals. And it's important and it's necessary if we're going to achieve the reforms inherent in the no child left behind bill. (Bush, 2002) [sic]

With the passage of the No Child Left Behind legislation, the government is providing valuable education dollars to improve the quality of teachers. President Bush makes it clear that “training”, or professional development, will be a major means by which the policy and leadership communities leverage improvement in teacher quality.

Teacher Quality is a multi-faceted area of educational literature and research. It lies at the heart of the No Child Left Behind (NCLB) law and is the latest example of teachers being viewed as the means of carrying out educational policy (Cohen, 1990). In this context, Teacher quality is defined as the knowledge, skills, and dispositions that contribute to teacher effectiveness at fostering improved student learning (Walsh, 2002). The policies represented by NCLB are based upon a common belief that improved student learning starts with higher quality and more effective teachers (Bush, 2001; Darling-Hammond, 2001; Garet & Porter 2001; Hawley & Valli, 1995, 1998; Laczko-Kerr & Berliner 2002; National Commission on Teaching and America's Future 1996, Sanders & Rivers, 1996; Sykes, 1999; Wenglinsky 2001). For nearly all of this work, the underlying question is "How can society improve the teaching and learning experience in the public school classrooms?" As No Child Left Behind exemplifies, the current answer *en vogue* lies in providing effective professional development opportunities for teachers (Wiley & Yoon, 1995).

However, just providing the opportunity for teachers to learn does not necessarily mean that learning will occur or, if learning does happen, that quality of instruction will be improved. For example, if a teacher goes through technology training, one might assume that not only does the teacher now understand technology better, but also that the knowledge gained will result in more effective use of technology in the classroom with students. Such an assumption would be a mistake. Exposure to a learning opportunity does not guarantee learning nor does it necessarily result in changes in classroom practice. The problem pertains to the assumption that teachers learn the intended objectives from a professional development experience. The 'What teachers are learning?' question remains

the least understood aspect of the professional development paradigm. According to Wilson and Berne (1999), research in this area has yet to “identify, conceptualize, and assess” what teachers are learning. To address this problem, empirical investigations are needed to provide quantitative evidence of a) what types of knowledge are being learned by the teacher, and b) to what extent is that learning taking place. Once these questions are answered, a professional development’s potential for influencing teacher quality and improving student learning can be assessed more accurately.

How are ‘Teacher Quality’, ‘Professional Development’, and ‘Teacher Learning’ related? Before teacher quality is improved, a teacher must first learn something from the professional development that they did not know prior to the experience. Teachers may acquire new knowledge, skill(s), or dispositions, but this ‘learning’ may not necessarily become apparent in the decisions, actions, and strategies used in the classroom. In other words, improvements in teacher quality are preceded by two events: a) teachers acquire new knowledge from a particular professional development opportunity, and b) decide whether or not to act upon the new understanding. Too often in educational literature concerning this issue of professional development and teacher quality, the teacher learning component and the actions based upon that learning are assumed to occur almost automatically. Or, at the very least, the ‘learning outcomes’ are determined by self reported interviews or surveys with the teachers after the professional development (Mullen et al, 1996). Little empirical evidence exists that assesses precisely what teachers may or may not be learning from a particular development experience.

If professional development does not insure improvements in teacher quality, then what does it do? Why should billions of public tax dollars be spent annually on building

better teachers when the benefit from such expenditures is so poorly understood?

Professional development allows for the *possibility* of teacher learning and improved teacher quality. Professional development provides a teacher with the opportunity to learn something they did not know before and the option of acting upon their new understanding in a positive and productive manner in the classroom. There is an old saying, “you can lead a horse to water, but you can’t make it drink.” Such may be the case with teachers, learning opportunities, and improvements to practice. A teacher can be provided with the opportunity to learn, but that does not mean they will necessarily learn or even act upon what they do learn. With so much reliance on professional development as the instrument of change in public school classrooms, the challenge for the academic community is to identify, quantify, and substantiate specific learning outcomes of a particular professional development experience by means of empirical research. Determining what teachers may or may not be learning and to what extent that learning is taking place is the first step to understanding how teacher quality (or teachers’ effectiveness at bringing about learning in their students) may change.

The Question and Its Importance

What are teachers learning from National Board certification? If good research questions are said to “emerge as the perfect intersection between sociohistorical circumstances and one’s own biography” (Boshier, 1994), then this represents a very good question. This study on the National Board for Professional Teaching Standard’s certification process grows out of the intersection of three separate strands of circumstances: 1) my experience in becoming a National Board Certified Teacher in Adolescent and Young Adult Science, 2) the mounting evidence suggesting that the

National Board for Professional Teaching Standards' (NBPTS) process of assessment is a powerful opportunity for teachers to learn, and 3) the current debate over what constitutes 'teacher quality' and the means (professional development) used to improve it. This study aims to identify, quantify, and substantiate teacher-learning outcomes from candidates pursuing National Board certification in Adolescent and Young Adult Science (AYA Science).

The National Board for Professional Teaching Standards (NBPTS) has maintained that the process of recognizing accomplished teachers should "provide opportunities for candidates to develop professionally" (ETS, 1999). Now, evidence is emerging that suggests that the process of National Board certification promotes teacher learning for the candidates. Whether they pass or fail, teachers say they feel better about themselves as professionals and believe they are better practitioners because of their efforts. However, what teachers *feel* and *believe* may be quite different from what they *learn*. Therefore, inquiring about the precise nature of the learning outcomes from Board certification becomes a very meaningful and important endeavor.

The stakes are high for everyone involved in education. In a public educational system, that spends roughly \$3500 per year (2.0% of its annual operating budget) on each teacher's professional development, questions regarding the effectiveness of a given program are not trivial (Miller, 1994; Killeen, 2004). In fiscally difficult times, states and local districts are debating the merits of providing financial incentives and support for National Board certification (Griffin, 2003). Financial support for the costs of certification and incentive programs for those who achieve National Board certification can be very expensive. States like North Carolina set aside more than \$26 million dollars

in 2003 to encourage and support teachers who pursue the coveted certification (Leef, 2003). Other states like Texas provide no financial support or incentive for the teachers who pursue National Board certification, but do accept successful achievement of Board certification in lieu of the state certification exam. Forty-eight states and 544 local districts offer some form of financial incentive or support for National Board (NBPTS, 2004).

The cost for National Board certification fees alone may be surprising. In 2003, approximately 16,000 teachers pursued National Board certification at a cost of \$2300 per candidate; that equals \$36.8 million in certification fees paid almost entirely by state departments of education, local districts, and to a lesser extent, teacher unions. Out of those 16,000 candidates, approximately half of the teachers achieved certification in 2003 (NBPTS, 2004). If 75% of them received a bonus, financial reward, or salary increase equivalent to \$2500², then an additional \$20 million needs to be included in the total public expenditures. For 2003 alone, nearly \$57 million (most of which derives from public funds) were invested in National Board certification. This may sound like a lot of money, but if put into the context of all funds put towards professional development, this amount is quite small. In the multi-billion dollar a year professional development industry, \$57 million is a pittance.³ With so much money going to improve this country's teachers, it is surprising that there is precious little empirical evidence that examines what teachers may or may not be learning from a specific professional development. Trying to

² Financial incentives range anywhere from \$1000 to \$7500 annual bonus for the life of the certificate (10 years). States like North Carolina offer a 12% increase in salary with successful completion of the process. For a complete review of the incentives and support offered by each state and more than 500 local districts, visit <http://www.nbpts.org/about/state.cfm>

³ Determining the annual expenditures for professional development is a tricky and very uncertain practice. For a detailed study on how estimates are calculated, see Miller, 1994 and Killeen et al, 2004)

determine what (if anything) these teachers may be learning from a perceived effective experience would therefore seem to be a most needed and valued goal.

A study that provides evidence regarding the degree to which Adolescent and Young Adult Science candidates learn to align their classroom practices with a particular set of standards for accomplished teaching, may allow for a more informed and less politically aligned debate concerning the merits of National Board certification as an effective teacher professional development. Furthermore, knowledge regarding teacher-learning outcomes would bring to light effective aspects of National Board certification and indicate how National Board certification as a professional development might be improved or eventually linked to student learning. By identifying, quantifying, and substantiating specific learning outcomes for teachers who participate in the National Board certification process, this study should support a robust discourse regarding National Board certification, the teaching-learning dynamic in secondary science classrooms, and the policies that affect both.

Description of the Intervention

What exactly is the National Board and what does the certification process entail? The NBPTS was established in 1987 through a Carnegie Foundation Grant as a means of defining, assessing, and recognizing accomplished teaching (NBPTS, 1991). NBPTS certified its first teacher in 1993 and participation has been growing ever since. The NBPTS has identified three responsibilities around its system of certification: (1) standards (establishing, reviewing, and refining standards of accomplished teaching through consensus about what teachers should know and be able to do); (2) assessment (providing a valid and accessible means to evaluate teachers against the standards); and (3) professional

development (providing teachers with the opportunity to strengthen their practice through self-examination) (Koprowicz, 1994). All standards, assessments, and scoring rubrics are based upon the five ‘core propositions of accomplished teaching’. The five core propositions as stated by the NBPTS are as follows:

- 1) Teachers are committed to students and their learning.
- 2) Teachers know the subjects they teach and how to teach those subjects to students.
- 3) Teachers are responsible for managing and monitoring student learning.
- 4) Teachers think systematically about their practice and learn from experience.
- 5) Teachers are members of learning communities.

(NBPTS, 2004a)

The year long certification process for teachers has two main components: the construction of a detailed, reflective, and analytical portfolio over a 4-6 month time span and the completion of a rigorous 4 hour computerized assessment⁴. The National Board offers certification in 27 different areas of expertise. Each certificate has its own set of standards although they are all based on the 5 Propositions of ‘What Teachers Should Know and Be Able to Do’. The portfolio for Adolescent and Young Adult Science has four sections that address the 13 standards for AYA Science. The four portfolio entries are: Teaching a Major Idea in Science, Active Scientific Inquiry, Whole Class Discussion in Science, and Documented Accomplishments: Contributions to Student Learning.⁵ (See

⁴ The assessment center ‘exercises’ have changed over the course of the last few years. Originally for example, the exam for AYA Science took two 8-hour days covering post-secondary level content material in science and pedagogical knowledge in the science classroom. Today, the exam has been reduced to a 4-hour exam focused entirely on science content. For a complete description of the assessment process, go to: <http://www.nbpts.org/candidates/acob/nextgen/n20.html>

⁵ It should be noted that starting in 2001, the ‘new’ format for portfolio construction was phased in over a two-year period. The original portfolio required 6 entries. An Entry called “Assessment” was incorporated into the other classroom performance entries and the Documented accomplishments for Professional and Community were combined into one. Both formats were involved in this study during year one, though which candidates had which form is unknown. The teachers in years 2 and 3 had to complete the new 4-entry version. Though this unexpected change in the intervention could be perceived as a threat to the study’s validity, it is unlikely to be a cause of too much concern. For one, the new version still addressed the same 13 standards and required candidates to provide evidence for each.

Appendix D for an overview of Standards). Using videotape, examples of student work, and artifacts representing professional accomplishments, teachers address questions in each section of the portfolio while constructing a presentation of their best practice. The final product serves as evidence demonstrating the teacher's impact upon classroom academic environment, student learning, and the school community.

Completing the portfolio is a demanding, rigorous, and at times tedious process embedded in the day-to-day work of teachers. One teacher in this study, Andrea from Virginia said,

I think if I had to go back and get a Ph.D. or either to have triplets – I would do that before I'd go through National Board again. (Group1, Teacher #39)

Another teacher, Robert from a mountain state said,

I thought the National Board Portfolio was the most difficult thing that I'd ever done in my entire career. I consider getting National Board Certification far greater than getting my masters' degree or anything else. I thought it was just an enormous project and very worthwhile. (Group 1, Teacher #27)

Other teachers in this study used such descriptions as 'absolutely overwhelming', 'massively significant', and 'highly stressful experience'. Not one of the 120 teachers interviewed for this study described the experience as being 'easy', 'not challenging', or 'dull'.

The National Board encourages teacher collaboration through support groups and district workshops. However, all work submitted by a candidate must be their own. The 4-hour Assessment Center exam is administered to individual candidates after the submission of the completed portfolio. The exam focuses on teacher content knowledge. Because of the labor and time involved in assessing the portfolios, the cost of National

Board certification is currently \$2300 with many states, districts, and unions covering some or all of the expense.

National Board Certification as Professional Development

The perception of National Board Certification as a productive professional development may be due in no small part to the numerous endorsements received by a wide range of organizations. For example, the Center for Research on Education, Diversity & Excellence has stated:

We believe the process (NBC) represents sound professional development practice—it is focused on subject matter content and student learning, uses teacher self-reflection and inquiry linked to the teacher's own teaching situation and practice, and is highly collaborative. This kind of thorough, focused professional development is far too rare for most of California's teachers. (CREDE, 2003, p 10)

How does National Board certification fit with current conceptions of effective professional development? The answer can be found by understanding the characteristics of quality professional development.

Over the last decade, a radical rethinking of what constitutes effective professional development for teachers has been taking place (Ingvarson, 1999; Little, 1993 & 1997; Ball & Cohen, 1995; Huberman 1993; Hargraeves 1995; Darling-Hammond & McLaughlin, 1996; Stein and Brown 1997; Sykes, 1999). This reexamination of professional development was motivated with a pervasive dissatisfaction with most traditional approaches to improving teacher quality.

The traditional model of staff development is the experience that most teachers have endured in the past. The traditional models can be summarized as follows (Hawley and Valli, 1999):

- 1) *The Individually guided model*: individual teachers performing self-assessments and designing appropriate curriculum
- 2) *The Observer/assessment model*: principal or colleague observe teacher in class and then comment
- 3) *The Development/improvement model*: teachers involve themselves in whole school reform efforts
- 4) *The Training model*: teacher participation in course work, workshops, and conferences.

Teacher learning in these models has not been considered very effective due in part to the passive process where teachers are the recipients of knowledge and skills as defined by an outside authority such as a principal, visiting expert, or government administrator. The traditional model of professional development is not constructed around any set of common standards or goals for the educators. For the most part, the experiences are isolated, extrinsically motivated, undisciplined, and leave little room to assess the accountability of results.

Kennedy (2001) discusses a concern for the quality of traditional models of professional development as either “out of date or inadequate to meet the demands of new approaches to teaching and learning of science and mathematics” (Kennedy, 2001 p. 46). In addition, Ball and Cohen (1995) argue for a teacher professional education that is embedded in practice and draws upon opportunities for critical analysis, reflection, and development of new understandings that grow out of daily teacher practices.

In response to these types of concerns, principles for designing meaningful professional development have been shown to “abound in the literature” (Wilson and Berne, 1999). The consensus model represents one of the new ways to think about this area. Hawley and Valli (1999) describe the consensus model by identifying eight principles. Professional development should be:

- 1) Driven by goals and student performance
- 2) Involve teachers in the planning and implementation process
- 3) School based and integral to school operations
- 4) Organized around collaborative problem solving
- 5) Continuous and ongoing involving follow-up and support
- 6) Information rich with multiple sources of teacher knowledge and experience
- 7) Provide opportunities for developing theoretical understanding of the knowledge and skills learned

Part of a comprehensive change process that includes issues of student learning, the consensus model of professional development sees the teacher as an active learner and the process of learning embedded in practice. The model also emphasizes the role of reflection and professional discourse as effective means of teacher learning.

For this research, both traditional and emerging models of professional development add something meaningful to the understanding of how teacher quality may improve as a result of National Board certification. Ingvarson (1998) supports this combination model and links professional development to teacher learning when he suggests:

In principle, both systems are essential and each should be complementary to the other, like two pillars holding up the same building (Ingvarson, 1998, p133).

This view of professional development allows for a thorough conceptualization of National Board certification as an effective learning opportunity. National Board certification incorporates elements of both approaches to professional development. For example, the process is completely voluntary as per the Consensus Model. It encourages professional discourse and collegiality as described in elements of both the traditional and consensus models. And finally, National Board certification asks teachers to examine their work both inside and outside the classroom as do both models. In addition, Board certification has well defined standards of performance and a well-specified goal as a

result of participation. It is focused on both process and content as it asks teachers to evaluate and comment on both aspects of practice as a means of accessing teacher knowledge and skill.

As National Board certification grows and matures, its impact may be felt beyond the teachers directly involved and the students they teach. It may challenge many of the fundamental or traditional assumptions about what professional development looks like and how it is implemented. As Ingvarson states in his assessment of National Board certification as a professional development:

Steadily increasing numbers of education authorities are accepting Board certification as evidence of professional development....The hope is that a new infrastructure of professional learning will develop around the incentive of Board certification, and there are signs that this is happening (Ingvarson, 1998, p134).

According to Reichardt (2000) “National Board certification provides a vision of good teaching and serves as a tool to direct individual teacher professional development.”

Reichardt goes on to say that there is “emerging evidence of the effectiveness of National Board certification as a method to improve teacher quality” (Reichardt, 2000). In the next section, this ‘emerging evidence’ will be presented.

National Board Certification and Teacher Learning

Ever since the NBPTS issued its first certificates of accomplished teaching in 1993, the claims regarding its value as an effective professional development in stimulating teacher learning have appeared throughout the educational press (Tracz et al, 1995; Kowalski et al, 1997). What kind of research has been conducted and what does it reveal about what teachers are learning? In this section, current knowledge regarding

teacher-learning outcomes from Board certification and the kinds of research that produced current understanding around this question will be presented.

Testimonials and anecdotal reports made up the first wave of evidence regarding what teachers may be learning from Board certification. Through reports and interviews with the press, candidates provided descriptions of their experiences from participating in National Board certification that highlighted possible impacts to both their personal and professional lives. These reports are consistent in theme and reveal a significant phenomenon for investigation. Though lacking in the validity of more rigorous pursuits, the testimonials from these teachers provides the necessary evidence warranting further investigations.

For example, numerous teachers have professed the benefits of National Board certification to their practice (Bailey& Helms, 2000; Gardiner, 2000; Jenkins, 2000; Chase, 1999; Benz, 1997; Haynes, 1995; Marriot, 2001; Roden, 1999; Wiebke, 2000). These teachers describe their experiences with NBC with such terms as, “enlightening” (Mahaley, 1999) or “revitalizing” (Areglado, 1999). These accounts provide insights into the value of the National Board certification experience, but tell little about what candidates learn.

Surveys have been conducted that expand upon testimonial accounts and provide more extensive interpretations of what the population of National Board Certified teachers (NBCTs) is learning from the assessments. For example, NBPTS issued two reports based upon survey data that provided a national profile of NBCTs and their feelings of “becoming a better teacher” from the certification process (NBPTS, 2001a; NBPTS, 2001b). This type of information helps to validate the process as effective, but

leaves open questions regarding validity of self-reports and the particulars of how the process of National Board certification could result in the professed outcomes.

Qualitative research studies that examine the outcomes of National Board certification have begun to clarify the possible learning outcomes from certification. These studies provide valuable knowledge that confirms the findings in anecdotal and survey reports and also reveal some possible connections between components of the certification process (i.e., other teachers and NBPTS materials), improved teacher quality, and student learning (Athanases, 1994; Chittenden & Jones, 1997; Kowalski et al, 1997; Sato, 2000; Tracz, et al 1995). Other studies structured around support groups for teachers involved in the certification procedures provide compelling evidence that candidates learn from Board certification by participating in extended professional communities (Burroughs et al, 2000; Manouchehri, 2000; Rotberg et al, 1998). Studies have also found a value for the NBPTS materials such as the standards documents and portfolio instructions, as important resources for teacher learning (Kowalski et al, 1997; Rotberg et al, 1998). These investigations provide meaningful insights into the means and ends of Board certification, but are lacking in the generalizability of their results. They remain bound by the self-reporting nature of their evidence. From the research to date, several conclusions can be made:

- 1) Most teachers find the experience of National Board certification to be effective professional development.
- 2) The discourse communities that form around the assessment experience are powerful avenues for candidate learning.
- 3) The NBPTS materials, such as standards documents and portfolio instructions, are a valuable resource for teacher's acquisition of knowledge.
- 4) Teachers learn to be 'more reflective practioners' as a result of the certification process.

As informative and important as the above qualitative studies are, there is a need to balance the research efforts into National Board certification with quantitative studies.

As Lyon states:

Qualitative-descriptive research cannot identify generalizable strategies that will likely improve academic achievement among students. Only quantitatively based experimental research can do that. (Lyon, 2000, np).

Very few in depth scientific studies exist regarding the effectiveness of National Board certification as a professional development (Goldhaber et al, 2003). Recent literature identifies a need to complement the rich collection of qualitative studies on teacher learning with quantitative investigations that attempt to clarify, identify, and substantiate specific outcomes (Floden, 2001; Crawford & Impara, 2001; and Porter et al, 2001).

How do we get beyond the “more reflective practioners” description of teacher learning from National Board certification to precise conclusions regarding what and how teachers are learning from this experience? This study represents one such investigation that adds to the understanding of teacher quality, professional development, and teacher learning.

The reason that empirical evidence on this subject is only now becoming available may be due to the fact that the number of National Board certified teachers has only recently reached sufficient numbers (32,000) to be the focus of meaningful quantitative investigations. This explanation is supported by several studies designed and funded in 2002 that should provide important and meaningful results in the months and years to come. Professional educational researchers, such as Carol Cohen, Connie Bernash, and Maxine Freund, are currently engaged in extensive quantitative studies that examine National Board certification as professional development (NBPTS, 2003).

The first of these studies was recently released and demonstrated a strong relationship between teachers identified by the National Board as accomplished and their students' standardized test scores, but found no impact on these scores from the certification process itself (Goldhaber et al, 2003). This result could be taken to mean that the certification process had no appreciable impact upon teacher quality as measured by improved test scores of students. However, since the study was focused upon early and middle elementary generalists, it could be argued that the certification experience is qualitatively different from a secondary science emphasis. Therefore this finding may not apply to the experiences of secondary teachers pursuing National Board certification in specific content disciplines.

Understanding Teacher Learning from the Certification Process

The character and flavor of teacher learning reported by both the NBPTS and the academic research community reflects a diverse mix of results. This study aims to move beyond the vague, and grandiose claims by NBPTS and its candidates to understand how participants' experiences can be understood as instances of measured change against a standards based knowledge domain. In the preceding section, a review of relevant literature presented how different types of studies and reports produce different descriptions of learning outcomes. Yet, how that learning might take place as a result of National Board certification was excluded. In this section, many of those studies will be revisited to better understand how such learning outcomes might occur and could be explained within the context and available resources of National Board certification. Do the distilled learning outcomes identified from qualitative studies make sense? To address the question, learning outcomes will be identified and grouped according to

common themes. The themes include: reflection, collegiality, professional and personal growth, and learning resources. This portion of the analysis will provide descriptions of the various instrumentalities and processes that potentially serve as avenues for claimed outcomes.

Reflection

A common claim made by teachers who have participated in National Board certification hovers around the idea of becoming a 'more reflective practitioner'. For the purposes of this discussion, reflection is defined as a process by which teachers regularly analyze, evaluate, and strengthen the quality and effectiveness of their work (Arglado, 1999). Anecdotal evidence for this particular learning outcome is present in such quotes as, "I reflect more on what I am teaching and how it affects the kids" and "I think more about why I'm doing something. I think more of the objectives---what I want to cover and why" (Rotberg, 1998). Teachers may also describe their reflection in terms of the questions the assessment raises. For example, in one case study, the teacher described her experience by saying, "I am questioning all aspects of my teaching style." This same teacher also describes the Board's assessment process's overall impact upon her as, "I am much more reflective about everything I do" (Wiebke, 1999). Still others express this improvement in their reflective capabilities by referring to it as a form of self-assessment. For example, one testimonial describes the National Board assessment as an opportunity to "evaluate ourselves honestly" (Aregrado, 1999).

The anecdotal evidence regarding the assessment's effect upon the reflective nature of a teacher's practice, would seem to coincide strongly with the NBPTS's standards for what 'accomplished teachers should know and be able to do'. More

specifically, Proposition #4 states that teachers should “think systematically about their practice and learn from experience”. The proposition then elaborates upon this point by describing accomplished teachers as individuals who have “a commitment to lifelong professional development” (NBPTS, 1991). NBPTS proposes that the object of a teacher’s systematic thinking should pertain to a whole array of practice parameters. From content understanding to collegial sources of teaching ‘wisdom’, the National Board places a significant emphasis upon the teacher who learns to think more deeply and extensively about their practice (Kowalski et al, 1997).

Collegiality

Another stream of evidence around what teachers learn from National Board assessment concerns the input of colleagues and community as a contributing contingency to the richness and quality of teaching and learning (Kowalski et al, 1997). In the words of one researcher, “the certification process opened up a dialogue with teaching colleagues” (Gardiner, 2000). This evidence supports the conclusion of others that National Board teachers represent a legitimate “discourse community” or “community of practice” (Burroughs, et al, 2000) and that these communities can alter teaching (Huberman, 1995).

There are many quotes from candidates that suggest that the certification process developed a high regard for collegiality. For example, “I’ve increased collaboration with other teachers” (Rotberg, 1996) and “I’m feeling extremely grateful to my fellow teachers” (Wiebke, 1999). This spirit of collegiality is not limited to a strictly local context. Some candidates expressed recognition of a larger community of National Board teachers serving as a vital resource to their practice. One teacher states,

I compare notes, share expertise, and swap advice with my network of other Board-certified teachers: hundreds of motivated expert teachers who share knowledge and support with one another in meeting the needs of children. This diverse group of teachers from across the United States has become an integral part of my professional support net (Jenkins, 2000).

It would appear that National Board certification has broken through the isolation of more traditional approaches to teaching and infused many candidates with an increased regard for community membership and its role in serving the needs of teachers.

Developing a collegiality among teachers is one of the stated aims of the NBPTS. Proposition #5 states that 'teachers are members of learning communities'. It provides further elaboration on the proposition by stating, "the work of teaching reaches beyond the boundaries of individual classrooms to wider communities of learning" (NBPTS, 1991, p3). The nature of this extended vision of teaching involves several facets. For example, teachers are not only expected to work with other teachers on issues of the immediate classroom, but also with parents, community, and school leaders for the purpose of school improvement and education reform.

Growth

Much of the evidence collected regarding teacher learning from the NBPTS assessment process could best be characterized as oriented around personal and professional growth. Personal growth is defined as those areas involved in self-esteem, confidence, and feelings regarding the work of teaching. In contrast, professional growth is defined as learning in areas directly or indirectly associated with aspects of practice such as communication, pedagogy, and development. I will consider each of these with the understanding that the term 'growth' implies a form of candidate learning.

By far, the most common refrain in the literature among candidates regarding **their** experience with the National Board deals with an amorphous feeling of self-**improvement**. Descriptions of the certification process such as, “the most dramatic and **transforming experience**” and “it gave me a lot of self-confidence” do not reveal much **detail** regarding the how’s and why’s around assessment procedures, but instead indicated **that** the candidates’ emotional connection with the endeavor (Rotberg, 1996). References **to** increased feelings of ‘enlightenment’, ‘empowerment’, ‘self-image’, and ‘self-respect’ **are** common among interviewed candidates (Kowalski et al, 1997). One almost gets the **sense** of a ‘religious’ experience from some of the more extreme cases. In one report, a **teacher** commented that “Earning my certification not only made me a better teacher, it **made** me a better person” (Wiebke, 2000).

The incidences of professional growth among candidates are equally interesting. **Many** comments pertain to a revitalization or confirmation of practice. For example one **candidate** states that National Board certification is one way to “reinvigorate yourself **professionally**” (Chase, 1999). Another teacher states that the certification process “**helped** me recapture the enthusiasm of my early years of teaching” (Jenkins, 2000).

Evidence to support the idea of professional growth also abounds in the literature. **The** nature of this data tends to support the notion that National Board certification has a **great** impact upon how teachers understand what they do and why. It helps them develop **more** advanced communication skills so they may more accurately and efficiently talk **with** peers, which is a valued skill according to some researchers (Wilson et al, 1987). The process also seems to ‘validate’ or ‘confirm’ their ideas pertaining to teaching and learning. Taken together, the evidence for both personal and professional growth from

the literature strongly suggests that the certification process is a powerful learning experience for the teachers.

Though personal growth is not directly addressed in the National Board's standards, the supporting rhetoric around the standards is filled with statements that promote exactly these types of outcomes. For example, as part of their mission statement, the NBPTS says that the certification process should "enhance teachers' self-esteem". The Board's commitment to a 'rigorous' assessment may also contribute to the candidates' sense of accomplishment (NBPTS, 1991).

The professional growth outcomes are more directly related to the standards. The NBPTS uses the term 'professional' to denote occupations (teaching being among them) that are based upon a 'body of specialized expert knowledge' and are coupled with a 'code of ethics emphasizing service to clients' (NBPTS, 1991). It is upon this overarching assumption that the five propositions of accomplished teaching are based. Therefore, when teachers discuss their increased awareness of student needs, new ways to teach a particular lesson, the impact of new theories and approaches to practice, they are articulating evidence for the Board's conception of 'professional growth'.

Resources for Learning

If reflection, collegiality, and personal and professional growth describe the content of *what* teachers are learning, then the question becomes, *how* are these teachers learning this curriculum? The National Board certification process has three well-defined components that serve as direct learning resources for the candidates and also provide the context for indirect learning resources. These components are: the portfolio construction, a formal examination at an off site testing center, and the National Board's Propositions

and Standards of accomplished teaching. I will briefly describe each of these components in terms of how they may explicitly and implicitly support or provide opportunities for teacher learning.

The first resource for teacher learning from National Board certification involves the standards and propositions for accomplished teaching that serve as the essential framework for the assessment (Kowalski et al, 1997). It should be noted that the standards were created under the Board's working assumption that the standards enumerate a broad base for teaching and that they also "conceal the complexities, uncertainties, and dilemmas of the work" (NBPTS, 1991, p. 13). Standards documents are created for a specified area of expertise (i.e., foreign language, art, science, or special needs) and/or grade level (i.e., primary, elementary, middle, secondary). Currently, each of the twenty-seven different areas available for certification have their own set of articulated and thoroughly communicated standards regarding what that specified group of teachers should know and be able to do. However, all twenty-seven certificate area standards are based upon the five basic propositions promoted by the Board. Everything the candidate is to think about, experience, answer, and communicate stems from the established standards pertaining to their area of specialization.⁶

It is from these standards that the portfolio tasks and many of the stated benefits of certification derive. For example, candidates discuss the important role the standards and propositions played in their assessment experience. "I find the standards giving me

⁶ It is important to note that the standards originate from committees made up predominantly of established teachers from diverse backgrounds in the designated areas. It is an assumption of the NBPTS that experienced teachers have knowledge that is valued regarding what accomplish teachers know and are able to do. Their 'wisdom' along with the input of administrators, education leaders, and academics make up the community of expertise that eventually define the standards. The standards go through review and revision cycles every three years so as to insure community consensus, remove any racial or ethnic bias, and refinements as deemed necessary.

the energy and desire to plan better” (Kowalski et al, 1997). Or, “The standards have revitalized my work with colleagues” (Areglado, 1999). The standards also play a role in developing the skills and mindsets of reflection by enabling a teacher to “closely examine their professional life through the lens of the Board’s standards and propositions”. As one teacher put it, “It gives me something to check my practice against. It got me off the automatic mode as an experienced teacher” (Kowalski et al, 1997).

If the standards form the ‘brain’ of the operation, then the heart of the National Board’s assessment process is the individual candidate’s construction of a diverse and comprehensive professional portfolio. The candidate receives either a fifteen-pound box that contains all the instructions, performance tasks, logistical information, and grading rubrics necessary to complete the six-month intensive process or they may download the digital equivalent after on-line registration. For the unaware, this package with more than a thousand pages of materials can be overwhelming and intimidating. However, after the initial shock, candidates discover the carefully designed assessment instrument is rich with advice, detailed procedures, and explanations regarding the purposes of the individual components of the portfolio.

Much of the learning associated with reflection, collegiality, and personal and professional growth are directly related to the number, depth, and types of tasks that compose the portfolio. For example, one of the first things the candidate must understand is that to complete the portfolio properly, extensive long term planning is required. The candidate needs to closely estimate what they will be teaching to whom at any given week during the spring semester. Such anticipation of teaching duties, forces the teachers

to coordinate with faculty that have similar or related teaching responsibilities. This coordination can be seen as the first step in establishing an atmosphere of collegiality.

Secondly, such meticulous planning may also stimulate candidates to reflect upon their practice and the curriculum they are charged to teach. What is the best lesson for a particular objective? What topics lend themselves to productive classroom discussions? What classroom activities showcase an individual teacher's approach to practice best? What are the themes or long term ideas that will be emphasized during the term? How will these strands be expressed in different lessons or units? How are others with similar job profiles in my school or district handling these issues? The list of questions goes on and on and on. After solving many series of problems around the construction of the portfolio, it is no wonder that many teachers feel good about themselves. Successful completion of the portfolio (in addition to their 'normal' workload) demands patience, tenacity, intelligence, and perseverance.

Finally, there is the formal assessment. The formal assessment is a 4 hour exam administered after the completion of the portfolio and before the end of June at an off site facility (i.e., Silvan Learning Centers). The exam assesses the teacher's depth and breadth of content knowledge understanding relative to their chosen field of specialization (NBPTS, 2004). Candidates' comments about this aspect of the certification process are limited due to confidentiality agreements between the Board and every candidate and therefore its contributions to learning outcomes are least understood or applicable to the questions of this analysis. For example, one candidate who failed the exam commented that he realized "it wasn't that I didn't have the ability, I just didn't deal with all the details" (American Teacher, 2000). The ideas expressed by this teacher

indicate learning regarding the process of certification not learning regarding practice in the classroom. However, the literature suggests that the exam seems to trigger teachers to collaborate in their efforts to prepare for the test. Such collaboration seems to reinforce the improved sense of collegiality (Kowalski et al, 1997).

This ‘triggering effect’ can be thought of as an example of implicit resources for teacher learning. It is not an official part of the assessment process, but one that seems to grow out of the requirements. Such implicit resources are common to all three explicit instruments of the assessment process. The standards stimulate discussion and study groups that in turn stimulate reflection, collegiality, and growth. Portfolio construction often entwined with discussions of the standards and propositions has the same effect. It appears that the implicit resources developed by candidates in response to the explicit tools of the Board, are of equal value in their contributions to teacher learning outcomes.

This review of available and relevant research on National Board certification as professional development provides a generalized indication of the most likely areas of teacher learning outcomes and the resources associated with that learning. Knowing what others claim are learning outcomes from National Board certification provides a good indication of what might be expected from this study.

Importance of this Study

What can this study contribute to what is already known? The answer lies in the quasi-experimental approach and the kind of knowledge that it could produce. As an empirical quantitative study, results are measurable outcomes that are generalizable to a specific population. Quantitative research can provide information and knowledge that can be quantified, verified, and applied to the pragmatic needs of the education community,

such as influencing policy formation and classroom practice. To date, the most extensive quantitative investigations of National Board teachers focused on the validity of the process at identifying accomplished teachers (Bond et al, 2000, Goldhaber et al, 2004). However, these studies were not designed to address questions of how the experience of National Board certification may have facilitated learning in the candidates. In this study, I focus on the relationship between the certification process and its potential impact upon teacher knowledge and provide results that shed new light on National Board certification as professional development.

The findings from this study are significant to a host of different and diverse audiences. For the NBPTS, the study can be used to refine and improve the certification process as a professional development experience for teachers. For educational leaders, the results of this study should inform and enrich the discussions regarding whether or not to invest in National Board certification as a professional development. Finally, for the secondary science classroom teachers contemplating National Board certification, this study provides a good sense of what the probable learning outcomes would be from the experience.

As for the debate between educational pundits regarding the merits of National Board certification, this study could also be an influence. The identification of specific learning outcomes would strengthen the position that National Board certification is a valuable professional development experience. Such findings would help to address the critics' concerns of the NBPTS who say that candidate claims of being "better" teachers because of the experience are "not enough" (Ballou et al, 1998; Wilcox, 1999; Pool et al, 2001). This is especially true for George Leef's claim that: "There is no evidence that

the certification process does anything to elevate a teacher's ability to instruct students" (Leef, 2004). Demonstrating that candidates (both those who pass and do not pass) learn from their assessment experience, would provide powerful evidence to support federal, state, and local initiatives to support teachers interested in seeking the advanced certificate. Though a teacher fails to meet the minimum requirements for certification, they still may have learned about their practice in ways that raises the level of their performance above what it was before they began. Showing that the 51% of AYA Science candidates (NBPTS, 2002) who do not succeed in attaining certification are actually successful in learning to align their practice closer to NBPTS standards greatly strengthens the idea that the certification process is a valuable standards based professional development experience. In addition, substantiated learning outcomes from a defined intervention can be viewed as an important contribution in addressing the assumptions pertaining to professional development and teacher learning.

Finally, the findings of this study could help to validate Core Proposition #4 regarding accomplished teaching, which states "Teachers think systematically about their practice and *learn from experience*" (italics added, NBPTS, 1991). Though the original intention of this phrase probably pertained to the day to day work of teachers in the classroom, its meaning could be expanded to include the experience of Board certification. By enriching the interpretation of the NBPTS core propositions, the legitimacy of the Board's work would be strengthened.

Summary

In Chapter 1, the problem to be investigated in this study was situated and defined. The question, "What are teachers learning from National Board certification?"

was presented and its importance discussed. A description of the National Board and what the specific intervention for this study entails was provided. Also, a review of relevant literature that pertains to National Board certification as a professional development and what is currently known about teacher learning from this experience was presented. Finally, a rationale describing the importance and implications of this research set the stage for the rest of this dissertation.

CHAPTER 2: METHODOLOGY

*I'm learning to fly but I ain't got wings
Comin' down is the hardest thing.*

--Tom Petty from "Learning to Fly"

Overview

Chapter 1 described the phenomenon, the questions raised by this phenomenon, and the rationale for investigating teacher learning from National Board certification. In Chapter 2, the 'nuts and bolts' of precisely how this study was conducted and who exactly participated in this research is described. After all the planning, thinking, and imagining that goes into the 'pre-production' of a research project, it is here where the 'rubber meets the road' and the actual physical collection of data takes place. Specific research parameters addressed in this chapter include:

- 1) Introduction
- 2) Research Design
- 3) Research Question
- 4) Hypothesis Descriptions
- 5) Threats to Internal and External Validity
- 6) Sampling Procedures
- 7) Population Demographics
- 8) Sample Demographics
- 9) Instrumentation
- 10) Inter-Rater Reliability

From the following discussion of methodology and demographics, an interesting and unique story emerges. It is the story of how I pursued an answer to the question "What are teachers learning from National Board certification?" It is the story of more than 120 secondary science teachers and their experiences. It is the story of unanticipated (but not unexpected) problems and how they were dealt with in a research project of

fairly great complexity. It is a story that must be told in order to appreciate the strengths and weaknesses of the findings and conclusions that follow.

Introduction

The validity of any claims or conclusions emerging from this research project is contingent upon the degree of accuracy of several key assumptions. In this chapter, two of these assumptions will be examined. The first assumption pertains to the homogeneity of the teachers from one year to the next. The Recurrent Institutional Cycle Design (RICD) assumes the three cohorts being compared (2001, 2002, and 2003) are homogeneous. If each cohort is derived from the same population each year, and that population does not change with regards to key demographic characteristics in their profile, then the causal effect agent can more clearly be identified as the intervention. For example, if 65% of the population pool were female in one year, it would be important that other years in the study not vary significantly from 65%. Any identified differences between cohorts would need to be explained and taken into consideration as possible confounding variables. In addition, the homogeneity assumption must also pertain to the relationship between a parent cohort population and the selected sample for each of the three years tested.

The second important assumption concerns the accuracy and precision of the assessment instruments used and the means by which interviews are converted into scores. If the protocols used to interview candidates do not accurately measure the specified construct (the standards of accomplished secondary science teaching as defined by the National Board), then the reliability of the results would be called into question. The degree to which the protocols are in alignment with the standards addresses the

accuracy of the results. Accuracy (how close one is to the true situation) is addressed with the quality of the protocols used, but precision is an issue that falls under the methodology and rubrics for scoring. The interviews may very accurately address knowledge, experience, and skills within the framework of the 13 standards of accomplished teaching, but without a precise means of evaluating and scoring the data, potential differences could get lost in the noise and confusion. Therefore, a fair measure of agreement is required between what the preponderance of evidence in a transcript indicates and what assessors report. This agreement can be expressed in terms of inter-rater reliability. The focus of Chapter 2 will be a discussion that assesses these two key assumptions and clarifies the strengths, weaknesses, and implications of each on the quality of the final conclusions.

Research Design

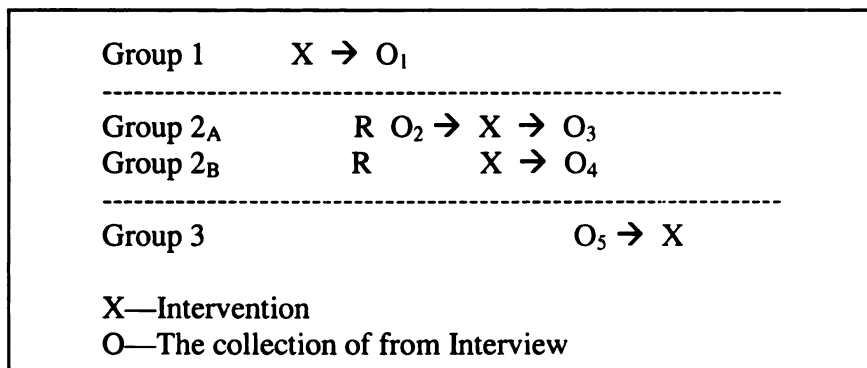
The methodology for measuring teacher-learning outcomes that result from a specified treatment requires an experimental design. The aim of such research is to demonstrate causality between the certification process (independent) and teacher learning (the dependent variable). Crucial to such a design is the random selection of subjects and their random assignments to treatments. However, potential learning from National Board certification begins with a self-selected population pool making a purely experimental approach not feasible due to considerable threats to internal validity (Campbell & Stanley, 1963, Cook & Campbell, 1979). In response, this study adopts a quasi-experimental design that accounts for the voluntary self-selected nature of the subjects' participation. It is called the Recurrent Institutional Cycle Design (RICD) and it controls (to the extent possible) for non-random threats to internal validity (Campbell &

Stanley, 1963) while providing a means of establishing some degree of causality between the treatment and observed results.

The RICD has been used for treatments that recur on a cyclical schedule where one group of individuals is finishing and another group is just beginning (Campbell & McCormick, 1957; Shavelson, 1987; Jimenez, 1999). By combining both cross-sectional and longitudinal components into the research design, data can be compared in both the within group and between groups dimensions. Numerous studies in the social and medical sciences have used some variation of the RICD to address questions pertaining to program effectiveness. In particular, the RICD has been used to determine the effects of an intervention on leadership development (Lafferty, 1998) and employment (Lin, 1999). However, this study marks the first time it has been used to examine teacher learning from professional development.

Applying the RICD to investigate the question; “What are teachers learning from National Board certification?” provided numerous advantages with acceptable limitations appropriate for a study of this scope and magnitude. The model is diagramed in Figure 2-1 where X is the cyclical treatment (NBPTS certification), O is the collection of data (interviews), and R is random assignment. As Figure 2-1 illustrates, RICD allowed for data relevant to teacher learning to be collected both cross sectional from different groups simultaneously and longitudinal from the same group over time (Campbell & Stanley, 1963). Time is measured along the x-axis and groups of subjects are along the y-axis. Group 1, Group 2, and Group 3 were selected from cohorts 2002, 2003, and 2004 respectively.

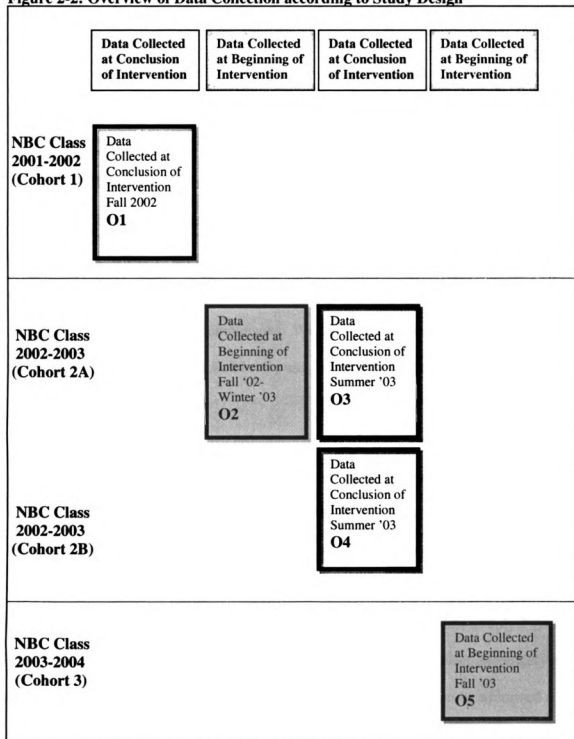
Figure 2-1: Design Model



Over a period of nearly 15 months (September 2002 through November 2003), data was collected from three selected groups sampled from three consecutive cohorts of AYA Science candidates as illustrated in Figure 2-2. The design allows for the comparison of the pre and post measures between groups (cross sectional) and within groups (longitudinal). By identifying pre to post gain scores, the research design provides an ability to establish a relationship between the defined intervention and any of the specified learning outcomes. One of the advantages of this particular design is that the effect of the treatment can be demonstrated by more than one comparison.

The establishment of causality between teacher learning and National Board certification does come with some restrictions. The limitations manifest themselves mostly in the external validity components of research. Generalizations of outcomes would be limited to only those individual teachers pursuing the current version of certification in AYA Science and not to all science teachers or certificates (Campbell & Stanley, 1963).

Figure 2-2: Overview of Data Collection according to Study Design



Quasi-experimental research designs are prone to attacks on their internal validity from a number of sources (i.e., history, maturation, testing, instrumentation, regression, selection, mortality, and others). Though no design is perfect, the RICD puts measures in place that address the most likely and potentially devastating vulnerabilities (Campbell & Stanley, 1963, Merriam, & Edwin, 1995; Cook, 1979).

The RICD was chosen as the method of answering the research question for several key reasons. First, the RICD allows for the pre-post comparison of multiple cohorts of individuals all experiencing the same intervention, but at different times. This quantitative strategy requires the collection of a relatively large amount of data in order to make statistically meaningful comparisons. With around 600 teachers on average pursuing AYA Science certification in any one year, a good population from which to select a sample was available.

Secondly, the RICD is cost effective. Ideally, the best methodology for answering the research question would be to collect data on three consecutive Cohorts of candidates (i.e. pre-post for 2002, 2003, and 2004) using a Solomon 4 Group Design. However, to implement such a design would require more than doubling the time for data collection over the current design and more than tripling the cost for such research. Life being short, the RICD allows for the collection of nearly 3 years of data in only 2 years at a much lower price tag. The compromise for such efficiency is a greater uncertainty in comparing results from between years. However, this uncertainty can be addressed and reduced by examining the demographic characteristics and establishing the degree of representation between the selected samples and their respective parent populations. If significant differences in measured characteristics are identified between cohorts, these

differences can be addressed as possible confounding variables based upon their theoretical significance to the phenomenon being examined. For example, if the average number of years of experience for all three cohorts is 12.5 and one group is significantly different from the average with 16.4 years of experience, then the issue becomes one of determining if 4 additional years of experienced in a fairly experienced population could explain any effects of treatment observed.

Finally, the RICD's 'patched up' aspect allows for built in control measures that strengthen internal validity. Since the One Group Pretest-Posttest Design is so weak (i.e. only Group 2A), additional components have been added to improve the validity of the results. If observations 1 and 2 are examined in isolation, the resulting design can be called a Static-Group Comparison. In this comparison design, two distinct groups are observed. Observation 1 looks at a group that just completed the treatment and Observation 2 looks at a group that did not yet experience the intervention. However, the timing of these observations is simultaneous. In this design, history, testing, instrumentation, and regression are each controlled for as possible confounding variables, but selection and mortality are not. Thus, the Static Group Comparison complements the One Group Pretest-Posttest Design well. Campbell and Stanley (1963) state this relationship as "the right combination of these two inadequate arguments might have considerable strength." It is this 'patched up' approach to the methodology that provides for a reasonable measure of internal validity on all threats except maturation, which will be discussed later.

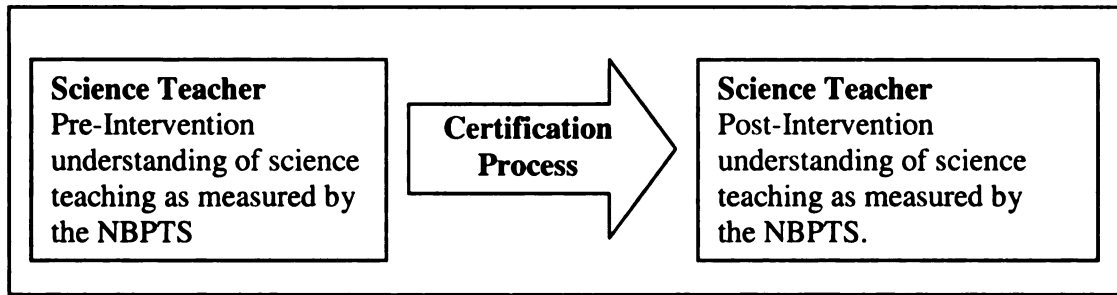
To account for the possible test-retest effect, Cohort 2 was divided into two groups. Group 2A was interviewed both pre (Group 2A-Pre) and post (Group 2A-Post)

intervention. While the second half of Cohort 2 was only interviewed post intervention (Group 2B). This strategy allows for any effects of observation (sometimes called the Hawthorne Effect) to be identified. In other words, comparing Group 2A-Post and Group 2B allows for the experience of being interviewed before the intervention to be taken into consideration as a possible cause for observed changes. Did I alter the phenomenon I am trying to study through the act of collecting data? Group 2B is designed to address this question by providing a control to Group 2A.

Since the scheduling of the intervention is such that post data for one group and pre data for another group can be collected simultaneously, Group 3 is added without too much additional expense. Group 3 serves as a redundant pre measure that can be used to understand Group 2A-Pre scores. For all its 'patched up' characteristics the final methodology for this study proves to be quite elegant and financially feasible for a quasi-experimental design.

The RICD still relies on the basic hypothesis that the specified intervention will result in improved or increased response concerning the particular characteristic(s) being measured. In the case of this study, candidates for National Board certification will improve in their understanding of accomplished teaching (as measured by the National Board's rubrics and scoring methodologies) as described by the AYA Science certificate's thirteen standards. Put more simply, gains attributable to the treatment can be observed by comparing the pre observations with the post observations in this study. Figure 2-3 illustrates the basic model to be tested with this research design. The following discussion provides detailed explanations of particular hypotheses and the specific observations used to test each hypothesis.

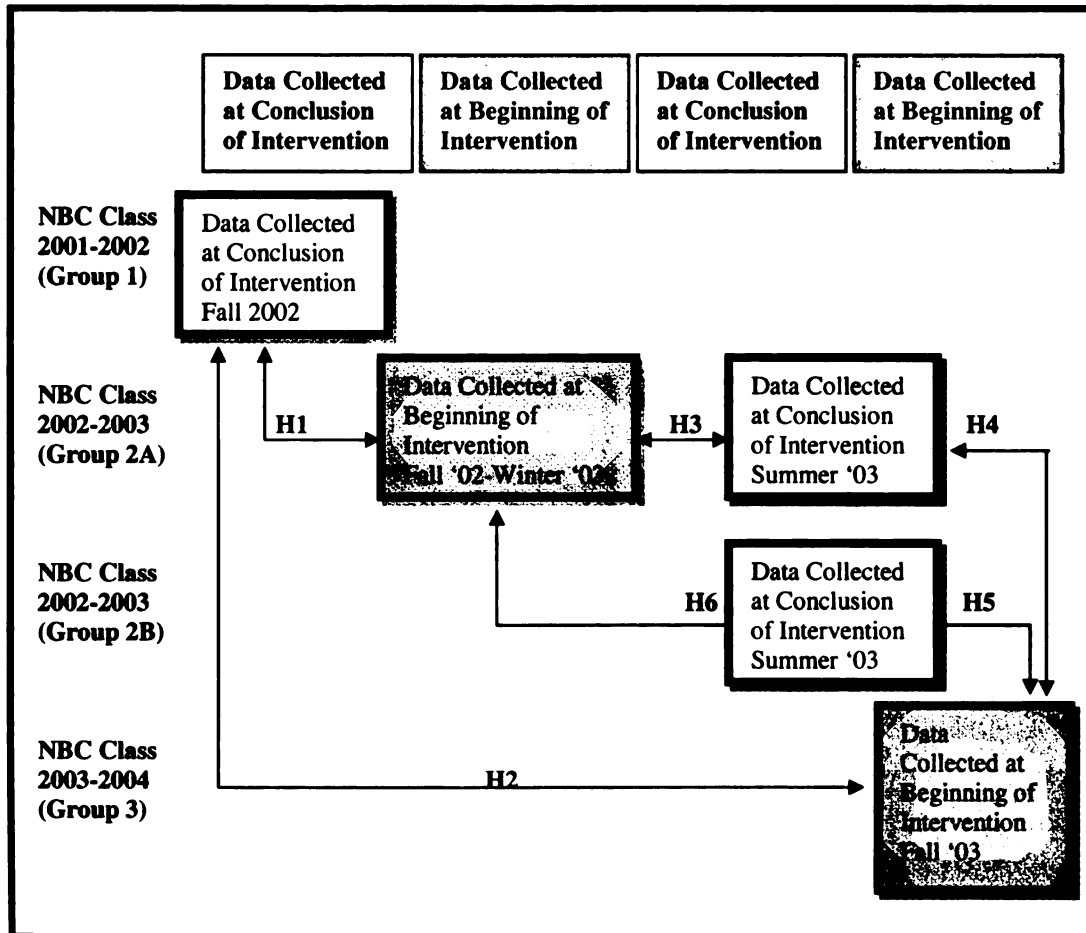
Figure 2-3: Overview of Expected Model for Research



Hypotheses

The effect of the treatment is demonstrated in each of the three different categories of hypothesized relationships: Non-Equivalent, Equivalent, and Combined. The first set of hypotheses (Non-Equivalent Hypotheses) examines all possible pretest-posttest comparisons both within and across the three cohorts. In each of the six hypotheses, it is predicted that the post measure will be greater than the pre-treatment measures. If the alternative hypotheses for these relationships exists (that post-scores are higher than pre-scores) than the argument for the causal effect of the treatment is strengthened. The Non-Equivalent Hypotheses are illustrated in Figure 2-4.

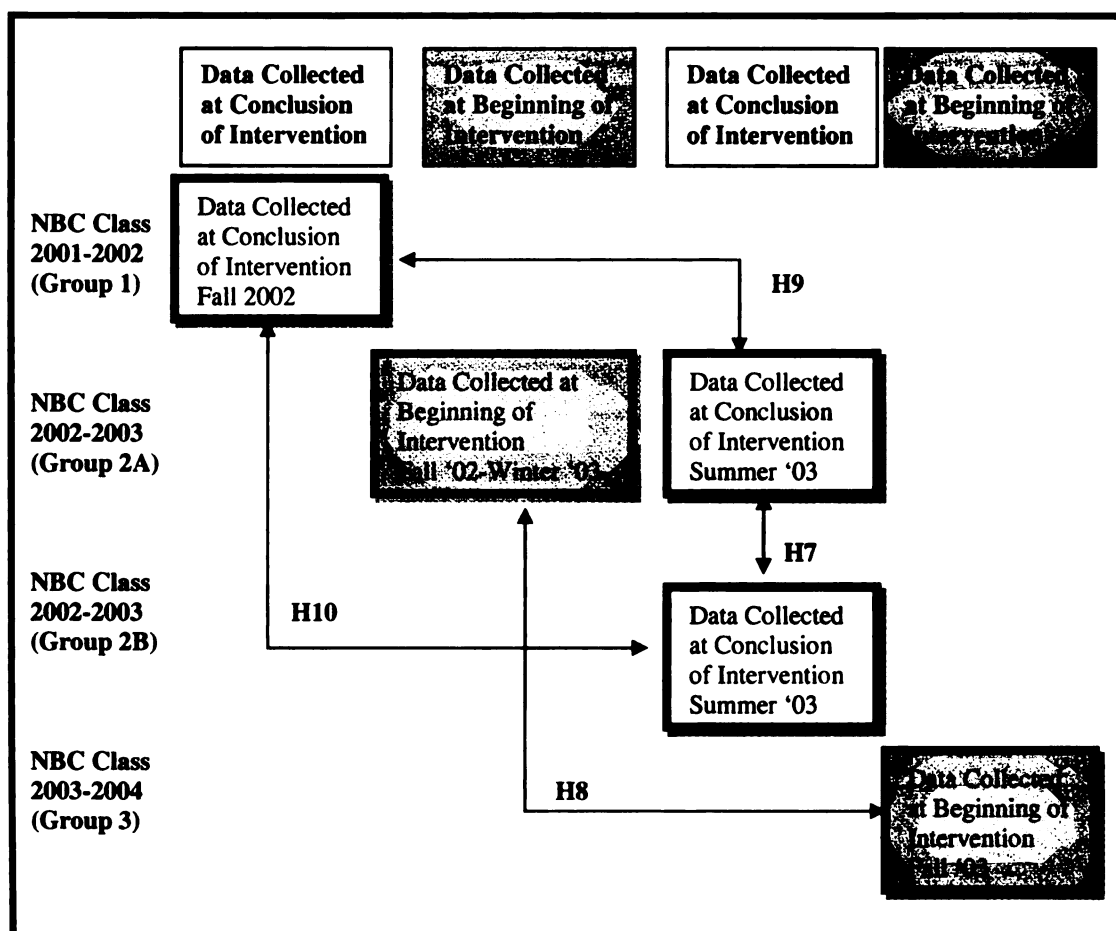
Figure 2-4: Non-Equivalence Hypotheses



The second set of hypotheses (Equivalent Hypotheses) predicts that observed scores from pre-groups should not be significantly different from observed scores from other pre-groups and that post-groups should not be significantly different from other post-group observations. The Equivalent Hypotheses are illustrated in Figure 2-5.

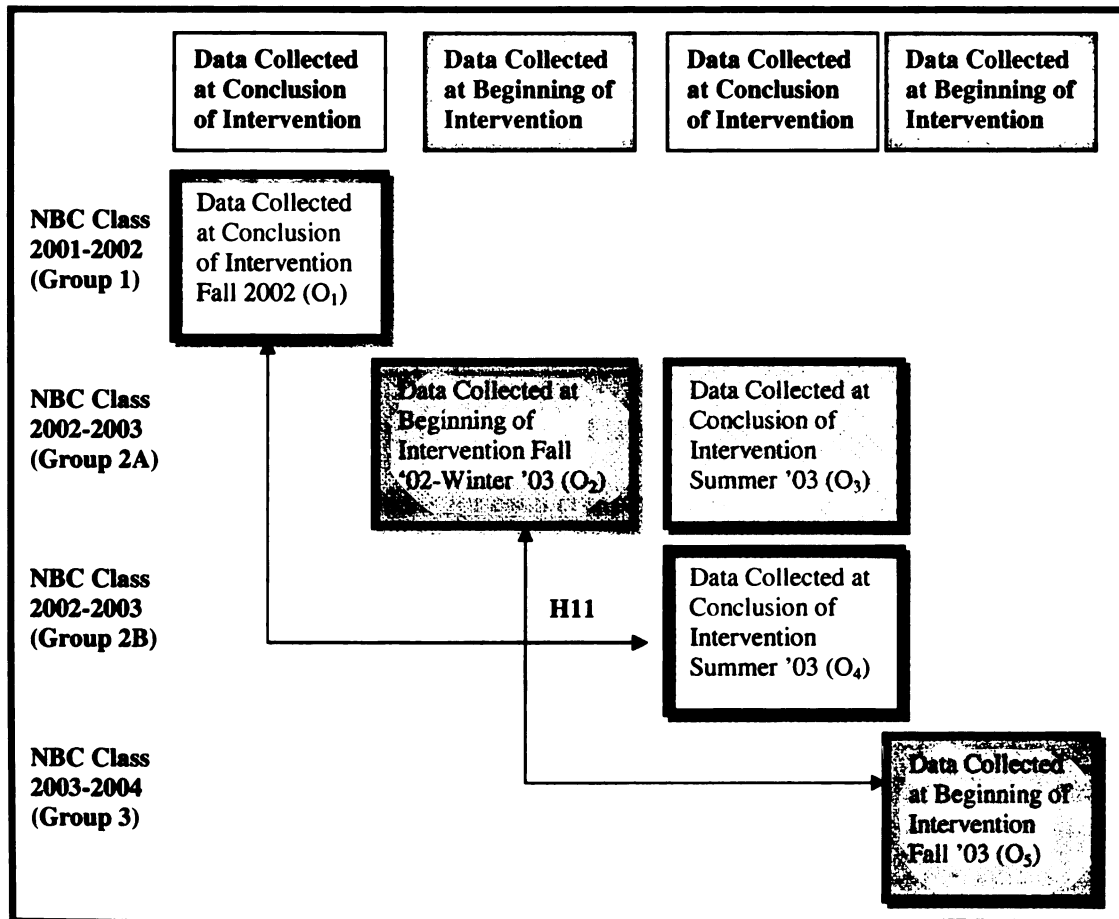
Together, both the Non-Equivalent and Equivalent sets of hypotheses are designed to test a causal relationship between the specified treatment and observed outcomes by providing an indication of the validity of the methodology and the quality of the data collected.

Figure 2-5: Equivalence Hypotheses



In the Combined Hypothesis, all three cohorts are considered simultaneously as illustrated in Figure 2-6. In many respects, the Combined Hypothesis provides the means for answering the research question. The Combined Hypothesis compares four out of five observation points, using data from all pre and post teachers involved in the study. Where Hypotheses 1-10 each indicates areas where the design may be strong or weak, the Combined Hypothesis attempts to identify observed gains.

Figure 2-6: Combined Hypothesis



For each of the 11 alternative hypotheses and corresponding null hypotheses, a detailed description is provided below. Due to the complexity of the design and observation comparisons, Table 2-1 provides a summary of the different designations for each data set or observation point.

Table 2-1: Group and Observation Designations

	Cohort Year	Pre or Post	Shorthand	Observation
Group 1	2002	Post	G1	O1
Group 2A-Pre	2003	Pre	G2A-Pre	O2
Group 2A-Post		Post	G2A-Post	O3
Group 2B		Post	G2B	O4
Group 3	2004	Pre	G3	O5

Each hypothesis (except the Combined Hypothesis) compares two observations points. The alternative hypothesis for each comparison predicts that differences will be observed between the points. Each corresponding null hypothesis predicts that no difference will be observed between the two points. The following list of alternative and their respective null hypotheses identifies which observations points are involved with each of the eleven comparisons. Table 2-2 provides a summary of all eleven hypotheses and the type of test used to determine difference. The hypotheses are:

- **Alternative Hypothesis 1 (H_{Alt1})**- Post scores from participants in Group 1 will be greater than pre scores from Group 2A-Pre.
- **Null Hypothesis 1 (H_{Null1})** – Post scores from participants in Group 1 will not be greater than pre scores from Group 2A-Pre.
- **Alternative Hypothesis 2 (H_{Alt2})** – Post scores from participants in Group 1 will be greater than pre scores from Group 3.
- **Null Hypothesis 2 (H_{Null2})** – Post scores from participants in Group 1 will not be greater than pre scores from Group 2A-Pre.

- **Alternative Hypothesis 3 (H_{Alt3})** – Post scores from participants in Group 2A-Post will be greater when compared with their pre scores in Group 2A-Pre.
- **Null Hypothesis 3 (H_{Null3})** - Post scores from participants in Group 2A-Post will not be greater when compared with their pre scores in Group 2A-Pre.
- **Alternative Hypothesis 4 (H_{Alt4})** – Post scores from participants in Group 2A-Post will be s greater when compared with the pre scores in Group 3.
- **Null Hypothesis 4 (H_{Null4})** - Post scores from participants in Group 2A-Post will not be greater when compared with the pre scores in Group 3.
- **Alternative Hypothesis 5 (H_{Alt5})** – Post scores from participants in Group 2B will be greater when compared with the pre scores in Group 3.
- **Null Hypothesis 5 (H_{Null5})** – Post scores from participants in Group 2B will not be greater when compared with the pre scores in Group 3.
- **Alternative Hypothesis 6 (H_{Alt6})** – Post scores from participants in Group 2B will be greater when compared with the pre scores in Group 2A-Pre.
- **Null Hypothesis 6 (H_{Null6})** - Post scores from participants in Group 2B will not be greater when compared with the pre scores in Group 2A-Pre.
- **Alternative Hypothesis 7 (H_{Alt7})** – Post scores in Group 2A-Post will differ when compared to the post scores in Group 2B.
- **Null Hypothesis 7 (H_{Null7})** - Post scores in Group 2A-Post will not differ when compared to the post scores in Group 2B.
- **Alternative Hypothesis 8 (H_{Alt8})** – Pre scores in Group 2A-Pre will differ when compared to pre scores in Group 3.

- **Null Hypothesis 8 (H_{Null8})** – Pre scores in Group 2A-Pre will not differ when compared to pre scores in Group 3.
- **Alternative Hypothesis 9 (H_{Alt9})** – Post scores in Group 1 will differ when compared to post scores in Group 2A-Post.
- **Null Hypothesis 9 (H_{Null9})** – Post scores in Group 1 will not differ when compared to post scores in Group 2A-Post.
- **Alternative Hypothesis 10 (H_{Alt10})** – Post scores in Group 1 will differ when compared to post scores in Group 2B.
- **Null Hypothesis 10 (H_{Null10})** – Post scores in Group 1 will not differ when compared to post scores in Group 2B.
- **Alternative Combined Hypothesis (H_{AltOv})** – Post scores from Group 1 and Group 2B will be greater when compared to the pre scores from Group 2A-Pre and Group 3.
- **Null Combined Hypothesis (H_{NullOv})** – Post scores from Group 1 and Group 2B will not be greater when compared to the pre scores from Group 2A-Post and Group 3.

Table 2-2 Summary of Hypotheses

Alt. Hypo.	Predicted Relationship	Type of t-Test	Shorthand
1	Group 1 > Group 2A-Pre	Independent 1-tailed	O1 > O2
2	Group 1 > Group 3	Independent 1-tailed	O1 > O5
3	Group 2A-Post > Group 2A-Pre	Dependent 1-tailed	O3 > O2
4	Group 2A-Post > Group 3	Independent 1-tailed	O3 > O5
5	Group 2B > Group 3	Independent 1-tailed	O4 > O5
6	Group 2B > Group 2A-Pre	Independent 1-tailed	O4 > O2
7	Group 2A-Post = Group 2B	Independent 2-tailed	O3 = O4
8	Group 2A-Pre = Group 3	Independent 2-tailed	O2 = O5
9	Group 2A-Post = Group 1	Independent 2-tailed	O3 = O1
10	Group 2B = Group 1	Independent 2-tailed	O4 = O1
Combined	(Groups 1 + 2B) > (Groups 2A-Pre + 3)	Independent 1-tailed	(O1+O4) > (O2 + O5)

By operationally defining ‘learning’ within the context of this investigation as observed pre to post gains (especially for the Combined Hypothesis), will allow for a) identifying effects of intervention on 13 dimensions of practice, and b) a rich analysis into what the observed ‘learning’ might mean. The experience of each candidate with the intervention of National Board certification serves as the independent variable. The dependent variable is represented by the assessed scores of each candidate in each of the thirteen standards of accomplished secondary science teaching examined.

Internal & External Validity

Embedded in the RICD are observable tests that insure a good measure of both internal and external validity. Because of the cross sectional and longitudinal data streams, the study provides control measures for insuring internal validity. For example, H_{alt1} ($O_1 > O_2$) and H_{alt5} ($O_4 > O_5$) both help rule out History, Testing, and Instrumentation as possible causes of any observed differences between these groups. Testing, Selection, and Mortality are all eliminated as causes of observed differences by H_{alt3} ($O_3 > O_2$) and H_{alt6} ($O_4 > O_2$). This design uniformly fails to account for maturation

as a threat to internal validity (Campbell & Stanley, 1963). However, since the research is focused on the acquisition of a series of complex and highly specialized skills and knowledge sets, the idea that “just growing older or more experienced in normal everyday social experiences could have produced the observed difference seems very unlikely” (Campbell and Stanley, p. 59, 1963).

Cross sectional observed differences between Groups cannot be explained by the effects of history or a test-retest effect. The biggest threat to such observed differences however could be due to differences in recruitment (selection) from one year to the next. To account for this possible confounding explanation, demographic information was collected from each cohort and its respective group to provide a profile for comparing how each cohort and group compares on the characteristics of gender, years of teaching, school context, and students ability. Finally, since the instruments used to measure differences were unchanged throughout the study, it is unlikely that this could be a threat to internal validity.

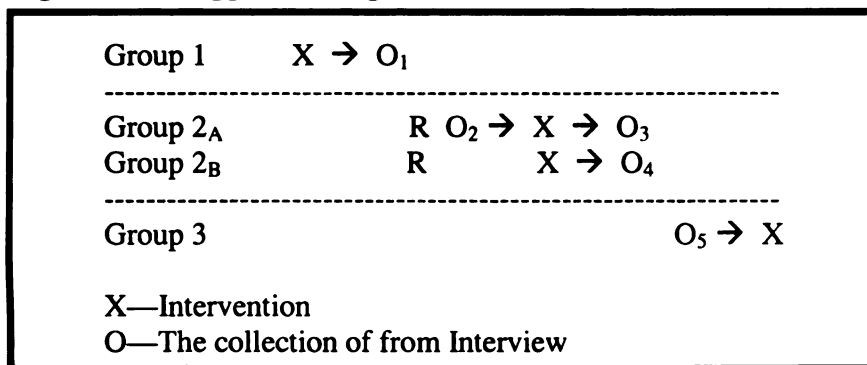
The external validity of the findings from this investigation is limited to the population of secondary science teachers opting to pursue National Board certification. To the extent that this group is similar to the general population of secondary science teachers, the greater the ability of this study to generalize to the larger teaching community. The design does control for the Interaction of the Treatment and Testing as well as Reactive Arrangements (Campbell & Stanley, 1963). The timing of data collection for this study was vitally important. National Board certification’s complex calendar did allow windows of opportunity to collect both pre and post data from respective groups at the same time. However, there were examples of pre post data

collection that did not overlap in simultaneously. Campbell and Stanley (1963) discuss the adaptability of the RICD to this possibility when they state:

It is assumed that it will be feasible to present the posttest for one group at the same chronological time as the pretest for another. This is not always the case in situations where we might want to use this design. (Campbell & Stanley, p 60, 1963)

“This design” Campbell and Stanley are referring to shows the staggered nature of data collection as represented in Figure 2-7. For some data collection in this study (i.e. Group 2B and Group 3), this variation of the model applies.

Figure 2-7: Staggered Design Model



Study Population

This investigation focused upon the population of secondary science teachers who self-selected themselves for National Board certification candidacy. More specifically, all secondary science teachers who qualify to be a candidate for National Board certification in AYA Science represent the population the results are generalizable to. These requirements maintain that a potential candidate 1) be certified in the state in which they teach, 2) currently teach at least two classes in the area of certification, and 3) have at least 3 years of full time teaching experience. For this study, any teacher who registered for the certification process had to verify these requirements before being

accepted as a candidate for National Board certification. Therefore, it is from this pool of self-selected candidates for AYA Science certification that the population for this study derived. The population pool for this study was made up of all registered teachers for AYA certification for each of the 3 years of the study. For each year this represents approximately between 450-650 teachers. From this pool, 40 teachers were selected from each of the three cohorts to participate in the study totaling 120 teachers.

Recruitment and Selection of Participants

The recruitment process for subjects in this study differed from the anticipated procedures. At the time of the study's inception, it was anticipated that the National Board would provide a list of available candidates for a particular year. The list would be randomized and a pre-determined percent of the population would be contacted and invited to participate in the study. Based upon the results from the pilot study (Lustick, 2001), this process of recruitment had over a 50 % positive response rate. Therefore, with an estimated population in any particular cohort of approximately 600 teachers and a need for 40 participants for the study; it was estimated that 100 teachers would need to be invited to achieve the required number.

For the first cohort (Group 1 Post Observation), this process worked fairly well. The National Board provided a list of approximately 400 candidates who had completed the requirements to be evaluated for National Board certification. The list was randomized using an Excel spreadsheet function and the first 100 teachers were invited to

participate. The first 46 responses were accepted and constituted the make up of Group 1.⁷

As per the design, observations of Group 1 were to take place at the same time as observations of Group 2A-Pre. However, the recruitment and selection procedures for Group 2A-Pre ended up being quite different than planned. Originally, a list from the Board of registered candidates for cohort two was to be obtained, randomized, and then a portion invited to participate. Those candidates agreeing to participate would then be randomly assigned to either Group 2A or Group 2B until each subgroup had 20 teachers in each. Group 2A was to be observed both pre and post intervention whereas Group 2B was observed only post intervention. However, the recruitment procedures varied from this plan. The alterations in procedures for identification and recruitment of Group 2 have their basis in three different areas of circumstance: 1) Legalities, 2) Institutional Constraints, and 3) a Policy Changes at the National Board.

Legalities

Unlike Group 1 which had completed and submitted their portfolio and taken their assessment center exercises at least 3 months previously, Group 2A-Pre were candidates who had only just registered for certification and indicated their intent to pursue National Board certification by paying the non-refundable \$300 registration fee. Observations were to be made during this period between the payment of the registration fee and the beginning of meaningful and earnest work on the portfolio. However, for Group 2A-Pre, the National Board was not allowed to provide a list of new registrants to be randomized and invited to participate. The National Board highlighted the need to maintain

⁷ There were 6 additional interviews conducted for two reasons: 1) the first few interviews were used to finalized the interview protocols and interview procedures and 2) Technical difficulties with the recording equipment made 3 other interviews not useable.

confidentiality with these newly identified candidates. Their rationale was sound and understandable: if the National Board shared the contact information of these new registrants with a third party, those candidates who were not successful at achieving certification later on might point to the ‘harassment’ of the third party precipitated by the National Board as reason for their undesirable outcome to certification. For Group 1, it made no difference because all their work had already been submitted. However, for the pre groups, no direct contact would be possible for fear of contaminating their chances of success. Therefore a new procedure needed to be worked out and approved of by both the National Board and myself.

The new procedure finally arrived at after several weeks of collaboration was for the National Board to contact the new registrants on behalf of the research study. A letter would go out from the Board to the newly identified registrants and provide a brief description of the study, the reasons why the National Board was writing them, and contact information including a self addressed postcard to learn more about the study and possible participation. Upon receiving this letter, the candidate could choose to “learn more about the study” or not. Those wishing to learn more returned the postcard with their contact information to the investigators.

As a result of the additional steps required to recruit teachers for the study, the rate of return dropped from 65% for Group 1 to 10% for Group 2A-Pre. Not only did the rate of return drop dramatically, but also the period of time between a candidate registering for certification and being contacted formally by the study increased significantly. Between the time an individual appeared in the National Board’s data base and the time of the interview averaged from 6 to 8 weeks. This compares to roughly 3

weeks turnaround time for Group 1. After receiving the postcards, a formal letter of invitation and a consent form were mailed out to the candidate. The candidate then had to do what the Group 1 candidates did (fill out and sign the consent form and return it in the self addressed stamped envelope).

Institutional Restraints

The second problem associated with data collection for Group 2 involved institutional constraints at both Michigan State University and the National Board for Professional Teaching Standards. At the Board, there was a significant delay between the different departments. The executive department was responsible for all correspondence with the investigators including providing answers to questions and data for the study. Once a request was made in writing to the contact person in the executive department of the National Board for a particular form of data, the contact person would then have to submit a formal request in writing to the appropriate department for the request to be filled. This process on average took 7 to 10 days. In addition, it was now the responsibility of the contact person in the executive office to use the contact information to generate a letter, mailing labels, stuff the envelopes and send them out. Depending upon the workload of the contact person, this process could take anywhere from a day or two to a few weeks. There was a period of time when I was contacting the National Board several times a day to determine the status of the mailings. It is difficult to determine if the contact person at the Board truly appreciated the time sensitive nature of their task. The actions (or lack of) of this individual could be explained by a number of different possibilities all of which are not relevant to this study. What is true and relevant

is that the convoluted procedures resulted in a large and significant time delay between identification of possible participants and the actual collection of data.

The problems associated with identifying and observing Group 2A-Pre were not limited to the National Board. Michigan State University also contributed to the time delay associated with collecting data on Group 2A-Pre. Even with all the issues already associated with the legalities and institutional procedures of the Board, the rate of return for those who were contacted by the Board dropped to a trickle. One or two postcards would be returned when 10 to 15 were expected. Such a disappointing rate was hard to explain. Was Group 2A-Pre so different than Group 1? Was the initial contact from the National Board somehow poisoning the pool? Why were far fewer than expected returning their postcards?

One explanation for the poor return rate became apparent several months later after Group 2 was identified. An undergraduate student helper for the department secretary could not find the mailbox with the my name (it was located on the top shelf eye-level far left hand corner) and never asked the secretary for assistance with the issue. Instead, these postcards were placed in an unmarked mailbox (bottom lower right corner). I discovered the postcards while checking other mailboxes to see if by accident some project mail had been misplaced. Approximately 14 cards were discovered. According to their postmarks, these cards were some of the first returned and raised the rate of return to over 10%. From that moment on, mail was checked at the point of entry into the building every day.

There were two immediate consequences to this unfortunate mistake. First, randomly dividing Group 2 into 2A and 2B was not possible. The priority became to

collect pre data from Group 2A as soon as possible before candidates were too far along in the intervention. Therefore, each new Group 2 participant identified was immediately placed into Group 2A-Pre. Only after Group 2A-Pre was complete were additional candidates placed into Group 2B. Because Group 2B was a post observation; a race against the clock was not necessary. It took over 5 months to solicit the participation of the more than 40 teachers necessary to complete Group 2. Where data collection for Group 1 was completed in about 6 weeks, Group 2A-Pre took several months to finish.

Policy Changes at the National Board

Finally, the last reason for the difficulties in identifying and recruiting participants for Group 2A-Pre rests with changes to the application calendar for National Board certification. Prior to the class of 2002-2003, applicants would register over the summer and during the fall and begin the process of certification just before or after Christmas vacation. This meant that most of the construction of the portfolio would take place during the spring semester. However with the 2003 cohort, changes were implemented that made it possible for candidates to register and begin work on their portfolios with much more flexibility to the calendar year. Where a majority of candidates still use the traditional calendar to carry out the requirements of National Board certification, a significant number opted for the more flexible schedule. The impact of this change on the study resulted in a smaller pool of candidates than anticipated for the September through December registration period.

The problems associated with Group 2A-Pre were studied and appropriate actions were taken to insure that collection of data for Group 3 would not suffer the same consequences. Teachers for Group 3-Pre were contacted beginning in February of 2003

and continued through October of 2003. As a result of the experiences with Groups 2 and 3, it became clear that one of the assumptions that the study rested on was seriously threatened. The study was conducted under the assumption that data would be collected in clearly identifiable pre and post intervention conditions. Post observations were made after a candidate completed and submitted a portfolio and taken their assessment center exams and before they received word from the National Board of the final outcome of their efforts. In all Post-Observation cases, this timing was achieved successfully.

However, for the Pre-observations, circumstances became more complex. First of all, the time delay between submitting a check for \$300 and receiving the candidate's "Box" had been eliminated through technology. In previous years, this delay could be as long as 3 months. Presently, candidates can pay the fee on line with a credit card and immediately have access to the information in the "Box" only in downloadable digital form. This one change effectively eliminated the 1-3 month period of relative inactivity for some candidates. It was during this time period that pre-data was to be collected. As a result of these developments, information was collected from each candidate that helped identify how much work they had already put into the construction of their portfolio. After further analysis of this data, it became quite evident that the "Pre" observation as originally intended no longer existed. The fact was that every candidate observed as part of the pre groups had to some extent already experienced part of the intervention. This experience took the form of any one or more significant descriptions. For example, reading the instructions, working on entries, collecting data on students, video taping, attending workshops, and conversations with local support groups and virtual communities all prevent a candidate from being labeled a pure "pre" subject in the

original sense. A candidate's experience in Group 2A-Pre ranged from a low of 2% to a high of nearly 50% with an average of around 20% of the portfolio process complete. This issue will become more important later on when all results are compared.

Demographic Variables

The primary purpose of the demographic information is to test the assumption that teachers from each of the three groups did not differ significantly from each other with regards to a series of predetermined measures. The study's goal of comparing pre and post results between different cohorts of teachers is based on the assumption that except for the year of certification, these groups would not be all that different from one another. If differences pre to post are observed, then the confounding explanation of differences in cohort will need to be addressed. Therefore it is imperative to examine the available data to best understand how the candidates from different cohorts compared and contrasted with each other.

To examine the demographic data, there are three specific questions that need to be asked:

- 1) How do each of the cohorts (parent populations from which the samples were selected) involved in this study compare to each other?
- 2) How well do the samples selected from the cohort populations accurately reflect the characteristics of the parent population?
- 3) How do the samples selected from the cohort populations compare to each other?

To address these questions, the demographic analysis is divided into three distinct comparisons: 1) Cohort to Cohort, 2) Cohort to Group, and 3) Group to Group. The discussion that follows will look at each one of these comparisons in detail.

Cohort-to-Cohort Comparisons

How did each of the three cohorts (2002, 2003, and 2004) compare with each other in their demographic characteristics? To answer this question the data was analyzed with a combination of paired t-tests, z-statistics, and chi-square tests. Data for each cohort provided by the National Board remained limited to a few basic characteristics. These variables included population size, gender, geographic region, years experience, and (for Cohorts 1 & 2) the outcome of certification process for each candidate. Though by no means exhaustive, the information does provide a good basis to compare the basic profile of each year's population. A summary of the Cohort-to-Cohort comparison is presented in Table 2-3.

Table 2-3: Comparison of Demographic Variables Among the Cohorts

Demographic Variable				Results of Pairwise Comparisons		
Geographical Origin	2001-02	2002-03	2003-04	Chi-Square Test Statistics		
	Cohort 1	Cohort 2	Cohort 3	Cohort	2002	2003
N	431	434	356	2001	19.49	13.18
Region	Percent	Percent	Percent	2002		16.15
New England	7.19	2.53	3.37	p< (df = 5)		
MidAtlantic	5.57	7.37	10.39	Cohort	2002	2003
South	51.51	52.53	46.91	2001	0.0016	0.0217
Midwest	18.1	14.29	20.22	2002		0.0064
Southwest	3.71	2.53	5.06			
West	13.92	20.74	14.04			
Gender	Percent	Percent	Percent	Chi-Square Test Statistics*		
Female	64.04	61.29	63.2	Cohort	2002	2003
Male	35.96	38.71	36.8	2001	0.585	0.059
				2002		0.304
				p< (df = 1)		
				Cohort	2002	2003
				2001	0.444	0.808
				2002		0.581
Years of Experience				Z-Statistics for Mean Differences		
Mean	13.16	12.72	12.09	Cohort	2002	2003
Standard Deviation	7.89	7.55	7.34	2001	0.830	1.948
N**	427	426	348	2002		1.171
				p< (Two-Tailed)		
				Cohort	2002	2003
				2001	0.407	0.051
				2002		0.241
Pass/Fail	Percent	Percent	Percent	Chi-Square Test Statistics*		
Achieved	37.35	40.55	N/A	Cohort	2002	
Not Achieved	62.65	59.45	N/A	2001	0.800	
*Corrected for Discontinuity						
** Excluded cases with missing data.						

Based upon the five vital characteristics available at the cohort level, it is clear from Table 2-4 that the cohorts do not differ from each other in most categories. Group 3 is a smaller population than the other two groups. One possible reason for this situation may be in the availability of funds to support and encourage teachers to pursue National Board certification. The availability of funds for incentive and supportive purposes may fluctuate from year to year depending upon the financial status of a district or state.

With regards to candidates' success at the National Board certification process, data was only available for Cohorts 1 and 2. (Due to the timing of this study, pass/fail data was not available for Cohort 3.) For both populations, the rate of passing was very close to 40%. This compares as expected with the overall passing rate of 50% for all 26 certificates combined and in agreement with the AYA Science historically stable pass rate of nearly 40%.

Only in years of experience is there a noticeable difference between cohorts. Group 3 would appear to have fewer years of experience and marginally significant at the .05 level. However, Group 3 is not significantly different from Group 2 with regards to this measure.

Where did the teachers in each of these Cohorts come from? The answer to this question is not surprising and quite consistent across all three cohorts. Since its inception in 1987, the National Board has found most of its support in the South. This support continues today followed by the Western and Midwestern States. The lowest represented regions in all three cohorts are the Southwestern and New England States. Only in the Mid-Atlantic States does a little inconsistency appear with Cohort 3 having nearly twice the representation as Cohort 1. One possible explanation for inconsistencies in regional

representation can be traced to fluctuations in state and district support for Board certification. If one year money is available and the next it is not, then it is reasonable that the numbers of teachers opting to pursue Board certification would parallel these changes.

When gender profiles are examined, an even higher level of consistency is observed. For all three cohorts, female candidates outnumber male candidates nearly 2 to 1. In a historically female dominated profession like teaching, this result is not surprising. However, the study did focus on the level of secondary science that traditionally has a higher percentage of males than other levels of PK-12 education.

With years of experience, Cohort 3 is shown to be significantly different (but only marginally at the .05 level with a p value of .051) from Cohort 1. With slightly over 12 years of experience, Cohort 3 would appear to be less experienced, but not necessarily younger. With more teachers entering the profession as a second career (through Troops to Teachers for example), it would appear that these non-traditional teachers are more willing to delve into National Board certification earlier than traditionally prepared teachers. However, one could argue that with all three cohorts averaging more than 12 and less than 14 years of experience, that this difference does not warrant too much concern. After seven years of teaching, it's not unreasonable to think of teachers as experienced. Overall, a dozen years in teaching indicates that most candidates for National Board certification in AYA Science have a wealth of experience that they bring to the process. It is important to note that the National Board requires that teachers have a minimum of 3 years full time teaching experience to qualify for certification candidacy. If one cohort had an average years experience half of the others, there would be reason

for concern. However, with these results, ‘years of experience’ does not appear to be a serious threat to the study.

A summary of the Cohort-Cohort comparison is provided in Table 2-4.

Differences pertaining to geographic regions among all three cohorts are not unexpected. All and all, the three populations are quite close to each other on the identified variables with the small differences in size and years experience. This level of homogeneity between cohorts would appear to satisfy the Recurrent Institutional Cycle Design assumption that from year to year the populations do not significantly change.

Table 2-4: Summary of Cohort Comparison

Demographic Variable	2001-02	2002-03	2003-04
	Cohort 1	Cohort 2	Cohort 3
Region	Different	Different	Different
Gender	Same	Same	Different
Years of Experience	Same	Same	Different
Pass/Fail	Same	Same	N/A

Chi Square for Categorical Variables

The same population is defined as an average value of the total divided by the number of cohorts compared. So the deviation is a measure of how different the actual is from the expected. With this analysis it is apparent that most candidates came from the South, West, and Midwest and the fewest candidates came from the New England, Mid-Atlantic, and Southwestern states. The greatest deviation from expected values is found in those areas represented by the smallest sample size indicating that the most likely explanation for such variability is due to the small number of individuals. Though these differences are consistent across all three populations, differences between groups with respect to region of origin are significant at the .05 level.

Besides availability of supportive funding at the state level, another possible explanation for identified differences is that the total number of teachers seeking AYA Science certification is still relatively small when compared to the total number of secondary science teachers (250,000 estimated secondary science teachers according to the National Association of Science Teachers, 2003). In addition, the small numbers of total candidates are being further reduced into six different categories increasing the chances of identifying differences in pairwise comparisons. Regardless of which explanation is more correct, the identified differences should not greatly impact the results of this study since in all likelihood the number of teachers who decide to pursue certification is beyond the realm of control for the researchers.

Cohort-to-Group Comparisons

Turning the focus now to the selected groups from the cohort populations, the question becomes, “How do the selected groups compare to their parent cohort populations?” The short answer is that each group is a representative sample of its parent population. An examination of each variable provides even more evidence for this claim. Table 2-5 provides a detailed summary of each of the three Cohorts and their respective group samples.

Table 2-5: Cohort-to-Group Comparison

2001-02		2002-03		2003-2004			
	Cohort 1	Group 1	Cohort 2	Group 2A	Group 2B	Cohort 3	Group 3
N	431	40	434	18	20	356	40
Region	Percent	Percent	Percent	Percent	Percent	Percent	Percent
New England	7.19	10.00	2.53	0.00	0.00	3.37	2.50
Mid-Atlantic	5.57	15.00	7.37	5.56	5.00	10.39	10.00
South	51.51	52.50	52.53	50.00	40.00	46.91	45.00
Midwest	18.10	12.50	14.29	5.56	10.00	20.22	20.00
Southwest	3.71	0.00	2.53	5.56	5.00	5.06	2.50
West	13.92	10.00	20.74	33.33	40.00	14.04	20.00
Chi-square		9.46		3.54	5.57		1.65
df		5		5	5		5
p<		0.092		0.617	0.350		0.895
Gender	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Female	64.04	77.50	61.29	77.78	60.00	63.20	67.50
Male	35.96	22.50	38.71	22.22	40.00	36.80	32.50
Chi-square*		2.92		1.94	0.01		0.25
df		1		1	1		1
p<		0.088		0.164	0.942		0.618
Years of Experience							
Mean	13.16	16.43	12.72	14.72	14.70	12.09	11.00
Standard Error		1.25		1.78	1.69		1.16
Standard Deviation	7.89	7.57	7.55	9.76	8.96	7.34	7.04
N**	427	40	426	18	20	348	40
z-statistic		2.62		1.13	1.17		-0.94
p<		0.009		0.260	0.240		0.348
Pass/Fail	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Achieved	37.35	40.00	40.55	44.44	50.00	N/A	N/A
Not Achieved	62.65	60.00	59.45	55.56	50.00	N/A	N/A
Chi-square*		0.08		0.09	0.66		
df		1		1	1		
p<		0.779		0.769	0.415		
*Corrected for Discontinuity							
** Excluded cases with missing data.							

With respect to region, all four groups (1, 2A, 2B, and 3) did not differ significantly from the parent population at the .05 level. Only Group 1 was significantly different at the .10 level. When gender is examined, the same condition exists: no group differed from its parent population at the .05 level with only Group 1 showing a significant difference at the .10 level. For the Pass/Fail comparison, once again data was only available for Groups 1 and 2, which showed no significant differences at either the .05 or .1 levels.

In the Cohort-Group analysis, 'years of experience' provides the most anomalous results. First of all, Group 1 is significantly different from its parent population at the .01 level with Group 1 having on average more than three years more experience. Though comparisons with the other three groups were not significantly different, a closer examination reveals some important tendencies. For example, Groups 1, 2A, and 2B all have more years experience than their parent population, though both Group 2A and 2B are not significantly different. Group 3, however, has fewer years experience (just over 1 year difference) than its parent cohort (though this difference was also not significant). Group 3 would appear to be less experienced than Groups 1 and 2. This may be due to alterations in the sampling process and one that would need to be addressed if this study was to be repeated.

When each group is compared with its cohort on the available information, a remarkable level of similarity exists. In summary, each group demonstrates the observed characteristics of region, gender, and pass/fail rates congruous with the parent cohort. Only years of experience showed signs of meaningful difference, though this is probably best explained with inconsistencies in sampling procedures. There also appears to be a

trend towards less experienced teachers applying for certification with each ensuing year. For 2002, the average number of years was 13.16, 2003 was 12.72 and for 2004 it drops to 12.10 years experience. The study also reflects this trend with each consecutive year having less years experience then the prior year. However, where samples for Groups 1 and 2 are higher than the population, sample 3 is lower. A summary of the analysis between Cohort and Groups is provided in Table 2-6.

Table 2-6: Summary of Cohort to Group Comparisons for Differences

Demographic Variable	2001-02	2002-03		2003-2004
	Cohort 1-G1	Cohort 2-G2A	Cohort 2-G2B	Cohort 3-G3
Region	Not Different	Not Different	Not Different	Not Different
Gender	Not Different	Not Different	Not Different	Not Different
Years of Experience	Different	Not Different	Not Different	Not Different
Pass/Fail	Not Different	Not Different	Not Different	N/A

Group-to-Group Comparison

The last question concerning demographics that needs to be addressed is “How do the selected samples from each cohort compare with each other on a wider range of characteristics?” The Recurrent Institutional Cycle Design rests upon a key assumption that from year to year, the samples selected from the parent populations (cohorts) for the study will not differ greatly from each other. Even if differences are identified from year to year in the target populations, these differences may or may not become manifest in the selected samples. To facilitate the efficient analysis of the more abundant demographic information on candidates at the Group level in this study, variables have been divided into categorical, continuous, and survey type data.

More detailed and extensive information regarding educational history, institutions attended, certification and preparation program details, standardized test

scores for both students and teachers, graduation and drop out rates in schools, district profiles, and socio-economic indicators such as rate of free and reduced lunch were not collected. Instead, three brief survey questions were asked at the time of written consent that asked each candidate about a) how they learned about National Board certification, b) their motivation for pursuing National Board certification, and 3) the support available/utilized during their efforts towards certification.

The reason for the omission of inquiries into other important candidate and school characteristics was more practical than theoretical. I was very sensitive to the time demands of the study on teachers who already had a full agenda of work related responsibilities. It was thought that a more extensive and therefore time-consuming pre-interview survey would prove a significant deterrence to participation in the study. In addition, the interview was already longer than an hour. Every additional question would put more demand on the attention of the participating teacher and thus might lead to a decrease of quality in the responses provided. Though it would have been helpful to collect the omitted data sets, pressures of practicality and time restraints resulted in the current compromise of demographic variables.

Categorical Variables

Categorical variables communicate information that falls within a series of particular choices (i.e. Gender) rather than a range (i.e. age). The additional demographic information for participants in each group was collected both prior to and at the beginning of each interview. The analysis of categorical variables is summarized in Table 2-7. A Chi-Square analysis of these variables reveals no significant differences between groups. The distribution of teachers with respect to grades taught, content

specialty, school context, geographic location, student type, or gender appears to be the same across all groups.

Table 2-7: Group-to-Group Comparisons on Categorical Demographic Variables

	Distribution of Teachers (%)				Chi-Square	DF	p<
	Group 1	Group 2A	Group 2B	Group 3			
GRADES					8.63	6	0.1954
9th-10th	30	38.89	5	22.5			
11th-12th	25	33.33	45	27.5			
9th-12th	45	27.78	50	50			
CONTENT					6.29	9	0.7110
Biology	42.5	33.33	45	40			
Chemistry	30	27.78	35	37.5			
Physics	2.5	11.11	10	10			
Other	25	27.78	10	12.5			
SCHOOL					10.50	9	0.3113
Urban	35	22.22	15	30			
Suburban	35	44.44	35	50			
Rural	27.5	27.78	50	20			
Other	2.5	5.56	0	0			
REGION					18.48	15	0.2382
MidAtlantic	15	5.56	5	10			
Midwest	12.5	5.56	10	20			
New England	10	0	0	2.5			
South	52.5	50	40	45			
Southwest	0	5.56	5	2.5			
West	10	33.33	40	20			
STUDENTS					13.90	9	0.1260
Below Average	12.5	5.56	15	5			
Average	40	66.67	40	25			
Above Average	25	11.11	25	45			
Mixed	22.5	16.67	20	25			
GENDER					2.64	3	0.4499
Female	77.5	77.78	60	67.5			
Male	22.5	22.22	40	32.5			

A special note about ‘student type’: No outside measurements such as standardized assessments, district wide tests, or any other form of data was collected on the students of the teachers in this study. The data on ‘student ability’ or ‘student type’ results from a teacher’s self-report. More specifically, each teacher was asked, “How would you generally describe your students?” The assignment of a 1, 2, 3, or 4 was

based upon the teacher's description. If the teacher said that generally speaking their students were 'below average' ability or "low" achievers, then that was coded as a '1'. If the teacher said that their students were 'average' ability, then that was coded as a '2'. If a teacher said that their students were "above average" in ability or "high" achievers, then this was coded as a '3'. In some cases the teacher would indicate that their students 'ran the gamut' of abilities or that their students were a 'mix' or 'varied' in ability. In the event that a teacher indicated that there was a range of student abilities in their classes, the response was coded as a '4'. Rather than be a measure of student ability, this information is more of an indication of how teachers perceived their students abilities. Interestingly enough, teachers who described their students as 'high' achievers (coded as a 3) were correlated with subjects who rated higher in this study. This tendency was consistent for both the pre and post observations. Translated, this might mean that teachers who had greater faith or more optimistic perception of their students abilities were more likely to score higher when compared to those teachers who rated their students less than 'high'. Those who described their students as mixed scored on a par with the group that said their students were average. This apparent relationship could represent teachers' accurate reflection of student ability and thus teachers with below average academic performance, do not score as well as their peers in this study. Or, their perceptions may or may not be an accurate reflection of student ability, but teachers who believe their students are higher than average performers (or another way to think of it could be these teachers have higher expectations of success) are more likely to score better in this study. Either way, the results do not affect the analysis or results of this

study directly, but rather the observation serves as an interesting point for possible future research.

Continuous Variables

If the continuous variables are included with the group-to-group comparison, some significant differences can be identified with use of t-tests. A detailed summary of these comparisons is provided in Table 2-8. Though groups did not differ with the average size of their classes or the length of their responses in this study, they were different with respect to years of experience (See Table 2-9). Each consecutive year saw a decrease in the average number of years taught over the course of this study. Just as with the parent populations, the years of experience decreased from Group 1 to Group 2 to Group 3. More specifically, Group 3 demonstrates a difference at the .05 level. In addition, not only does Group 3 have fewer years experience than Groups 1 and 2, but it also shows fewer years experience than its parent population. This relationship is consistent with the Cohort-Group comparison, which also showed that Group 3 had fewer years experience than the other two preceding cohorts.

Table 2-8: Group-to-Group Comparisons on Continuous Demographic Variables

	Groups				Comparisons of the Sample Groups					
	Group 1	Group 2A-Pre	Group 2B	Group 3	Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Sample Size	40	18	20	40						
Years of Teaching Experience										
Mean	16.4	15.3	14.7	11.0	Model	3	635.1	211.7	3.24	0.0248
Std Dev	7.6	10.2	9.0	7.0	Error	114	7452.0	65.4		
Class Size										
Mean	25.5	24.7	25.8	25.1	Model	3	14.2	4.7	0.16	0.9244
Std Dev	5.4	4.9	5.3	5.8	Error	114	3425.2	30.0		
Length of Profiles (WORDS)										
Mean	5032	5835	5299	5611	Model	3	10786178	3595393	1.41	0.2443
Std Dev	1274	2326	1182	1675	Error	114	291248936	2554815		

Table 2-9: Orthogonal Contrast Tests between Groups on Years of Experience

Years Teaching (Contrasts)					
Contrast	DF	SS	MS	F Value	Pr > F
Group 3 vs Others	1	509.42	509.4189	7.79	0.0062
Group 1 vs Group 2	1	38.596	38.59595	0.59	0.4438
Group 2A vs Group 2B	1	3.8	3.8	0.06	0.8099

Survey Questions

Before a candidate was interviewed, they provided a signed Consent Form (See Appendices I & J) in accordance with the University's policy regarding the ethical conduct of research. On this form were four multiple-choice questions aimed at getting a sense of how the candidate a) learned about National Board certification, b) what incentives may have been involved in the choice to pursue certification, and what (if any)

resources they may have used during the process. The results shown in Table 2-10 indicate some interesting similarities and differences.

Table 2-10: Group-to-Group Comparisons on Survey Question Responses

	Group 1	Group 2A	Group 2B	Group 3	Chi-Square	p<
1. How did you first hear about National Board certification?						
a) colleague	47.50	44.44	50.00	65.00	3.395	0.335
b) media	7.50	27.78	20.00	5.00	8.156	0.043
c) union	10.00	5.56	5.00	5.00	1.000	0.801
d) school administration	15.00	11.11	20.00	15.00	0.591	0.898
e) other (please specify):	35.00	33.33	20.00	15.00	5.131	0.162
2. What incentives did your district, state, or school offer to encourage teachers to pursue National Board Certification?						
a) salary, step, or rank increase	37.50	33.33	80.00	32.50	14.184	0.003
b) yearly bonus for life of certificate	52.50	27.78	30.00	52.50	5.795	0.122
c) one-time bonus upon achieving certification	12.50	27.78	50.00	17.50	11.679	0.009
d) none	12.50	5.56	5.00	12.50	1.480	0.687
e) other (please specify):	20.00	22.22	30.00	20.00	0.932	0.818
3. In your efforts to complete the certification requirements, which of the following resource(s) do you anticipate using or have used?						
a) school or district support group	50.00	77.78	20.00	65.00	15.620	0.001
b) email group	10.00	11.11	60.00	32.50	20.151	0.000
c) web	25.00	38.89	20.00	40.00	3.812	0.282
d) none	10.00	11.11	5.00	2.50	2.450	0.484
e) other (please specify):	52.50	22.22	25.00	45.00	7.204	0.066

With regards to the first question on how the candidate heard about National Board certification, only Group 2A was different. They heard about the certification process through the media to a higher degree than the rest of the groups. The rest of the groups heard about National Board certification primarily through colleagues (i.e. word of mouth).

Question # 2 was potentially a very important question for this study. If enough individuals indicated that they pursued National Board certification with no financial incentive, then a means of comparing learning outcomes between those with intrinsic

motivation (no incentives) and those candidates with extrinsic motivation (incentives) would be possible. Unfortunately, approximately 90% of the teachers participating in this study across all groups listed some form of financial incentive. Therefore, an important dimension of linking learning with motivation could not be addressed. What the results do show is that among the 90% who had some sort of financial incentive, Group 2B was significantly different than the other groups in that they were more likely to be enticed by salary, step, and/or rank increase or with a one time bonus after successfully completing the process.

With regards to Question #3 on support through the process, Group 2A and Group 3 were more likely to expect support from their school or through a district support group; whereas Group 2B utilized support from an email or online resource. Generally speaking, approximately 90% of the subjects in this study utilized some form of support to help them through the certification process. To what extent and how valuable this support was to their efforts is unknown. Questions regarding the role of support networks and/or motivating factors in the quality and quantity of learning from National Board certification must be left to future research projects.

For now and for purposes of this study, the responses to these questions paint a fairly clear picture. First of all, a majority of teachers heard about National Board certification through a colleague. Finally, Nearly all the teachers who participated in this study had some form of financial incentive and utilized some form of support through the process. The significant differences identified with this analysis (i.e. Group 2A hearing about certification through the media or Group 2B's difference with incentive) are most likely due to the small sample size of Group 2A (n=18) and 2B (n=20). This explanation

is supported by the fact that significant differences were not found in either of the larger Group 1 and 3. In addition, if the results from Groups 2A and 2B are averaged; there differences from the rest of the study would in all likelihood disappear. Therefore, it is not necessary to place too much importance on how these differences might relate to the observed results.

In analyzing the similarities and differences between Groups 1, 2A, 2B, and 3 with regards to demographic information, 12 different characteristics were compared. Table 2-11 provides a summary of where significant differences were identified. Of those areas that showed difference (i.e. Years of Experience, Learning of, Incentive for, and Support for National Board certification), the most important would appear to be Years of Experience. In Chapter 3, these variables will be revisited as possible confounding variables in explaining observed changes from pre to post observations.

Table 2-11: Summary of Group-to-Group Comparisons on Demographic Variables

Demographic Characteristic	Group 1	Group 2A	Group 2B	Group 3
GRADES	ND	ND	ND	ND
CONTENT	ND	ND	ND	ND
SCHOOL	ND	ND	ND	ND
REGION	ND	ND	ND	ND
STUDENTS	ND	ND	ND	ND
GENDER	ND	ND	ND	ND
Years of Teaching Experience	ND	ND	ND	Different
Class Size	ND	ND	ND	ND
Length of Profiles (WORDS)	ND	ND	ND	ND
Learn of National Board	ND	Different	ND	ND
Incentive for National Board	ND	ND	Different	ND
Support for National Board	ND	ND	Different	ND

ND - Not Significantly Different

Instrumentation

There were two investigative instruments used over the course of this study: the interview protocols and the assessment rubrics. The interview protocols were developed

during the pilot investigation (Lustick, 2001) and later refined during the initial interviews of this study. The protocols were designed to mimic the entire portfolio construction process, but on a much smaller scale. Where the average candidate might spend upwards of 400 hours constructing their portfolio over a four to nine month period, this investigation attempted to collect the same sorts of evidence provided in a portfolio through a 70-minute interview.

The structured stimuli-response interview was employed in this study because of its advantages for collecting richer data when compared to surveys and self-reporting instruments. Research in this area has indicated that a structured interview can result in a more robust database. As Mullens states in a report on assessing the impact of the Eisenhower Professional Development Program on teacher quality

Structured interviews with teachers allow for a different type of assessment of teachers' experience with professional development and of changes in their knowledge and practices. Probing questions allow researchers to gather detailed data on the influence of professional development activities on teachers belief systems and to a lesser extent practices. This kind of inquiry provides a basis for understanding the effectiveness of specific types of learning opportunities and how the delivery of those opportunities benefits teachers most. Mullens et al, 1996

Since the goal of this study was to assess knowledge and 'changes in their knowledge', the use of a structured interview seemed quite appropriate. Because data collection by structured interview is more labor intensive and less practical to use on a large scale, it is much less common than other forms of data collection such as surveys or self-reports (Mullens et al, 1996).

The structured interview developed for this study emerges in part from a technical report by Kennedy, Ball, and McDairmid on examining and tracking changes in teacher knowledge through research (Kennedy, Ball, and McDairmid, 1993). In this report, the

authors state that one possible way of identifying changes in what teachers know is by “presenting teachers with hypothetical teaching situations”. They go on to state that “if the situations were standardized” then “the amount of irrelevant, idiosyncratic differences in responses” could be reduced and “the detailed, contextualized information about teachers perceptions of practice” would be increased. Focusing the protocols on teaching situations and standardizing them for all study participants “allows for researchers to see how the various aspects of expertise—knowledge, beliefs, attitudes about learning teaching and subject matter were drawn on to make teaching decisions” (Kennedy, Ball, & McDairmid, 1993).

The structured stimulus-response interview for this study had 6 sections representing all parts of the portfolio construction.⁸ Each section was modeled after each theme of the four mandatory portfolio entries as well as the background and school context information that is also required. The section included a pedagogical ‘scenario’ typical of a secondary science classroom. Table 2-12 summarizes a comparison between the structured interview protocols and the requirements (portfolio and assessment center exercises) for certification.

Table 2-12: Structured Interview and Portfolio Construction Comparison

Required Aspects	Structured Interview Protocols	NBPTS Portfolio Entry
Introductory Questions	Teacher Background	Teacher Background
	School Context	School Context
	Student Profile	Student Profile
Scenario #1	Teaching a Major Idea in Science Over Time	Teaching a Major Idea in Science Over Time
Scenario #2	Scientific Inquiry	Scientific Inquiry
Scenario #3	Best Practice	Assessment Center
Scenario #4	Whole Class Discussion	Whole Class Discussion
Scenario #5	Community, Professional Development, and Leadership	Community, Professional Development, and Leadership

⁸ For a complete presentation of the AYA Science portfolio prompts, see Appendix A.

For each interview, teachers received a handout describing Scenarios 1-5, but were not given the questions they would be asked about each of those scenarios during the interview. See the Interviewee and Interviewer versions of the protocols in Appendices B and C respectively. Each question in each Scenario (except scenario #3) was modeled after the same set of prompts provided in each entry of the portfolio construction. By modeling the protocols on the portfolio construction process, I collected data in parallel with what the National Board collects in the finished portfolio. Just as the portfolio construction prompts can be linked to a one or more of the thirteen standards of accomplished science teaching, each question in the protocol can also be traced to the same list of thirteen standards. The weight and balance of these standards as reflected in the portfolio prompts is the same in the structured interview questions. For example, 10% of the questions can be linked to the standard of Equity in the classroom in the portfolio prompts. In the interview questions, 10% pertain to the standard of Equity in the Classroom.

The second instrument used in this investigation consisted of the extensive rubrics and scoring procedures developed and used by the National Board of Professional Teaching Standards for Candidate Portfolio assessment and adapted for this study. Experienced and knowledgeable National Board assessors for AYA Science were invited to score the interview transcripts. They were instructed and trained to apply the same sophisticated and complex assessment tools the Board uses in assessing actual candidate portfolio entries. The rubrics are based upon the 13 standards of accomplished secondary science teaching. The following is a brief description of each of the 13 scales of measure. (For a more detailed description of each standard, see Appendices D & F).

Standards to be Assessed

The AYA Science certificate is based upon a teacher's ability to measure up against the 13 standards of accomplished teaching. The standards are the result of an arduous and time intensive process that includes the input of experienced science teachers, academics, researchers, and educational leaders. They are field tested regularly and every three to five years are re-evaluated and adjusted as deemed necessary by the National Board and the science education community. They represent a consensus of belief as to what constitutes 'accomplished teaching' in science. They are by no means exclusive or definitive, but rather, one set of characteristics considered by some to represent excellence in secondary science teaching. Table 2-13 provides an overview of the 13 standards as separated into four sets.

Table 2-13: Overview of Standards for AYA Science

I. Preparing the Way for Productive Student Learning	
	I. Understanding Students II. Knowledge of Science III. Instructional Resources
II. Advancing Student Learning	
	IV. Science Inquiry V. Goals & Conceptual Understanding VI. Contexts of Science
III. Establishing Favorable Context Learning	
	VII. Engagement VIII. Equitable Participation IX. Learning Environment
IV. Supporting Teaching and Learning	
	X. Family & Community Outreach XI. Assessment XII. Reflection XIII. Collegiality & Leadership

Set I, “Preparing the Way for Productive Student Learning” includes Standards 1-3 all of which pertain to the inputs a teacher brings with them to class before the start of a lesson. Standard I: *Knowledge of Students* involves researching a teacher’s students to understand their learning styles, previous experiences in science classes, strengths and weaknesses in learning science, and level of current understanding regarding major ideas and concepts in science. Standard II: *Knowledge of Science and Pedagogy* addresses a teacher’s understanding of scientific content knowledge in both breadth and depth. The pedagogical component refers to a teacher’s knowledge and skills when teaching a particular science concept to students. Standard III: *Instructional Resources* concerns a teacher’s knowledge, use, and creation of resources that support learning in the classroom such as technology, lab equipment, supplies, and manipulatives.

Set II, Advancing Student Understanding, includes Standards 4-6 all of which pertain to the actual teaching of content in a lesson. Standard IV: *Scientific Inquiry* is specific to the science certificate since inquiry is considered to be a fundamental aspect of teaching science. How scientists ask questions and seek answers through a form of systematic process is vital to understanding the knowledge constructed, discovered, or investigated. Scientific inquiry is more than the ‘scientific method, it also describes the pedagogy associated with open-ended investigations. Standard V: *Goals and Conceptual Understanding* pertains to a teacher’s ability to structure units and lessons so that students have opportunities to investigate, explore, and learn about ideas at a deeper level than the memorization of facts and definitions. Finally, Standard VI: *Contexts of Science* describes a teachers’ ability to help students connect abstract big ideas to their lives and

experiences. It may include the history of science, science as a social issue, science as a political issue, and science as an influence upon citizens.

Set III, Establishing a Favorable Context for Student Learning, includes Standards 7-9 all describing a teachers ability to conduct class in a positive and equitable manner. Standard VII: *Engagement* pertains to a teacher's ability and skills at asking questions, listening to students, and providing written feedback and opportunities for students to participate in the learning process. Standard VIII: *Equitable Participation* addresses a teacher's awareness of and ability to include all learners in the classroom experience. It also recognizes that individual students may have special needs that a teacher must address and accommodate in the teaching/learning experience. Standard IX: *Learning Environment* describes how a teacher effectively manages a classroom so that learning is a positive experience, that everyone has an opportunity to learn, and that the classroom is an intellectually and scientifically stimulating place for learners to be.

Set IV, Supporting Teaching and Learning, includes standards 10-13 and addresses a teacher's work at improving student learning outside the classroom. Standard X: *Family and Community Outreach* describes the collaborative nature of a teacher's work with parents, guardians, and the greater educational and surrounding communities. Standard XI: *Assessment* pertains to the skills and knowledge that teachers bring to evaluating student understanding of ideas taught in class through both formal and informal techniques. Standard XII: *Reflection* concerns a teacher's willingness, ability, and aptitude at critically thinking about their classroom practice and its effect upon student learning. A teacher reflects on practice in order to recognize their strengths and weaknesses and work to build upon the former and improve the later. Finally, Standard

XIII: *Collegiality and Leadership* describes a teacher's ability to work with a professional community of educators for the benefit of both student learning and the quality of education at the local level and beyond. For the National Board's definition of these standards, see Appendix D. There have been numerous studies addressing construct validity of these standards as a measure of teacher quality. Among these studies, Bond, 2001 stands out as one of the most comprehensive and important.

Interview Protocols

Every phase of this investigation was challenging. However, identifying the most effective protocols for the interview process proved to be one of the most difficult. I needed to construct an interview experience that closely paralleled the portfolio construction process without being cliché, trite, or obvious. It also had to limit the amount of self-reporting data and maximize the third person analytical data. The questions and artifacts should be recognizable as legitimate science classroom possibilities falling within the providence of a typical science lesson. And yet, all but one scenario would be new situations for each candidate. The candidates had never seen these artifacts, heard these conversations, or watched the video. Their assessment and analysis of each scenario based on the questions they were asked would provide a unique glimpse into their knowledge, values, and beliefs which could later be measured according to the National Board's 13 standards of accomplished teaching in AYA Science.

The basic assumption was that if teachers in the study were presented with some artifact of teaching and learning similar to their own portfolio artifacts that the analysis they provide would be a good indication of how they would address the same question in

their own portfolio construction. For example, if a question asks about equity in the scenario, and the candidate says very little about equity, then we might assume that in their own self-analysis for the portfolio, they would also have very little to say about equity.

The following is a brief discussion of each of the 6 parts of the protocols. For an in-depth comparison of the interview protocols and portfolio prompts, please see Appendix E. The protocols as presented here remained basically unchanged over the course of the study. Even when weaknesses were later identified, they were not corrected for fear of altering or influencing the results.

Scenario I is modeled after the portfolio entry “Teaching a Major Idea in Science”. It includes an artifact that the teacher used to assess students’ understanding of kinetic theory of matter before and after the unit. Kinetic Theory was chosen as the topic because of its presence in most General Science, Chemistry, and Physics classes. It is also a topic addressed to differing degrees in middle school. Being such a general idea in science, it was anticipated that most secondary science teachers would have some familiarity with it and therefore it was not so esoteric as to be a surprise. Also, it is a challenging and abstract concept for students at of all ages to learn. The questions asked of the candidates during the interview closely resemble the portfolio prompts for the entry on Teaching a Major Idea in Science. Scenario I is a difficult and demanding task of analysis for the interviewee since it requires the teacher to analyze and comment upon someone else’s work. Because of its perceived difficulty, teachers discussed Scenario I immediately after the introductory questions.

Scenario II continues with the analysis of another teacher's work, but this time it is focused on the life sciences and the difficult concept of Natural Selection. This scenario was modeled after Entry 2, which is titled "Active Scientific Inquiry". The theory of Natural Selection was chosen for this section because of its inclusion in nearly all high school textbooks and classrooms. It also allowed for teachers to voice ideas on the controversial topic (in some areas of the county) concerning the teaching of evolution⁹.

A transcribed dialog between a group of students working cooperatively on an introductory activity commonly known as the "Peppered Moth Investigation" is presented as a situation that allows teachers to express their ideas about scientific inquiry, equity, engagement, and learning environment. In many respects, it is the most complex scenario of the interview requiring participating teachers to analyze content, student understanding, scientific inquiry, equity, and science pedagogy all at the same time. Once again, the interview protocols closely follow those of the portfolio prompts.

For Scenario III, the interviewee gets the opportunity to report an instance of best practice in a guided self-reflection format. After two sections of intensive analysis of someone else's teaching, it was a relief for most to be able to discuss their own teaching. This scenario is not modeled after any particular Entry in the portfolio, but rather is more of a summation of the reflective process present in all four entries addressing all four areas of standards with a special emphasis on content knowledge.

Scenario IV is modeled after Entry 3 of the portfolio, "Whole Class Discussion in Science". For this scenario, the interviewees watched a 6-minute continuous clip from an

⁹ It is interesting to note, that not one teacher in this study made a negative remark about this content area. In fact, there were numerous comments to the importance of teaching Natural Selection to students.

actual 20-minute tape included as evidence in a portfolio for AYA Science. A 6-minute clip was intentionally chosen from the 20-minute tape that included many very interesting moments. Moments in the discussion that were both quite strong and quite weak with regards to the National Board's standards. The idea was that this clip would allow for a well thought out and balanced analysis of the teacher's work and the apparent student learning as evidenced by their comments and questions both towards each other and the teacher.¹⁰ Since it did not seem to be an efficient use of time or a reasonable task to ask a teacher in an interview to watch a 20 minute tape in a 70 minute interview, the 6 minute clip provided a good taste for observing a discussion and answering questions with data collected during the first and only viewing. Teachers were asked not to watch the sealed tape until after instructed to do so during the interview. Every teacher verbally indicated that they had abided by this request.

The interview protocols that followed the viewing were modeled closely upon the portfolio prompts for Entry 3. These prompts address many of the standards dealing with collegiality, assessment, understanding and goals, engagement, and knowledge of science. The whole class discussion takes place during a field trip for an 'AP Environmental Science' Class. For most teachers who teach biology, chemistry, or life science, the concepts were familiar. A few physics teachers in the study commented that they did not know much about 'ecology', but the discussion was not just about content, but the process of scientific inquiry and debate. The results from this part of the interview were quite interesting and informative.

¹⁰ It is interesting to note that the original 20-minute clip was used by the National Board in their assessor training as their benchmark example of accomplished whole class discussion in science. In other words, the tape was used to demonstrate to assessors what a '4' or highly accomplished videotape 'looked like'.

The final section, Scenario V, once again, gives teachers an opportunity to discuss their own experiences and ideas. It is modeled after Entry 4 of the portfolio “Documented Accomplishments Outside of Class”. The section is divided into two equal parts: Professional Development & Leadership Experiences and Community & Family Experiences. In both sections, teachers were asked which activities/accomplishments out of a list of 15 did they had direct experience with and to rate each item on a 1-5 scale with regards to each item’s impact upon their ability to improve student learning. For items that teachers did not have direct experience with, the assessment was left blank. In addition, they were asked if anything was missing from the list that they thought was especially helpful in their opinion in improving their ability to bring about learning in their students. The list is by no means exhaustive, so contributions to the list indicated a depth of professional and community experiences.

If the assumption were made that the protocol’s reliability in measuring learning against the standards depends upon a strong alignment between the standards and the protocols, then it would appear that the interview protocols have a very good reliability. This can be determined by examining a detailed breakdown of the protocol to verify that it does indeed align strongly with the standards being assessed. With such a qualitative approach to this issue, Appendix E demonstrates that each question asked of the candidate over the course of the interview finds its origins in the standards of accomplished teaching for the Adolescent and Young Adult Certificate. Most of these prompts are derived directly from either one or a combination of more than one portfolio prompt. One thing that is clear is that the distribution of opportunities to address specific

standards during the interview is not equal among all thirteen standards as is also true in the portfolio instructions.

Each question of the interview protocols and the series of responses from both pre and post groups could each serve as a very interesting qualitative analysis.

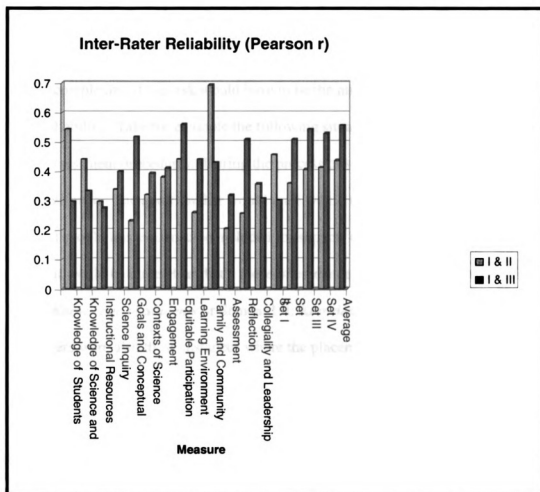
Unfortunately, in the context of a dissertation, this brief description along with the more detailed analysis in Appendix E will have to be satisfactory. This brief qualitative examination of the protocol's reliability as an instrument to assess knowledge according to the 13 standards of accomplished teaching provides some evidence that the instrument does address all the standards of accomplish teaching. The fact that the interview protocols and portfolio prompts are strongly aligned as demonstrated in Appendix E is a strong indication that the instrument (when used properly) would help to assess the complex construct that is accomplished teaching in AYA Science. It is the complexity of task that becomes the next focus of analysis when Inter-Rater reliability is examined.

Inter-Rater Reliability

Inter-Rater reliability is a measure of the degree to which raters agree in their assessment of each standard for each candidate. An examination of Figure 2-8 reveals some important observations. The first observation is the fact that measures of different standards have different levels of reliability, though these differences occupy a rather small range. With a maximum average reliability of 0.632 and a minimum average reliability of 0.259, the mean value of 0.458 demonstrates that more measures fall towards the lower end of the range than at the high.¹¹

¹¹ It should be noted that the two comparisons made both involve Assessor I. I was Assessor #I (the study's Principle Investigator) and was the only assessor who scored every transcript from each groups. Assessors II and III did not score enough common transcripts to make a valid comparison. As a source of potential bias, my role in scoring transcripts is very important. However, an analysis of the scores excluding my data

Figure 2-8: Comparison of Inter-Rater Reliability (Pearson r) across standards



How does an overall reliability of 0.458 inform the evaluation of assumption on the precision of measurement? In most research communities, a reliability of 0.46 can be considered “low to moderate”. This description of the correlation co-efficient is supported in one statistical text that describes a correlation coefficient of $r = .48$ as ‘moderately large’ (Shavelson, 1996, p173), but the context of this evaluation or the nature of the research that it describes is unknown. Considering the high degree of complexity of the assessment tasks in this study, a reliability of 0.458 is understandable.

produces nearly identical results. This provides strong evidence to a minimal effect from any bias I might have had during this study.

However, it must be considered a serious limitation to the overall precision of the data and qualify any conclusions drawn from this study. But the question still remains, Why isn't the reliability higher?

The complexity of the task would have to be the number one reason for the measured reliability. Take for example the following situation, which was quite common during the assessment procedures. During the process of scoring, the assessor would encounter evidence. The question that would arise would then be "Under what category (or standard) should this evidence be included for support of a particular standard?" In most cases, it would be quite clear that a piece of evidence was clearly supportive of Standard I: *Knowledge of Students* or Standard II: *Knowledge of Content and Pedagogy*. However, there were also those instances where the placement of a particular piece of evidence was not so clear or obvious.

For example, if a teacher claims that the use of a computer based activity was warranted because both male and female students enjoyed working with computers, then the assessor would have to decide whether this information is evidence for Knowledge of Students, Knowledge of Pedagogy, Equity of Instruction, or Instructional Resources. They may opt to include it as supporting evidence in one or more of these standards, but it is in this judgment that much of the variation can be found. Not all assessors would agree in which and in how many categories to include. This issue was not strongly addressed in the training materials and training session (See Appendix F) for this study.

Another example of the overlapping nature of some of the standards used pertains to assessment. In *Knowledge of Students*, it states that teachers know how to assess their students' learning. Standard XI: *Assessment* also emphasizes student understanding.

Therefore, an assessor has more than one category in which to place evidence pertaining to assessment. For this study, the level of analysis was on a candidate's understanding of each of the thirteen standards. National Board's level of analysis focuses upon the a candidate's overall score. With such complexity and opportunity to place evidence in more than one standard in this study, it is not surprising that the Inter-rater reliability is not stronger.

The assessment process for this study was based upon the assessment procedures and experiences employed by the National Board for the scoring of 'live' portfolios in the field. In that practice, it makes no difference if evidence applies to more than one standard, because the assessor need only be concerned with making a single final evaluation based upon *the preponderance of evidence*. For purposes of this study, these procedures were adapted to the questions investigated regarding areas of specific learning. To answer these questions, the primary difference between the actual assessment procedures and those used in the study can be traced to this idea that assessors are scoring a "portfolio" or transcript 13 times, not just once. The total score gives an indication of the reliability of the assessor's overall impression of a particular candidate. However, unlike the actual in the field process whose goal is to decide if the evidence supports accomplished or not accomplished teaching, the assessors in this study were never asked to make this overall judgment. Instead, the total represents the average or total of all thirteen measures for an individual candidate in the study.

If sets of standards are considered, the reliability remains at 0.412, but the variability of the numbers as measured by the range stabilizes greatly. With a maximum of 0.444 and a minimum of 0.401, it is clear that though assessors may not have been able

to agree on which standard within a group of related standards evidence belonged, their agreement varied less regarding where evidence belonged in a broader category of standards. In the analysis of results, this finding will be important to consider when specific areas of pre to post gain are considered.

Inter-rater Reliability analysis for this study reveals a low to moderate relationship between different assessors scores for the same interview. Figure 2-8 provides a visual comparison of how Assessor 1 compared with Assessor 2 and Assessor 3. A Pearson correlation of .458 was found to exist between all three raters. One way it might have been improved is if more time and resources had been allocated for the training of the assessors for the task of scoring interviews for this study. At the time of inception, it was thought that the extensive experiences of each assessor in the assessment process would negate the need for a more extensive training process. Each assessor received the same packet of training materials (See Appendix F for details), instructions over the phone, numbers of exercises, and bias awareness training. Overall, the entire process required about 6 hours of work. This compares to the 3 days of training the Board conducts with its assessors before they score 'live' entries. Because two of the assessors used in this project were both assessors and assessor trainers, a more thorough training was thought to be redundant. However, in retrospect, more training (possibly face to face) would probably have improved inter-rater reliability. Such an approach would have added significant costs to the project. Once again, compromises and negotiations produce the best results with the available resources. A summary of inter-rater reliability among all three assessors for each standard, set of standards, and overall is provided in Table 2-14.

Table 2-14: Summary of Inter-Rater Reliability

Inter-Rater Reliability					
Set	Standard	Estimate of True Score Variance	Estimate of Total Variance	Est. of Error Variance	Estimated Reliability
1	1	0.161	0.361	0.200	0.445
1	2	0.217	0.424	0.207	0.511
1	3	0.188	0.438	0.250	0.429
2	4	0.168	0.428	0.260	0.393
2	5	0.121	0.371	0.250	0.327
2	6	0.264	0.662	0.398	0.399
3	7	0.124	0.392	0.268	0.317
3	8	0.293	0.463	0.171	0.632
3	9	0.144	0.480	0.336	0.299
4	10	0.224	0.432	0.208	0.518
4	11	0.156	0.432	0.276	0.361
4	12	0.185	0.471	0.286	0.393
4	13	0.107	0.324	0.217	0.331
Total	13	21.784	47.585	25.802	0.458
1	Set 1	1.123	2.736	1.613	0.410
2	Set 2	1.345	3.329	1.984	0.404
3	Set 3	1.332	3.323	1.991	0.401
4	Set 4	2.002	4.513	2.511	0.444

The estimated reliabilities in this table were calculated by dividing the estimated true score variance by the estimated total variance. To estimate the true score variance for each of the standards, the covariances between the ratings of each pair of assessors were computed. The estimated true score variance for each of the standards is the average of the corresponding covariances. The total score variance is estimated by averaging the variances of ratings of each of the assessors. The estimate of error variance results from subtracting the estimate of the true score variance from the total variance.

In summary, the instrument analysis indicates a high degree of agreement between the interview prompts and the portfolio prompts as they address individual or groups of standards respectively. With regards to inter-rater reliability, the assessors in this study demonstrated an overall reliability of 0.458 considered low to moderate. With such a complex and difficult assessment task, a reliability of 0.458 represents an

important weakness of this investigation. All findings derived from this study should be conditional upon a less than ideal inter-rater reliability. The methodological assumption regarding the adequacy of the assessment instruments' accuracy and precision is satisfactory to a limited degree, but limits the generalizability of this study's findings. The effect of the moderate reliability is to inflate the variability of the scores making the tests of the hypotheses statistically more conservative; that is, making it more difficult to reject the null hypotheses.

The final assumption that needs to be addressed pertains to the timing of data collection with regards to the experience of the intervention. Collecting data at the appropriate time is crucial to securing the most valid results. As the Mullen report states:

Timing of data collection in a pre-post comparison is critical since the pre collection needs to be as close as possible to the beginning of the intervention and the post collection at the appropriate interval after the change could be reasonably expected to occur. Improper timing can lead to less than valid results. This is especially true when attempting to gauge the effect of a particular professional development. (Mullen, et al, 1996, p32)

In this area, the internal validity of the study came upon its most significant threat. In Chapter 4, this issue will be explored and discussed at greater length.

Summary

This chapter dealt with the issues and approaches associated with the research methodology. The Recurrent Institutional Cycle Design was used to investigate a series of hypotheses that would explain observed treatment effects upon the learning of secondary science teachers in this study. Through both cross sectional and longitudinal data set comparisons, most threats to internal and external validity can be controlled for with this methodology. Procedures for recruiting and data collection as well as

demographic information regarding cohort participants were also provided in this chapter. In the next chapter, I will present the results from the hypothesis testing.

CHAPTER 3: QUANTITATIVE RESULTS

'Til your error you clearly learn.

-Bob Dylan from "Licensed to Kill"

Overview

In this chapter, statistical analysis of the results is presented. Chapter 2 addressed three important assumptions 1) the validity of the methodology chosen for answering the research question, 2) the homogeneity of the cohorts and their respective samples, and 3) the reliability of the measurement instruments and procedures. Chapter 3 presents the results within the context of the identified strengths and weaknesses so far discussed. In addition, this chapter discusses the timing of data collection with respect to the intervention. Issues associated with data collection will be explored in an analysis and discussion of candidate 'status'.

Chapter 3 presents analyses focused upon the testing of each hypothesis and the identification of specific areas of pre to post score gain. Analyses are divided into two sections. The first section addresses the validity of the methodology used to answer the research question. By close examination of Hypotheses 1-10, the strengths and weakness of the RICD will be apparent. The second section focuses on the Combined Hypothesis and the identification of sets and standards that demonstrate the most significant gains from pre to post observations. Chapter 3 is presented in the following order:

- 1) Overview
- 2) Data Collection
- 3) Validity of Design
 - a. Non-Equivalence Hypotheses 1-6
 - b. Equivalence Hypotheses 7-10
 - c. Issue of Status
 - d. Adjusted Results
- 4) Pre to Post Gains Analysis: Combined Hypothesis

- 5) Confounding Variables
- 6) Summary

Data Collection

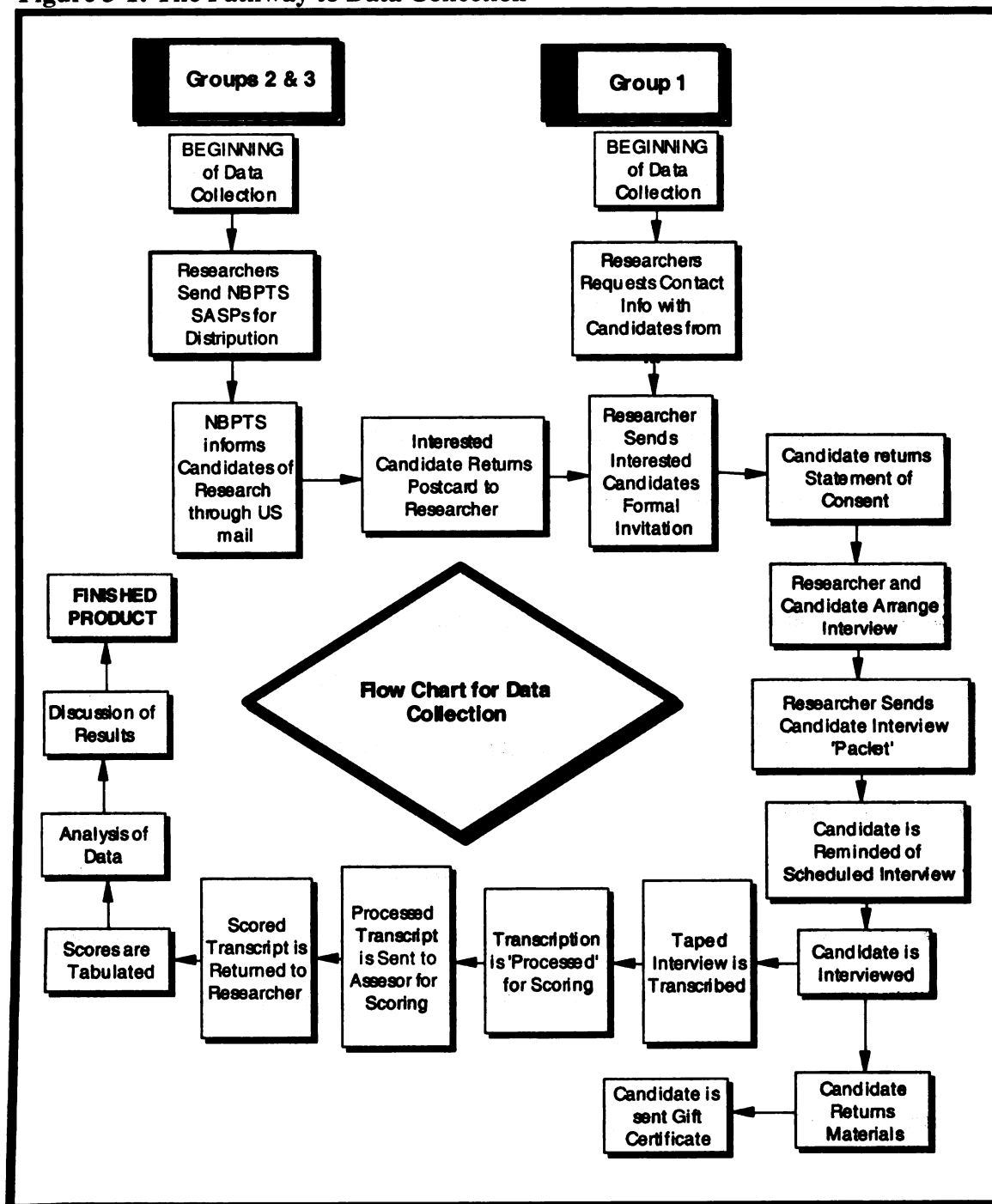
Before delving into the data analysis, it is prudent to take a step back and explain the origin of the means for each observation point. As mentioned briefly in Chapter 2, the timing of data collection was considered very important to identifying the possible effects of the intervention. Pre-data were to be collected after candidates self-selected themselves for Board certification by paying the non-refundable \$300 registration fee, but before meaningful work on portfolio construction had begun. Post-data was to be collected in the time period after a candidate submitted of the completed portfolio and finished the assessment center exercises (around June) and before they were notified by the Board of whether or not they passed (late November). If the overall timing of data collection was important, each step along the way deserves some discussion.

After recruiting each participant as described in Chapter 2, data collection began with the completed consent form and then continued with the telephone interview of the teacher-candidate. After the audio taped interview was transcribed, a ‘processed’ version of the transcription¹² of each interview was then scored by at least two assessors using the rubrics and standards of the National Board certification process. The assessors then provided one score for each of the 13 standards of accomplished teaching in Adolescent

¹² The ‘processed’ transcript was a crucial step in this research project. The assessors’ responsibilities were to resemble their experience with ‘live’ portfolios as much as possible. To hand them a ‘raw’ transcript would have impeded their ability to adequately and fairly evaluate the written words. National Board is a stickler for format (font, margins, spacing, etc) and the researchers wanted the interview transcripts to resemble a real entry visually as much as possible. The aim of the processing was to improve the appearance, but not the meaning or intent of the words. See Appendix I for complete details.

and Young Adult Science described in Chapter 2. The 13 assessed scores for each candidate were then aggregated to the group level so that means representing different observations could be compared for significant differences at the overall, set, and individual standard level of analysis. The process for data collection is illustrated in Figure 3-1.

Figure 3-1: The Pathway to Data Collection



Hypotheses Testing

According to the Recurrent Institutional Design, there are two groups of hypotheses: those that predict a difference (Non-Equivalence Hypotheses 1-6) and those that predict no difference (Equivalence Hypotheses 7-10). The Non-Equivalence Hypotheses look at the predicted gains by comparing pre groups with post groups. The purpose of the Equivalence Hypotheses 7-10 is to provide a check of the methodology used in this study. If the methodologies and instruments are valid, then there should be no difference between pre group-pre group comparisons and post group-post group comparisons. For this study, the Combined Hypothesis was added to examine gains with the largest possible degrees of freedom making use of all 118 participants in 4 out of the 5 observation points. The analysis will begin by looking at the Equivalence Hypotheses.

Equivalence Hypotheses (H7-H10)

The detailed results of testing Hypotheses 7-10 are provided in Table 3-1. The table provides the results of hypothesis testing at the Overall and Set levels of analysis. A two-tailed independent t-test was used to check for significant differences in all four equivalence hypotheses since the means compared could move in either an up or down direction. Since no significant differences were identified in either the overall average or the subsequent sets of standards, an individual analysis of each standard is not presented. An error control procedure (i.e. the Bonferroni Adjustment) was not used in the analysis of the Equivalence Hypothesis since each observation data set involved in a comparison is separate and distinct. Though multiple hypotheses are being tested, each hypothesis compares two different observation points or data sets.

Table 3-1: Analysis of Equivalence Hypotheses (H7-H10)

Group Statistics						Independent Samples Test				
Standards Overall Average						t-test for Equality of Means				
Group	N	Mean	Std. Dev.	Std. Error	t	df	Sig.2-tailed	Mean Diff.	Std. Error	
Overall Averages										
H7	2A-Post	18	2.723	0.418	0.098	-0.508	36	0.615	-0.070	0.137
	2B-Post	20	2.792	0.425	0.095					
H8	2A-Pre	18	2.641	0.559	0.132	0.795	56	0.430	0.101	0.127
	3-Pre	40	2.540	0.391	0.062					
H9	2A-Post	18	2.723	0.418	0.098	-0.703	56	0.485	-0.088	0.126
	1-Post	40	2.811	0.453	0.072					
H10	2B-Post	20	2.792	0.425	0.095	-0.154	58	0.878	-0.019	0.122
	1-Post	40	2.811	0.453	0.072					
Set1 Averages										
H7	2A-Post	18	2.755	0.426	0.100	-0.397	36	0.693	-0.054	0.135
	2B-Post	20	2.808	0.407	0.091					
H8	2A-Pre	18	2.694	0.594	0.140	0.741	56	0.462	0.100	0.135
	3-Pre	40	2.595	0.411	0.065					
H9	2A-Post	18	2.755	0.426	0.100	-0.248	56	0.805	-0.030	0.120
	1-Post	40	2.784	0.421	0.067					
H10	2B-Post	20	2.808	0.407	0.091	0.210	58	0.835	0.024	0.114
	1-Post	40	2.784	0.421	0.067					
Set 2 Averages										
H7	2A-Post	18	2.708	0.440	0.104	0.026	36	0.979	0.004	0.158
	2B-Pre	20	2.704	0.522	0.117					
H8	2A-Pre	18	2.602	0.587	0.138	1.719	56	0.091	0.247	0.144
	3-Pre	40	2.355	0.466	0.074					
H9	2A-Post	18	2.708	0.440	0.104	-0.274	56	0.785	-0.039	0.141
	1-Post	40	2.747	0.519	0.082					
H10	2B-Post	20	2.704	0.522	0.117	-0.300	58	0.765	-0.043	0.142
	1-Post	40	2.747	0.519	0.082					
Set 3 Averages										
H7	2A-Post	18	2.725	0.523	0.123	-0.671	36	0.507	-0.107	0.159
	2B-Post	20	2.831	0.458	0.102					
H8	2A-Pre	18	2.664	0.632	0.149	0.520	56	0.605	0.080	0.154
	3-Pre	40	2.584	0.498	0.079					
H9	2A-Post	18	2.725	0.523	0.123	-1.050	56	0.298	-0.154	0.146
	1-Post	40	2.878	0.512	0.081					
H10	2B-Post	20	2.831	0.458	0.102	-0.346	58	0.731	-0.047	0.136
	1-Post	40	2.878	0.512	0.081					
Set 4 Averages										
H7	2A-Post	18	2.708	0.442	0.104	-0.740	36	0.464	-0.109	0.147
	2B-Post	20	2.817	0.462	0.103					
H8	2A-Pre	18	2.613	0.542	0.128	0.076	56	0.939	0.009	0.122
	3-Pre	40	2.604	0.372	0.059					
H9	2A-Post	18	2.708	0.442	0.104	-1.206	56	0.233	-0.150	0.125
	1-Post	40	2.859	0.438	0.069					
H10	2B-Post	20	2.817	0.462	0.103	-0.339	58	0.736	-0.041	0.122
	1-Post	40	2.859	0.438	0.069					

The results of this analysis show that no significant differences exist in each of the four hypotheses at the .05 level. Hypothesis 8 when tested on Set 2 of the standards was significant at the .10 level of significance. However, in all cases, the investigator fails to reject the null hypothesis indicating that the mean scores compared in each hypothesis for each level (overall averages and Sets 1, 2, 3, and 4) are not significantly different. From this result, I infer that the pre-observations do not differ from each other and that the post observations do not differ from each other. A comparison of the pre-observations with the post-observations will be explored with the Non-Equivalent Hypotheses. Table 3-2 provides a summary of the Equivalent Hypotheses results and also includes a power measurement. The power for each hypothesis is quite low indicating a maximum probability of 12% and a minimum of 3% of making a Type II Error or failing to see difference when differences really exist.

Table 3-2: Results Summary for Equivalent Hypotheses (H7-H10)

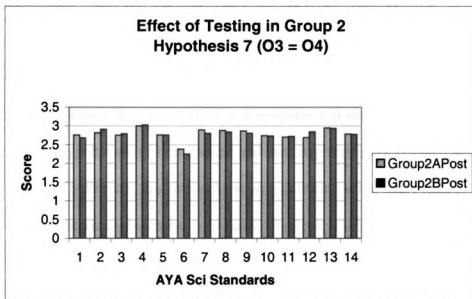
Hypothesis	Comparison	Type of t-test	Mean Diff	SE of Diff	t-value	df	No. of Tails	Sign.	$\alpha =$ 0.05	Power	Mean Diff if Power is at least .50
									Critical Value		
7	O 3 = O 4	Indep.	-0.070	0.137	0.508	36	2	0.615	2.028	0.070	0.278
8	O 2 = O 5	Indep.	0.101	0.127	0.795	56	2	0.430	2.003	0.118	0.255
9	O 3 = O 1	Indep.	-0.063	0.125	0.504	49	2	0.617	2.010	0.070	0.250
10	O 4 = O 1	Indep.	0.007	0.121	0.056	51	2	0.956	2.008	0.028	0.243

Why is finding no difference between post-post comparisons and pre-pre comparisons important? Another way to think about this series of hypotheses is when pre-groups are compared regardless of year of certification; assessed scores in this study are not significantly different. Likewise, when post-groups are compared regardless of year of certification, assessed scores in this study are also not significantly different.

These results build confidence in the methodology and measurement instruments used in this study. If the results were random, then it would be expected that at least half of the equivalent hypotheses would demonstrate differences in either direction. Where two hypotheses differed in a positive direction (H8 & H10) while two differed in a negative direction (H7 & H9), none of these differences were significant at the .05 level. Therefore, randomness does not appear to be the main influence on the results for these equivalent hypotheses supporting the validity of the research design.

Hypothesis 7 ($O3 = O4$) is an especially important test. Hypothesis 7 examines the two post-observations of Group 2. Group 2 was divided into Group 2A and Group 2B in order to test for the effect of testing. Group 2A was observed prior to the intervention (2A-Pre) and after the intervention (2A-Post) whereas Group 2B was only observed after the intervention. If Group 2A-Post ($O3$) was significantly different from Group 2B, then the act of collecting pre intervention data on Group 2A would become a rival explanation for observed differences. In other words, any observed gains in assessed scores could be attributed to either the amazing learning experience of being interviewed prior to the intervention or the intervention. The non-rejection of the null hypothesis for Hypothesis 7 indicates that there was no observed effect from testing. Figure 3-2 shows a bar graph that illustrates the comparison of Group 2A-Post and Group 2B on all measures. Measure 14 examines the overall average of all thirteen standards. It clearly demonstrates that the two groups are nearly identical on each of the observed measures, therefore eliminating the effect of testing as a possible explanation of differences that may be revealed later on in the analysis.

Figure 3-2: Bar Graph Comparing Group 2A-Post and Group 2B



The four equivalence hypotheses discussed here H7 (O3 = O4), H8 (O2 = O5), H9 (O3 = O1), and H10 (O4 = O1) all show homogeneity and no significant differences between mean comparisons. These hypotheses are important in assessing the internal validity of the methodology used in this study. According to the Recurrent Institutional Cycle Design, there should be no significant differences between pre observations of different groups and post observations of different groups. The results support these hypotheses.

Non-Equivalence Hypotheses (H1-H6)

The Equivalence Hypotheses (H7-H10) were very consistent in their results. The Non-Equivalence Hypotheses (H1-H6) are less consistent and more complex in nature. These are the hypotheses that compare the post-observations with the pre-observations both with and between groups. In each hypothesis, the post-observation is expected to be higher than the pre-observation. Because of the expected direction of difference, a 1-

tailed t-test was used to compare means. All t-tests are independent except for Hypothesis 3, which is a dependent t-test and examines the within group differences. As with the Equivalence Hypotheses, an error control procedure (i.e. the Bonferroni Adjustment) was not employed in the analysis of the Non-Equivalence Hypothesis since each observation data set involved in a comparison is separate and distinct. Though multiple hypotheses are being tested and each hypothesis is examined at the Overall and individual Set levels, this series of hypothesis testing is not being used to identify learning outcomes, but rather continue with a look at the internal validity of the methodology.¹³ Detailed results of hypothesis testing for Hypotheses 1-6 are presented in Table 3-3. The organization of this table is the same as with the Equivalent Hypotheses described above. First, the overall averages are compared and then each of the 4 Sets of standards is examined.

¹³ If a Bonferroni Adjustment was used, alpha would be set at 0.01 (0.05/5), Hypothesis 2 ($O1 > O5$) would be significant at the Overall, Set 2, and Set 4 comparisons. Hypothesis 4 ($O3 > O5$) would be significant at Set 2 as well.

Table 3-3: Non-Equivalence Hypotheses (H1-H6)

Group Statistics						Independent Samples Test				
Standards Overall Average						t-test for Equality of Means				
Group	N	Mean	Std. Dev.	Std. Error		t	df	Sig.2-tailed	Mean Diff.	Std. Error
Overall Averages										
H1	1-Post	40	2.811	0.453	0.072	1.229	56	0.224	0.170	0.138
	2A-Pre	18	2.641	0.559	0.132					
H2	1-Post	40	2.811	0.453	0.072	2.868	78	0.005	0.271	0.095
	3-Pre	40	2.540	0.391	0.062					
H3	2A-Post	18	2.723	0.418	0.098	0.867	17	0.398	0.082	0.094
	2A-Pre	18	2.641	0.559	0.132					
H4	2A-Post	18	2.723	0.418	0.098	1.615	56	0.112	0.183	0.113
	3-Pre	40	2.540	0.391	0.062					
H5	2B-Post	20	2.792	0.425	0.095	2.291	58	0.026	0.253	0.110
	3-Pre	40	2.540	0.391	0.062					
H6	2B-Post	20	2.792	0.425	0.095	0.944	36	0.351	0.151	0.160
	2A-Pre	18	2.641	0.559	0.132					
Set1 Averages										
H1	1-Post	40	2.784	0.421	0.067	0.660	56	0.512	0.090	0.136
	2A-Pre	18	2.694	0.594	0.140					
H2	1-Post	40	2.784	0.421	0.067	2.039	78	0.045	0.190	0.093
	3-Pre	40	2.595	0.411	0.065					
H3	2A-Post	18	2.755	0.426	0.100	0.599	17	0.557	0.060	0.101
	2A-Pre	18	2.694	0.594	0.140					
H4	2A-Post	18	2.755	0.426	0.100	1.356	56	0.181	0.160	0.118
	3-Pre	40	2.595	0.411	0.065					
H5	2B-Post	20	2.808	0.407	0.091	1.904	58	0.062	0.214	0.112
	3-Pre	40	2.595	0.411	0.065					
H6	2B-Post	20	2.808	0.407	0.091	0.695	36	0.491	0.114	0.164
	2A-Pre	18	2.694	0.594	0.140					
Set 2 Averages										
H1	1-Post	40	2.747	0.519	0.082	0.945	56	0.348	0.145	0.153
	2A-Pre	18	2.602	0.587	0.138					
H2	1-Post	40	2.747	0.519	0.082	3.552	78	0.001	0.392	0.110
	3-Pre	40	2.355	0.466	0.074					
H3	2A-Post	18	2.708	0.440	0.104	0.932	17	0.364	0.106	0.114
	2A-Pre	18	2.602	0.587	0.138					
H4	2A-Post	18	2.708	0.440	0.104	2.715	56	0.009	0.353	0.130
	3-Pre	40	2.355	0.466	0.074					
H5	2B-Post	20	2.704	0.522	0.117	2.628	58	0.011	0.349	0.133
	3-Pre	40	2.355	0.466	0.074					
H6	2B-Post	20	2.704	0.522	0.117	0.569	36	0.573	0.102	0.180
	2A-Pre	18	2.602	0.587	0.138					

Table 3-3: Non-Equivalence Hypotheses (H1-H6) Continued

Group Statistics						Independent Samples Test				
Standards Overall Average						t-test for Equality of Means				
	Group	N	Mean	Std. Dev.	Std. Error	t	df	Sig.2-tailed	Mean Diff.	Std. Error
Set 3 Averages										
H1	1-Post	40	2.878	0.512	0.081	1.367	56	0.177	0.214	0.156
	2A-Pre	18	2.664	0.632	0.149					
H2	1-Post	40	2.878	0.512	0.081	2.602	78	0.011	0.294	0.113
	3-Pre	40	2.584	0.498	0.079					
H3	2A-Post	18	2.726	0.522	0.123	0.553	17	0.587	0.061	0.110
	2A-Pre	18	2.664	0.632	0.149					
H4	2A-Post	18	2.725	0.523	0.123	0.977	56	0.333	0.140	0.143
	3-Pre	40	2.584	0.498	0.079					
H5	2B-Post	20	2.831	0.458	0.102	1.859	58	0.068	0.247	0.133
	3-Pre	40	2.584	0.498	0.079					
H6	2B-Post	20	2.831	0.458	0.102	0.940	36	0.354	0.167	0.178
	2A-Pre	18	2.664	0.632	0.149					
Set 4 Averages										
H1	1-Post	40	2.859	0.438	0.069	1.836	56	0.072	0.246	0.134
	2A-Pre	18	2.613	0.542	0.128					
H2	1-Post	40	2.859	0.438	0.069	2.808	78	0.006	0.255	0.091
	3-Pre	40	2.604	0.372	0.059					
H3	2A-Post	18	2.7083	0.442	0.104	0.810	17	0.429	0.095	0.118
	2A-Pre	18	2.6128	0.542	0.128					
H4	2A-Post	18	2.708	0.442	0.104	0.935	56	0.354	0.105	0.112
	3-Pre	40	2.604	0.372	0.059					
H5	2B-Post	20	2.817	0.462	0.103	1.932	58	0.058	0.214	0.111
	3-Pre	40	2.604	0.372	0.059					
H6	2B-Post	20	2.817	0.462	0.103	1.255	36	0.218	0.204	0.163
	2A-Pre	18	2.613	0.542	0.128					

All 6 non-equivalent hypotheses indicate mean differences in the correct or predicted direction as indicated by mean differences that are all positive. Out of the 6 non-equivalence hypotheses examined at the Overall Level, H2 ($O1 > O5$) and H5 ($O4 > O5$) were significant at the .01 and .05 levels respectively therefore rejecting the null hypothesis for each. H1 ($O1 > O2$), H3 ($O3 > O2$), H4 ($O3 > O5$), and H6 ($O4 > O3$) did not demonstrate significant differences at the Overall level and I fail to reject the null

hypothesis for each of these hypotheses. It should be pointed out that half of these comparisons include O2. This circumstance will be the focus of the discussion and analysis later when the issue of 'status' is explored.

At the level of the sets, results are consistent with what is found overall. Hypotheses 2 and 5 indicated greater significant differences in mean scores than Hypotheses 1, 3, 4, and 6. For Hypothesis 2 ($O1 > O5$), Set I was significant at the .05 level while Sets II, III, and IV were all significant at the .01 level. For Hypothesis 5, significance was greatest for Set II at the .01 level while Sets I, III, and IV are only marginally significant at the .05 level. Set II was also found to be significant in Hypothesis 4 at the .01 level. Hypotheses 1, 3, and 6 demonstrated no significant differences in mean scores for any of the Sets. It should be noted once again that all three of these Hypotheses use O2 in their comparisons.

A closer examination of the Non-Equivalent Hypotheses reveals some important details summarized in Table 3-4. For example, in two hypotheses (H2 and H5) that were significant at the Overall level, the effect size is quite large at .66 for each. This means that the effect of the intervention of observed changes to assessed standards is equal to 66% of a standard deviation. In some educational research literature, an effect size of .15 is considered 'fair', making the documented effect size in these two hypotheses outstanding (Goldhaber, 2003). However, the magnitude of these results is tempered by the other four hypotheses that did not demonstrate difference.

Table 3-4: Results Summary for Non-Equivalent Hypotheses (H1-H6)

									$\alpha = .05$	Effect Size	Power	Mean Diff if Power is at least .50
Hypo.	Comparison	Type of t-test	Mean Diff	SE of Diff	t-value	df	No. of Tails	Sign.	Critical Value			
1	O1>O2	Indep.	0.170	0.138	1.229	56	1	0.112	1.673		0.331	0.231
2	O1>O5	Indep.	0.271	0.095	2.868	78	1	0.003	1.665	0.662		
3	O3>O2	Depend	0.082	0.094	0.867	17	1	0.199	1.740		0.202	0.164
4	O3>O5	Indep.	0.183	0.113	1.615	56	1	0.056	1.673		0.477	0.190
5	O4>O5	Indep.	0.253	0.110	2.291	58	1	0.013	1.672	0.658		
6	O4>O2	Indep.	0.151	0.160	0.944	36	1	0.176	1.688		0.233	0.270

As a group, the Non-Equivalent Hypotheses show a higher power than the Equivalent Hypotheses summarized in Table 3-2. Greater power indicates a higher probability of committing a Type II Error (i.e. not seeing differences when difference actually exist). Second, Hypothesis 4 is significant at the .10 level and only marginally significant at the .05 level with a significance of .056. This is important because Hypothesis 4 is the only non-significant hypothesis that does not include a Group 2 comparison. This observation adds credence to the notion that something may be wrong with observation number two (Group 2A-Pre).

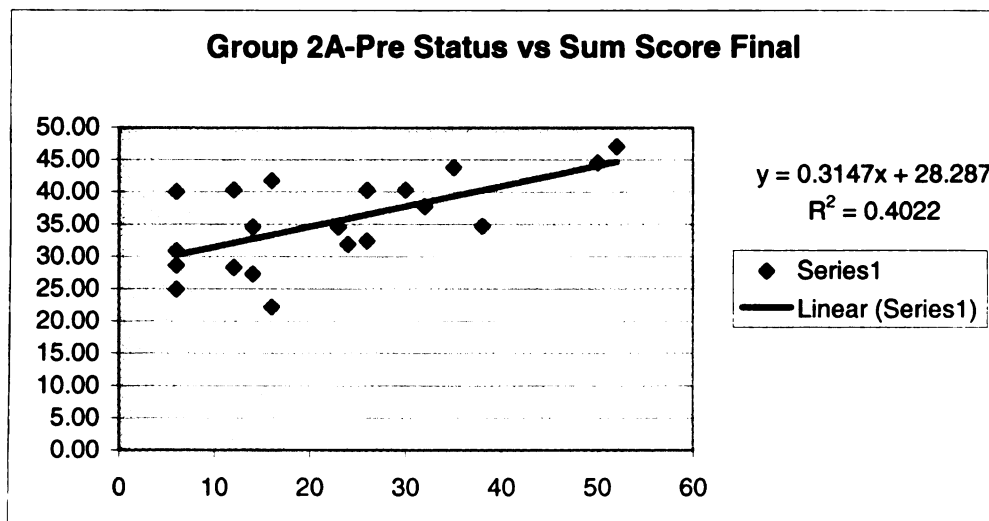
The remaining non-significant hypotheses (H1, H3, and H6) all involve the observation of Group 2A-Pre. Among these hypotheses, Hypothesis 3 is important because it is the only longitudinal measure in this study examining how Group 2A might change from pre-observation to post-observation. Why is it that the observations that include Group 2A-Pre do not show significant differences and those comparisons that do *not* include Group 2A-Pre demonstrate significance? There is reason to believe that something is not right with Group 2A-Pre. After considering the problems of recruitment

for Group 2A-Pre described in Chapter 2, I theorized that there might be a connection between the recruitment issue and the lack of difference observed. In other words, the unexpected status condition of participants in Group 2A-Pre may have had an influence on the quality of assessed scores. The following section discusses this possibility more fully.

Status Issue

If the problem of not collecting data in a ‘true’ pre-intervention condition is real and the intervention has an effect upon what the candidate knows as indicated by the assessed scores on the thirteen standards, then there might be a relationship between the amount of experience a candidate has with the intervention (status) and the observed scores for Group 2A-Pre. With this reasoning, I investigated the status issue as it might relate to observed scores in Group 2A-Pre (See Appendix G for a complete discussion of how status was calculated). The result was a moderate and positive correlation between amount of experience a candidate has with the intervention and the observed scores for that candidate. The correlation is presented in Figure 3-3.

Figure 3-3: Group 2A-Pre versus Final Sum Score



A Pearson Correlation (r) of .0.6342 (square root of R squared) was too strong to ignore. I decided to ask the question, “What might the data for Group 2A-Pre look like if data collection had taken place under ideal conditions (in an actual pre-intervention condition)? In other words, if a candidate’s status were reduced by a certain percentage, how would the significance change for a particular hypothesis? At what percentage of ‘status reduction’ does a particular hypothesis become significant at the .10 and .05 level? Answers to such questions would provide a way of comparing the relative strength of each hypothesis to the overall model and substantiate the claim that Group 2A was plagued by important data collection issues.

Before these questions can be addressed, there is another implication to the problem of pre-observation and Group 2A-Pre. If the status issue is real, it should also be a problem with the other pre-observation in Group 3. Therefore an identical analysis was performed on Group 3 to see if the status issue manifested itself there as well. Figure 3-4 illustrates the findings of this analysis. Figure 3-4 shows a positive correlation with a Pearson Coefficient (r) of 0.4961 indicating a fair relationship between status and score¹⁴, but not as strong as with Group 2A-Pre. This lower correlation might be explained by the size of N in Group 3 compared to Group 2A-Pre. Group 3 ($N = 40$) was more than double the size of Group 2A-Pre ($N = 18$). With evidence that a candidate’s status may have influenced the final sum of assessed scores, a regression analysis would provide some indication of the magnitude of the problem.

¹⁴ This correlation does not include 1 outlier who had a very high status, but one of the lowest scores. If this outlier is included, Pearson Correlation drops to 0.3461.

Figure 3-4: Group 3-Pre Status versus Final Sum Score

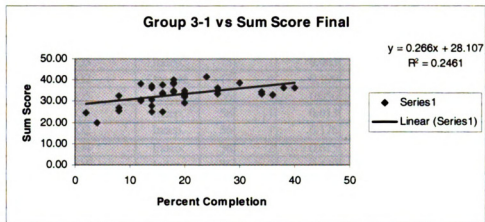


Table 3-5 presents the results from adjusting a candidate's status by a set percentage amount. What this means is that if data had been collected from each candidate with 15% or 30% less involvement with the intervention, then the changes to differences between means would be reflected in changes to the significance. In this regression analysis, the problematic 'pre' scores are extrapolated to what they might be if closer to a true 'pre' condition. This extension of data is intended to clarify meaning and explore the problematic nature of observation O2 (Group 2A-Pre).

At this point in the analysis, I want to know if the inconsistency of observed gains is due to a) an ineffective intervention or b) an unforeseen problem with data collection. The 'status' issue holds promise for explaining the observed results. The unexpected methodological problems encountered during the collection of data from the pre-groups, should not cloud the possible meaning of the results. Just as it would be unwise to conclude that the intervention had no observable effect because of a methodological issue, it would also be foolish to ignore the problems and irresponsible not to try and compensate for them.

Table 3-5: Analysis of Percent Reduction in Status and Resulting Change in Significance

Hypo.	Comparison	Type of t-test	df	No. of Tails	Sign.w/no status	Sign. 15% status	Sign. 30% status	Sign. 55% status
1	O1 > O2	Indep.	56	1	0.112	0.045	0.015	0.001
2	O1 > O5	Indep.	78	1	0.003	0.001	0.000	0.000
3	O3 > O2	Depend.	17	1	0.199	0.205	0.091	0.019
4	O3 > O5	Indep.	56	1	0.056	0.043	0.003	0.000
5	O4 > O5	Indep.	58	1	0.013	0.009	0.000	0.000
6	O4 > O2	Indep.	36	1	0.176	0.096	0.033	0.003
7	O3 = O4	Indep.	36	2	0.615	0.578	0.622	0.622
8	O2 = O5	Indep.	56	2	0.430	0.657	0.242	0.066
9	O3 = O1	Indep.	56	2	0.485	0.445	0.490	0.490
10	O4 = O1	Indep.	58	2	0.878	0.875	0.875	0.875

In Table 3-5, an analysis of percent reduction in status and the consequential change in significance is present for both the Non-Equivalent Hypotheses (H1-H6) and the Equivalent Hypotheses (H7-H10). The column ‘Sign.w/no status’ presents the results as discussed earlier in Table 3-4; Hypothesis 2 and 5 are significant at the .05 level and Hypothesis 4 is significant at the .10 level. With a 15% relative reduction to each subjects’ status, Hypothesis 1 and Hypothesis 4 becomes significant at the .05 level. Hypothesis 6 becomes significant at the .10 level. Only Hypothesis 3 remains insignificant. With a 30% hypothetical relative reduction in each subjects’ status, all hypotheses except Hypothesis 3, become significant at the .05 level. At the 30% reduction mark, Hypothesis 3 becomes significant at the .10 level. It is not until a hypothetical relative status reduction for each candidate of 55% that Hypothesis 3 becomes significant at the .05 level. At the 55% mark, all other hypotheses are significant at the .01 level.

These projected outcomes shine a light on the relative strengths and weaknesses of the non-equivalent hypotheses. It becomes apparent that after Hypotheses 2, 4, and 5; Hypotheses 1 and 6 are closest to significance. Each of these hypotheses compares

Group 2A-Pre (O2) with each of the other cohorts. With only a 15% reduction in status, 5/6 of the hypotheses become significant in supporting the rejection of the Null Hypothesis. Furthermore, this hypothetical analysis demonstrates and confirms the fact that Hypothesis 3 is the weakest of all becoming significant at the .10 level with a 30% relative reduction in status and not significant at the .05 level until a full 55% reduction in status is achieved.

These hypothetical results indicate that either a) collection of data was nominal and no change was observed in Group 2A pre to post or errors in data collection interfered with the accurate measurement of experienced gains by the candidates. Given the fact that minor (15%) adjustments in status greatly impact the significance of the Non-Equivalent Hypotheses (H1-H6), but produce little change in the Equivalent Hypotheses (H7-H10), provides a clue regarding Group 2A-Pre. Why does Hypothesis 3 ($O3 > O2$) act more like the Equivalent Hypotheses than the Non-Equivalent Hypotheses? Is the lack of difference observed in Group 2A due to an ineffective intervention or some procedural issue characteristic to only Group 2A? Since all five other Non-Equivalent Hypotheses behaved according to expectations, the most likely explanation points to a procedural error rather than a lack of effective treatment.

Since this exercise is focused on the overall final sum scores (averages) of each observation, I can assume that the changes in a more detailed analysis of sets of standards and individual standards would correspond accordingly. Therefore, since this hypothetical analysis was not used to substantiate the learning candidates may have demonstrated, but rather the strengths and weaknesses of the model and methodology, an

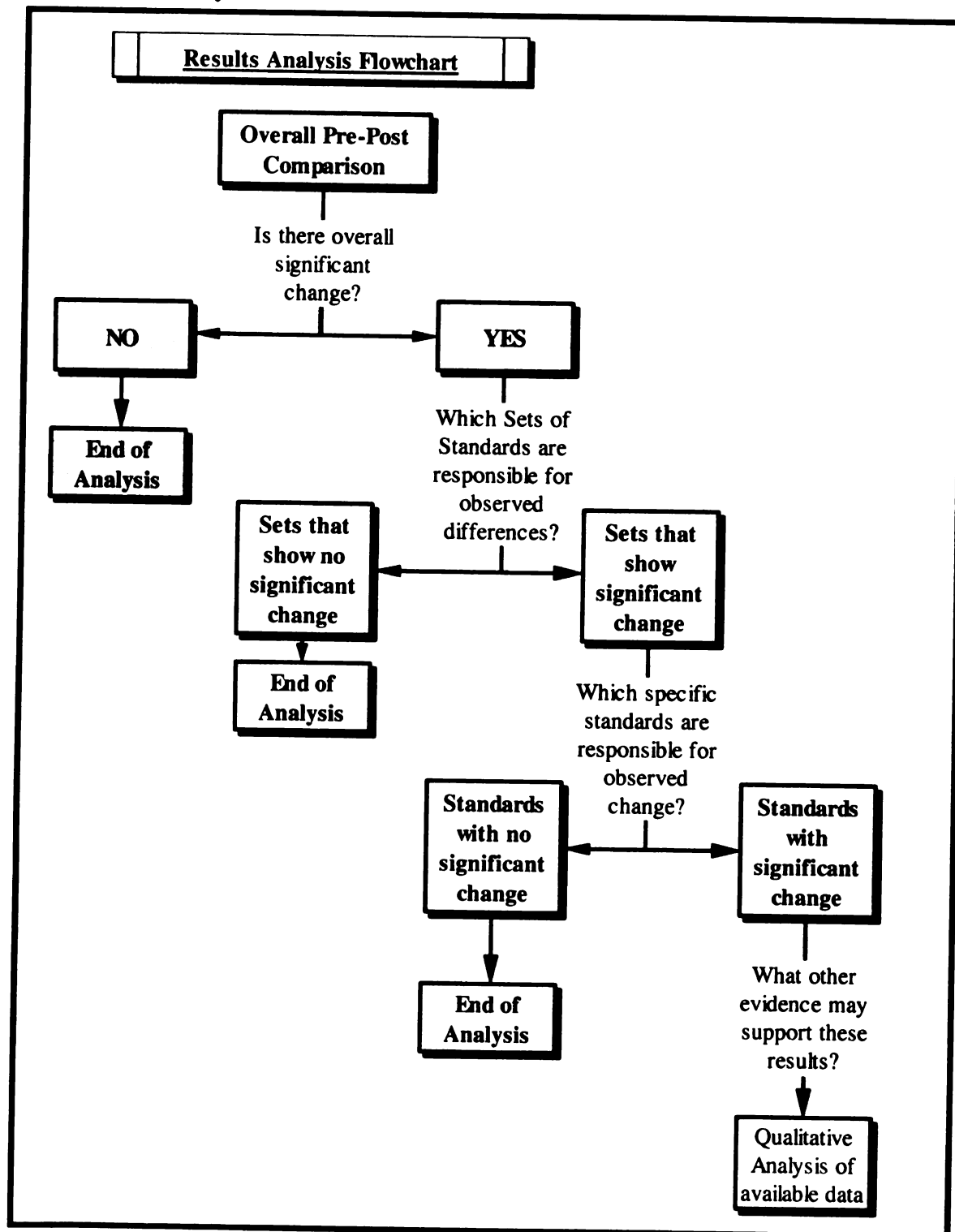
analysis of how this hypothetical status reduction might influence results at the sets or standards level will not be conducted.

A critic of this study could point to the lack of significant differences found in 4 out of the 6 Non-Equivalence Hypotheses and conclude that the intervention is ineffective in promoting teacher learning. To draw such a conclusion would be to deny other valid explanations and supporting evidence that suggest that the intervention does affect teacher learning. To ignore the status issue would be irresponsible on my part as Principal Investigator. To fully understand and explain the observed results, all possible explanations need to be explored. Status as an unforeseen procedural problem remains an important issue, but one that should not impede the process of identifying possible learning outcomes that teachers may be experiencing from National Board certification. Turning to the results of the Overall Hypothesis next, it will be important to remember the role status may have played in diminishing observed differences.

Results of the Combined Hypothesis

The Flowchart for analyzing the results of the Combined Hypothesis is presented in Figure 3-5 which provides a branching schematic for the decision making process associated with this hypothesis. In this approach, testing continues only when significant differences are identified at the Overall, Sets, and then the Standards levels of analysis.

Figure 3-5. Analysis Flowchart



The Recurrent Institutional Cycle Design for this study yielded a total of five observations. Table 3-6 presents the descriptive statistics for the Combined Hypothesis using four out of the five observations, pooling data from all 118 participants.¹⁵ All data sets except for O3 (Group 2A-Post) are included in this comparison. Throughout this analysis, one-tailed contrast t-tests were used to determine significance.¹⁶

Table 3-6: Descriptive Statistics for all Groups in the Combined Hypothesis

Group	Obs.	N	Mean	Std. Deviation	Std. Error	95% Confidence		Min.	Max.
						Lower Bound	Upper Bound		
Group 1	1 (post)	40	2.811	0.453	0.072	2.666	2.956	1.654	3.692
Group 2 A	2 (pre)	18	2.641	0.559	0.132	2.363	2.919	1.702	3.615
Group 2 B	4 (post)	20	2.792	0.425	0.095	2.593	2.991	2.038	3.644
Group 3	5 (pre)	40	2.540	0.391	0.062	2.415	2.665	1.538	3.192
Total		118	2.690	0.457	0.042	2.607	2.773	1.538	3.692

This study asked, “Does National Board certification promote learning in teachers participating in the process?” If so, the post-observations would be greater than pre-observations. Table 3-7 provides the results. There are 114 degrees of freedom indicating every participating teacher in the study was taken into account for this comparison. The value of the contrast has a *p* value of 0.009, which is significant at an alpha level of 0.05. The corresponding effect size of this observed difference is 0.473 or 47 percent of a standard deviation, which is a relatively strong indication that there are meaningful differences between pre and post group scores.

¹⁵ In Group 2A, one more subject than anticipated dropped out of the certification process (I anticipated six dropping out of the certification process and the study, but the actual number was seven) and technical problems with the tape recorder during one interview allowed for only 18 usable pre-post comparisons.

¹⁶ T-tests were used to compare two post groups with 2 pre groups. ANOVA analysis that compares the four groups without consideration of pairings produces similar if not less significant results. The same three standards found significant from the t-tests remain significant in the ANOVA analysis at the .05 level. Since the comparison is between pairs of groups and not four groups independent from each other, the contrasting paired t-test is most appropriate.

Table 3-7: Test of Significance at Overall Level for the Combined Hypothesis

Standard	Value of Contrast	Std. Error	t	df	Sig. (1-tailed)	Effect Size
Overall	0.423	0.176	2.400	114	0.009	0.473

Because a significant change from pre to post was identified in the overall comparison, I can look more closely at the level of standards to pinpoint more specifically what teachers may have learned from the certification process. Four sets of standards for AYA Science require four separate t-tests for analysis with the same data sets, so it becomes necessary to employ an adjustment procedure that takes into account the use of multiple t-tests, which increases the likelihood of committing a Type I error. To address this concern, a Bonferroni adjustment procedure was employed. This conservative adjustment reduces the risk of a family-wise error, while still allowing for the identification of observed differences (Yip, 2002). Because I wished to maintain a 0.05 alpha level for each of the four tests, significance was determined at an alpha level of 0.0125.

At this level, as Table 3-8 reveals, the contrasts for Set II (Advancing Student Learning) and Set IV (Supporting Teaching and Student Learning) were both found to be significant at $p = 0.008$ and $p = 0.005$ respectively. Set III (Establishing a Favorable Context for Student Learning) was found to be marginally significant at $p = 0.013$. Set II and Set IV had effect sizes of 0.482 and 0.524 respectively indicating the main areas of observed learning. Because significant differences were identified in three out of the four sets, I can examine each of these three set of standards more closely to identify the specific standards that may be responsible for the observed learning.

**Table 3-8: Test of Significance at the Sets of Standards Level
for the Combined Hypothesis**

Set	Value of Contrast	Std. Error	t	df	Sig. (1-tailed)	Effect Size
I. Preparing the Way for Productive Student Learning	0.304	0.176	1.727	114	0.043	0.341
II. Advancing Student Learning	0.494	0.202	2.442	114	0.008	0.482
III. Establishing Favorable Context for Student Learning	0.461	0.204	2.253	114	0.013	0.444
IV. Supporting Teaching and Ss Learning	0.459	0.173	2.656	114	0.005	0.524

Sets II, III, and IV have a total of 10 standards requiring 10 t-tests. Once again, a Bonferroni Adjustment procedure was used to reduce the chances of a Type I error due to repeated use of the test. Again, to maintain an overall alpha level of 0.05, the significance for each test was set at $\alpha = 0.005$. At this level, two standards are significant and two are marginal as shown in Table 3-9. *Scientific Inquiry* from Set II and *Assessment* from Set IV are significant at 0.001 and 0.002 with effect sizes of 0.606 and 0.596 respectively. The two standards that were marginally significant included *Goals and Conceptual Understanding* from Set II and *Reflection* from Set IV at $\alpha = 0.009$ and 0.007 respectively. Though marginally significant at the level of the Set, Set III did not have any standards significant at the 0.005 level.

**Table 3-9: Test of Significance at Individual Standard Level
for the Combined Hypothesis**

Set	Standard	Value of Contrast	Std. Error	t	df	Sig. (1-tailed)	Effect Size
II. Advancing Student Learning	Science Inquiry	0.667	0.217	3.073	114	0.001	0.606
	Goals and Conceptual Understanding	0.494	0.206	2.392	114	0.009	0.472
	Contexts of Science	0.321	0.279	1.151	114	0.126	
III. Establishing Favorable Context for Student Learning	Engagement	0.477	0.208	2.294	114	0.012	0.452
	Equitable Participation	0.448	0.242	1.851	114	0.033	0.365
	Learning Environment	0.457	0.223	2.049	114	0.021	0.404
IV. Supporting Teaching and Student Learning	Family and Community Outreach	0.174	0.217	0.803	114	0.212	
	Assessment	0.647	0.214	3.022	114	0.002	0.596
	Reflection	0.607	0.241	2.515	114	0.007	0.496
	Collegiality and Leadership	0.409	0.180	2.276	114	0.012	0.449

Confounding Variables

What might account for the observed differences at the overall, sets, and standards levels of analysis? Are the gains observed in this study due to the intervention or something else? What percent of the observed variance can be attributed to possible covariates? To answer these questions, an analysis of covariance (ANCOVA) was conducted using potential confounding factors. Co-variates included gender, years of experience, class size, student type, school context, and geographic region. The results of this analysis are presented in Table 3-10.

In this ANCOVA, only “Student Type” is a significant covariate and possible confounding variable at the 0.05 level, $p = 0.026$. The teacher’s gender, years of experience, class size, school context, and geographic region did not co-vary with the observed gains in assessed scores. So, is ‘Student Type’ a viable alternative for explaining observed results?

Table 3-10 Analysis of Covariance

Source of Variations	Degrees of Freedom		Sum of Squares		Mean Square		F Value		Pr > F	
Model	14		5.39		0.38		2.12		0.0167	
Cohort Group		3		1.78		0.59		3.26		0.0245
<i>Pre-Post Comparison</i>		1		0.65		0.65		3.59		0.061
Gender of Teacher		1		0.27		0.27		1.49		0.2256
Years Experience		1		0.00		0.00		0.01		0.9391
Class Size		1		0.04		0.04		0.24		0.622
Student Type		3		1.75		0.58		3.21		0.0261
School Context		2		0.52		0.26		1.42		0.2473
Region		3		1.03		0.34		1.88		0.1378
Error	101		18.36		0.18					
Corrected Total	115		23.75							
R-Square	0.2269									

‘Student Type’ is not derived from an independent outside measure such as a standardized test or formal cognitive assessment. Rather, it is the self-reported opinion of the teacher. As part of the introduction to the interview, each candidate was asked, “How would you generally describe your students?” Teachers then went on to describe their students in quite general terms (i.e. low, below average, average, above average, high, varied, or mixed.). These responses were then coded into one of 4 possible categories: Low, Average, High, or Varied. Therefore, what is really being examined in ‘Student Type’ is the teacher’s perception of their students’ general ability.

What is interesting is that those teachers who tended to describe their students abilities in the high end of the range, received higher assessment scores in this study. This trend was consistent in data collected before the intervention with the pre-groups and after the intervention with the post-groups as demonstrated in Figure 3-6.

Actual student ability may have nothing to do with this observed relationship. Rather, higher scores in this study may be related to a teacher’s high expectations of their students’ abilities. Those teachers who had low expectations of their students’ abilities scored lower. Table 3-11 examines the estimated mean ratings between group and

students' abilities. Those teachers who had low expectations of their students' abilities scored lower. Table 3-11 examines the estimated mean ratings between group and student type. It seems unlikely that the differences from pre to post are caused by or the result of 'Student Type', but rather the teachers' self reported data about Student Type may be a good indicator regarding which teachers will tend to score higher (both pre and post) in this research study.

Figure 3-6: Estimated Means Ratings (Scores) by Student Type

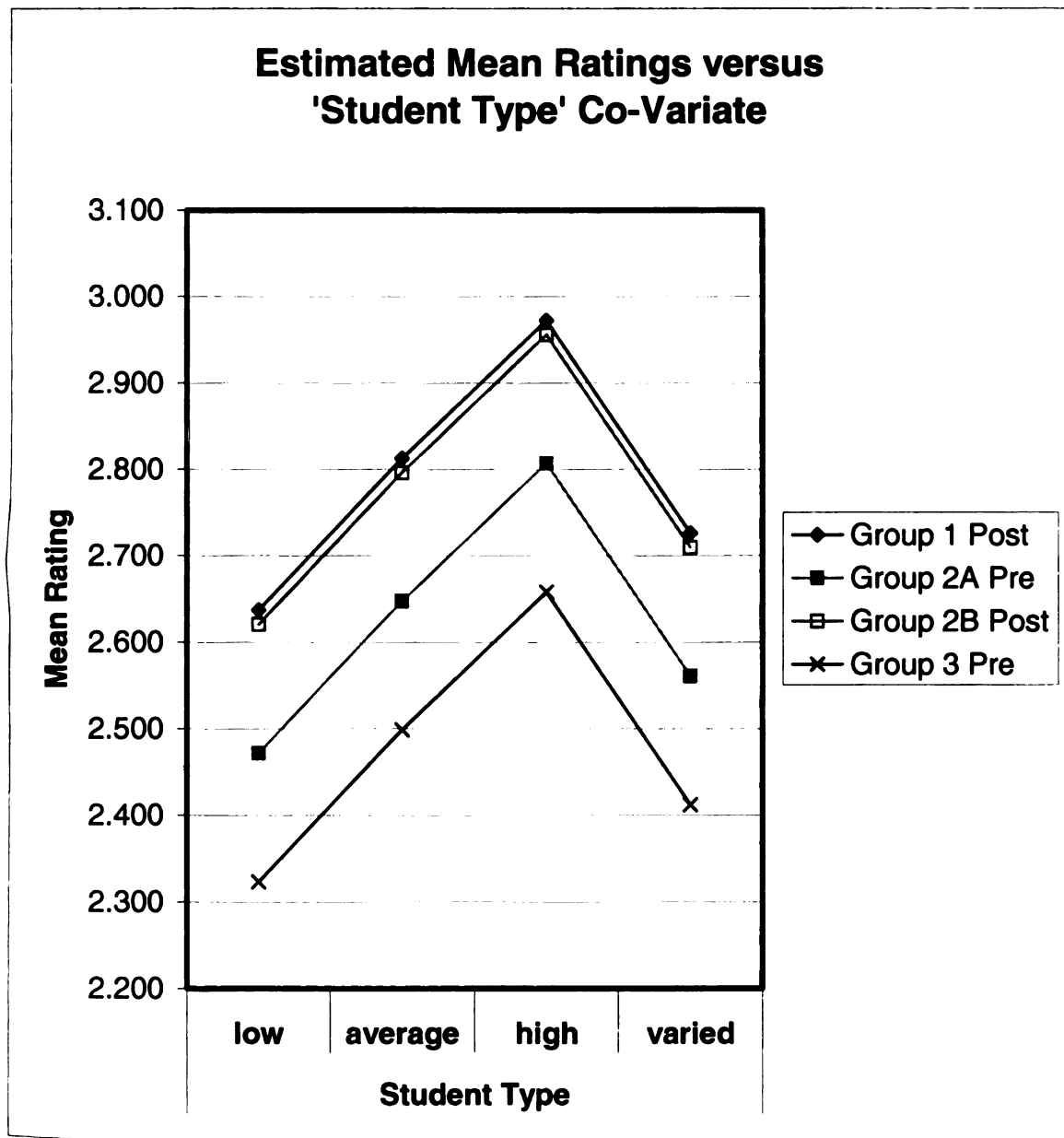


Table 3-11: Estimated Means using Student Type & Group

Group	Student Type			
	1 (Low)	2 (Average)	3 (High)	4 (Varied)
1-Post	2.637	2.813	2.972	2.726
2A-Pre	2.472	2.647	2.807	2.561
2B-Post	2.620	2.796	2.956	2.709
3-Pre	2.323	2.498	2.658	2.412

In Figure 3-6, the consistency of results is very interesting. Not only do the post groups score higher than the pre groups, but those teachers who indicated that their students were a mix of abilities or varied in ability, scored close to those who identified their students as average. This is an observation worthy of future study. In Figure 3-6, the two post groups (1-Post and 2B-Post) are nearly identical. The two pre groups (2A-Pre and 3-Pre) are less than the post, but also different from each other. Group 2A-Pre stands out as unique being higher than the pre group, but lower than the post. This is further support of the notion that the status of Group 2A-Pre may have had a negative influence upon the results.

Summary

In Chapter 3, the results of analyzing the data were presented. Table 3-12 summarizes each group's overall mean score, standard deviation, and variance. In this table, the post means are higher than the pre means. For Group 2A, the mean difference between post and pre observations is (0.08). In Table 3-13, the results from the Non-Equivalent Hypotheses (H1-H6), the Equivalent Hypotheses (H7-H10), and the Combined Hypothesis are presented. The overall analysis of the Combined Hypothesis indicates that significant gains were observed from pre to post in the study population. Upon closer examination, these gains can be narrowed down to Sets of standards II, III,

Table 3-12 Summary of Group Overall Mean Scores

Group	Obs	N	Mean	Std. Dev.	Var
1-Post	O1	38	2.82	0.460	0.212
2A-Pre	O2	18	2.64	0.559	0.313
2A-Post	O3	18	2.72	0.418	0.174
2B-Post	O4	20	2.79	0.425	0.181
3-Pre	O5	40	2.54	0.391	0.153
2A	O3-O2	18	0.08	0.400	0.160

Table 3-13 Summary of Hypothesis Testing

										a =		
										0.05		
Hypothesis	Comparison	Type of t-test	Mean Diff.	SE of Diff.	t-value	df	No. of Tails	Sign.	Critical Value	Effect Size	Power	Mean Diff. if Power is at least .50
1	O1 > O2	Indep.	0.18	0.141	1.273	54	1	0.112	1.674		0.35	0.236
2	O1 > O5	Indep.	0.281	0.097	2.912	76	1	0.003*	1.665	0.662	0.89	0.161
3	O3 > O2	Depend.	0.082	0.094	0.867	17	1	0.199	1.74		0.2	0.164
4	O3 > O5	Indep.	0.183	0.113	1.615	56	1	0.056***	1.673		0.48	0.19
5	O4 > O5	Indep.	0.253	0.11	2.291	58	1	0.013**	1.672	0.658	0.73	0.184
6	O4 > O2	Indep.	0.151	0.16	0.944	36	1	0.176	1.688		0.23	0.27
7	O3 = O4	Indep.	-0.07	0.137	0.508	36	2	0.615	2.028		0.07	0.278
8	O2 = O5	Indep.	0.101	0.127	0.795	56	2	0.43	2.003		0.12	0.255
9	O3 = O1	Indep.	-0.098	0.128	0.767	54	2	0.485	2.005		0.11	0.257
10	O4 = O1	Indep.	-0.029	0.124	0.23	56	2	0.878	2.003		0.04	0.248
Comb.	O1+O4 > O2+O5	Contrast	0.432	0.176	2.4	114	1	0.009*	1.658	0.473	0.77	0.292

* Significant at the .01 level

** Significant at the .05 level

*** Significant at the .10 level

and IV. Applying a Bonferroni adjustment to control for error, Standard IV (*Scientific Inquiry*) and Standard XI (*Assessment*) demonstrated significance at the .0125 level. In addition, this chapter also provided a detailed analysis of each of the 6 non-equivalent hypotheses and each of the 4 equivalent hypotheses. The results of these analyses indicate that Hypotheses 2 and 5 were most consistent in their presentation of significant gains. With the use of regression analysis, a hypothetical relative status reduction for each candidate and their inferred change in score, demonstrated that Hypotheses 1, 4, and 6 would likely become significant had data been collected 15% sooner in the Pre-Groups. Hypothesis 3 requiring a 55% reduction before becoming significant at the .05 level revealed the weakest comparison involving Observation 3 (Group 2A-Pre). This is strong evidence that something is eschewed with Group 2A-Pre. Finally, an ANCOVA of possible confounding variables revealed that only 'Student Type' was a significant covariate. In Chapter 4, I will present the qualitative evidence from this study and discuss why these results make sense and provide possible explanations for their meaning. I will also connect specific aspects of the certification process to the observed learning outcomes.

CHAPTER 4: QUALITATIVE RESULTS

With every mistake, we must surely be learning.

-George Harrison "While My Guitar Gently Weeps"

Overview

The qualitative evidence from this study will be examined and discussed in Chapter 4. Chapter 3 revealed specific areas of observed gain from pre to post from a quantitative perspective. However, those gains remain only numbers on a page, until an accurate explanation can address a series of key questions. Do the teacher's comments about Board certification coincide with observed learning outcomes? How can these examples of learning be understood in the context of National Board certification? What specific resources for learning arise from the certification experience?

The goal of this study was try and assess teacher learning by quantitatively comparing pre and post scores on 13 standards of accomplished teaching as defined by NBPTS. The assumption for this approach was that changes in observed pre to post scores for a particular standard could then be inferred to represent the candidate's 'learning' or change in understanding associated with the specified domain. In this section, the three standards that demonstrated the most improvement as determined by the assessment process will be discussed. Namely, *Scientific Inquiry*, *Assessment*, and *Reflection*.¹⁷ Do these learning outcomes make sense in the context of the National Board certification process? How can these examples of learning best be described and explained? To answer these questions, qualitative data collected during the interview with each candidate will be

¹⁷ Though only marginally significant, *Reflection* is included in this analysis for two reasons. First, reflection is pervasive and central to the National Board certification process. Second, teachers in this study commented on 'reflection more than any other standard.

used to contextualize and enrich the discussion. It is therefore important to understand the genesis of this qualitative data.

Qualitative Data

Many candidates, who graciously accepted an invitation to participate in this study, incorrectly assumed that the ‘conversation’ with the interviewer would serve as a sounding board to voice their opinions and ideas about the certification process. The official letters of contact with the candidates (See Appendix I) never indicated or implied that National Board certification would be the focus of the interview. Rather, the letter stated that the conversation would be based upon their “ideas and experiences related to teaching and learning”. Still, many teachers indicated that they wanted to discuss their specific experiences with the process; especially those teachers in the post-groups.¹⁸

In addition to collecting the necessary information to assess learning on the 13 standards of accomplished teaching in Adolescent and Young Adult Science by way of the structured interview, I was also keen on finding out what these teachers thought of their experience. The question of how best to do this without contaminating or biasing the data one way or the other remained an issue. When would be the optimal opportunity to inquiry with candidates about their experiences? What questions should be asked?

Since the requirements for National Board never ask for candidates opinions on the process, the questions needed to be separate from the other protocols so that it could be easily isolated and removed during transcript processing. It also needed to be towards the end of the interview so that nearly all data could be collected without the interviewer or assessor knowing what the candidate might think about the actual process. Therefore,

¹⁸ To prevent speculative type responses from teachers in the pre-intervention groups being included in this analysis, only evidence from post intervention interviews were considered for this aspect of the discussion.

imbedded deep in the first list of professional development experiences of Scenario 5, 'National Board certification' is listed as the second to last item.

In this part of the interview, teachers were presented with a list of 15 professional development experiences (See Appendix B for details). They were asked to indicate those items with which they had direct experience. Then, they were to rate each item they checked on a 1-5 scale regarding how well the experience helped them "improve their ability to bring about learning in their students'. Since they had all completed the certification process, 'National Board certification' was checked and rated by every teacher. At the time of response, no questions were asked about specific items in this list or reasons for rating. However, after each table was completed, candidates were asked, "Is there anything in particular missing from this list that you found especially helpful in improving your ability to bring about learning in your student?" When both tables (the professional development history and family and community outreach) and follow-up questions were complete, candidates were asked: "From these two tables, which one item do you think was most helpful in improving your ability to bring about learning in your students?"

In response to this question, teachers contemplated both lists and then responded with their choice and the reasoning behind it. If the teacher chose 'National Board certification', then response complete with explanation remained in the transcript, as evidence to be considered by assessors and no further inquiries were required by the interviewer. However, if they chose an item another other than National Board certification, then at the conclusion of their response they were asked about their certification experience. More specifically, they were asked, "By the way, could you talk

a little bit about why you rated National Board certification a _____?” The blank was filled in with whatever ranking on the 1-5 scale they chose. The candidates responded with an explanation that provided detailed evidence regarding their overall experiences, positive aspects, and/or problematic aspects. The candidate comments from this section of the interview are the source of the qualitative data used in this part of the discussion.

From Figures 4-1 and 4-2, it is clear that the number of candidates’ comments regarding specific standards correspond with the actual observed results. The standards that demonstrate the most gain (Scientific 4: *Scientific Inquiry*, Standard 11: *Assessment*, and Standard 12: *Reflection*) also resulted in the most qualitative responses for those same areas. This agreement between the quantitative and qualitative data streams provides further support for the validity of observed learning outcomes. What topics teachers chose to share regarding Board certification map nicely onto the areas of observed gains. In the discussion that follows, each of these three observations will be explored and explained, and understood in the context of learning resources available through the certification process.

Figure 4-1: Number of Comments Corresponding Directly with Standards

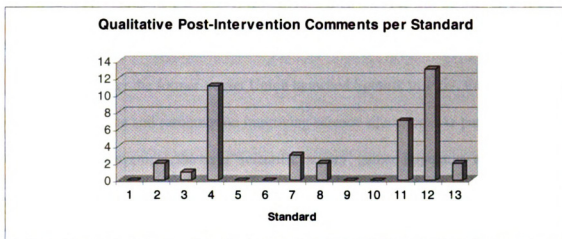
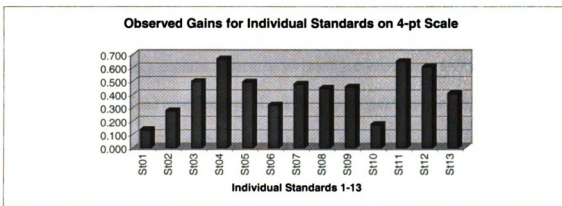


Figure 4-2: Observed Gains for Individual Standards on a 4-pt Scale



Standards with Significant Observed Gains

Standard 4, (*Scientific Inquiry*) demonstrated the greatest gain from pre to post with an effect size of 0.606 or nearly 61% of a standard deviation. Of all 13 standards measured, this represented the greatest amount of improvement from pre to post observations. The second more significant gain was found in Standard 11 (*Assessment*) with an effect size of 0.596 or nearly 60% of a standard deviation. Finally, the third largest observed gain was in Standard 12 (*Reflection*) with an effect size of 0.496 or

nearly 50% of a standard deviation. The following discussion will examine each of these outcomes and how they make sense in the context of National Board certification.

Scientific Inquiry: Evidence for Learning

Shortly after the former Soviet Union launched Sputnik in 1957, the United States began focusing time and resources on improving science education. As part of that science literacy movement, the term ‘scientific inquiry’ gained popularity as the new way to teach science. Its meaning as a pedagogical strategy has continually changed and continues to evolve. One of the first promoters of this new approach was Joseph Schwab. Schwab (1962) described ‘scientific inquiry’ as a mode of science education that would more accurately reflect the scientific process. He emphasized scientific inquiry not as habits of mind in students, but ‘as a mode of teaching’ (ISP, 2004). In this view, the teacher when presenting material in lectures or reading content from textbooks would model the habits of mind involved with scientific inquiry, such as questioning, analyzing, and evidence gathering. Rather than just disseminate scientific facts and concepts to receptive students, this view of science education stressed that students learn how to ask questions, challenge assumptions, and seek validity to perceived truths (Deboer, 1991). In the 40 years since its introduction, scientific inquiry has developed an array of labels and catch phrases, such as discovery learning, hands on activities, exploration, teaching by problem solving, and inductive methodologies (ISP, 2004). Most importantly, it has expanded to not only refer to how a teacher should teach, but how a student should learn science.

National Board’s definition of scientific inquiry can trace its roots to Schwab’s earlier conception of teaching science as analysis. For National Board, Scientific Inquiry

serves both as the means and the ends of a teaching-learning process. In the extended discussion of the standard, the Board states:

It is not a basic goal of science instruction to fill students with as much information as possible; rather, it is to help students acquire the mental operations, habits of mind, and attitudes that characterize the process of scientific inquiry --- that is, to teach them how scientists question, think, and reason. (NBPTS, 1997, p31)

According to the standard, the best way for teachers to reach this goal successfully is have students take on an “active role” in their learning by arranging frequent opportunities for “hands on” science activities and “open-ended investigations” complete with post activity time for reflection and analysis of results. Teachers’ understanding of teaching with scientific inquiry is reflected in the types of choices and decisions made during their planning, lesson management, and assessment techniques. Teachers choose age and skill level appropriate classroom activities that are as much ‘minds on’ as they are ‘hands on’. Other indications that a teacher effectively employs scientific inquiry in the classroom pertain to questioning style, wait time after asking a question, discussion management, and an acceptance of the ‘unpredictable consequences of an activity and student-centered pedagogy” (NBPTS, 1997, p. 32).

Though the definition of scientific inquiry may be broad and have different meanings to different teachers, the National Board defines it with specific characteristics and observable qualities. A literal laundry list of skills, dispositions, habits of mind, and pedagogical approaches characterize a teacher who knows and is able to use this approach effectively in the science classroom. Therefore, if assessment in this study finds improved scores from pre to post, I might assume that teachers are learning to more

closely align their practice with this conception of scientific inquiry and teaching. Does the evidence support this assumption?

For those teachers who commented on the scientific inquiry aspect of certification as a significant area of learning, it is apparent that the National Board's version of 'scientific inquiry' was a new approach to teaching science. For example, when Sharon, a teacher from Wyoming, was asked what she learned from the certification process, her response expresses a recurring theme among many candidates.¹⁹ She said:

I would point as an example to the increased use of inquiry within my classroom. I think that that has had, you know, some strong benefits in terms of helping students to think about what science is. And science is a process and not just a memorization of facts and spew them back out at the teacher. And I do think that doing the National Boards has helped me to incorporate that more into the classroom. (Group 2A-Post, Teacher #12)

Sharon from Group 2A-Post articulates precisely the spirit of what National Board's conception of scientific inquiry is all about. It describes a learning environment where the teacher is not the sole authority on content knowledge and student centered active learning results in the learners constructing their own understanding of natural phenomenon. Seeing value in this approach, the teacher points to an 'increased use' of this approach presumably because of 'strong benefits' to student learning. Finally, this teacher describes how a scientific inquiry approach helps students understand not only the content of science, but also the process of science as a valid and important goal.

For other teachers, the certification experience motivated them to incorporate more scientific inquiry into their classroom instruction. For example, Mike, another teacher from Wyoming, states:

¹⁹ To protect each person's identity, all of the teachers' names in this discussion are pseudonyms.

[The] National Board is making me look at how much scientific inquiry I'm doing where the students are actually doing the inquiry versus me just regurgitating. (Group 2B, Teacher #32)

By doing more inquiry-based lessons, Mike came to an understanding that there is a clear distinction between teacher-centered lectured-based instruction and student-centered activity-oriented learning. Rather than simply 'regurgitating' information, scientific inquiry allowed students to have more of a participatory role in the learning process.

For both of these teachers, National Board certification allowed them to revisit, rethink, and try again a process that they were already familiar with using in the science classroom. However, for some teachers, scientific inquiry represented a whole new way to teach. In attempting to fulfill the requirements of the portfolio, they were 'forced' to try and teach according to a scientific inquiry method. For example, Susan, a teacher from Arkansas, comments:

I had a real tough time coming up with and dealing with the inquiry base process. And I found out that other science teachers that had gone through the National Board certification – some who got it and some who didn't – had a tough time with that. It's very difficult to not want to jump in and help the kids. And to see them sort of struggling and kind of thinking what they needed to do type thing. And even though, you know, I would – I had to be very careful with my questions so that they would think of what they had to do next without me giving them an idea as to what to do. (Group 2A-Post, Teacher #17)

Susan is describing her experience with trying to teach in a new way. The efforts were difficult and went against her existing tendencies and habits of mind. This teacher needed to be much more self-conscious regarding how she asked students questions and how her responses to students were formulated. For an experienced teacher with well-rehearsed scripts for interacting with students, the standards for scientific inquiry proved to be a difficult challenge, but probably a powerful learning experience.

One reason why scientific inquiry proved to be a arduous task for some teachers, may pertain to the perceived change in the teachers role as classroom authority—the adult present in who needs to control what happens and when. This idea manifests itself by how teachers described their handling of unexpected consequences or events that happened during a lesson. For example, Condoleeza from California said:

I noticed that there was almost as much learning going on from students making mistakes as students doing the right thing. Whereas before I had done that – kind of stepped away and allowed students to pursue inquiry truly at their level – their own experiments – their own ideas of what would happen – their own analysis – and peer discussion of what was happening in their experiment. I tried to control the situation and make sure that the students would get the right outcome. (Group 1 Teacher #40)

For Condoleeza, the requirements of National Board certification forced her to relinquish control over the learning process and encourage students to take on more responsibility in developing their own investigations, predictions, and group explanations for observations. ‘Making mistakes’ becomes an aspect of the ‘right thing’ in teaching science rather than a dreaded deviation from the anticipated path of the classroom lesson. Prior to certification, this teacher was strongly focused on students getting the ‘right outcome’. As a result of certification, she now has an appreciation for the means by which students look for answers just as she does for the answer itself. Rather than be completely motivated by the students acquisition of content, this teacher now expresses a value for the student’s role in defining what content is learned and by what means.

Condoleeza continues by saying:

Instead of being so controlled in making sure that the students gained all the content. It [National Board certification] forced me to step back and have a more student-centered environment. (Group 1 Teacher #40)

Some might argue that ‘making sure the students gained all the content’ is a good thing and that the steps this teacher has taken has weakened her effectiveness rather than strengthened it. However, by adapting scientific inquiry as required by the National Board, may not replace the goal of content learning, but rather, it may support and enrich the endeavor for students and the teacher.

One possible reason that scientific inquiry provides a strong learning experience for the teachers pertains to the consequences of giving up control over the information flow during class. For those teachers new to the pedagogical approach, moving to a more ‘student-centered environment’ is synonymous with relinquishing control to particular aspects of classroom management. However, once the apprehension is overcome for those teachers, many times they experience unexpected consequences that become productive ‘teachable moments’. For example, Michael from Wyoming described a situation where he was working with a group of students who appeared to be stumped by the results of a procedure. The group’s troubles caused him to pause before engaging them with questions. Where the inclination was to explain and resolve their impasse, Michael suggests, “Let’s take another look at this.” He then describes what might happen as a result of this comment:

Hopefully something would be sparked in some body’s brain that would propel the group in the right direction. (Group 2B, Teacher #32)

This teacher has made a conscious effort to place more control over the learning process in the hands (and minds) of the students in the group. The results from this decision are known with less certainty than if they were just told the answer. But even with increased uncertainty, Michael sees enough benefits to continue with this process. Rather than rely on predetermined ‘cookbook’ laboratories, he says:

I'm gearing more of my labs towards that [open ended investigations] if it lends itself to the content. So that way the students take more of a self-discovery approach rather than a cookbook type lab. I'm avoiding the cookbook type labs. (Group 2B, Teacher #32)

Scientific Inquiry was observed in this study to be the standard of greatest improvement from pre to post observation. For those teachers who commented upon this aspect of the certification process as significant to their learning, several reasons emerge. Scientific Inquiry for some was a new experience that once tried resulted in some positive effects in the classroom. Scientific inquiry was difficult for some teachers because it required a change in the position of the teacher as the single authority in the classroom. Finally, by giving more responsibility to students for their own learning, teachers experienced unexpected situations, which gave rise to productive teaching and learning opportunities. How those teachers determined whether a moment was productive or not pertains directly to how a teacher assesses student understanding. It is towards the *Assessment* that the discussion turns next.

Assessment: Evidence for Learning

Assessment in educational circles has a wide range of meanings. From standardized tests that provide a particular view of what a student or students may or may not understand to more immediate and classroom based practices. It is this later categorization that is most applicable to this study. Assessment in this sense (commonly referred to as embedded, formative, continuous, or classroom-based assessment) is defined as the process of gathering information and then evaluating students' ideas and reasoning about the particular subject matter being taught. The results from this process are then used to inform instructional decisions (Gallagher, 2000). Effective assessment relies heavily on a teacher's strong understanding of content. The National Board's

agrees with this definition of 'Assessment'. In their detailed discussion of Standard 11: *Assessment*, the National Board defines it as "the process of using formal and informal methods of data-gathering to determine students' growing scientific literacy, understanding, and appreciation" (NBPTS, 1997, p. 45).

Evidence in support of learning related to *Assessment* in this study is substantial. The theme throughout this evidence pertains to the National Board's repeated requirement of focused, detailed, and extensive review of evidence around student learning. For many teachers, this is a new practice. Many are accustomed to a traditional 'teach and test' mentality that results assessment practices that focus only on factual recall ability. Through the efforts to construct a meaningful portfolio, issues of student assessment are explored in rich detail. The process "made" Kate, a teacher from California, think about her lessons "in more detail and think about assessment" (Group 2A-Post, Teacher #2). Another teacher, Karen from Kentucky, expands upon this theme by saying:

Well, like I used to just grade a test. You know based on how the grades were on the test that would kind of be my indication of if the kids learned or not. And now, I just see that there's all types of assessment and that that how a student does on your test is going to have an influence on your teaching and how you instruct. You know I never looked at that as a tool for changing my instruction. (Group 1, Teacher #9)

Karen expresses a deeper understanding and appreciation for assessment that did not exist prior to the certification process. The practice of teaching is enriched by assessment, not plagued by it. Assessment becomes a tool for improving student learning instead of a requirement at a unit's end.

Another effect of the detailed assessment requirements of National Board caused Karen to change her view of students in the learning process. She continues by saying:

I realized that you really need to look at a student's individual needs and style – you know like for a long time I taught just college bound kids and you kind of think that they are just all the same. And they are not....it just made me individualize more. (Group 1, Teacher #9)

Karen describes a 180-degree readjustment regarding their approach to teaching and learning. From a teacher centered passive learning environment to a student centered individualized learning community. Assessment facilitated this change by allowing the teacher the opportunity to more closely examine what individual students may or may not be learning and the teacher's causal relationship to the assessed outcome.

Another teacher echoes this idea of discovering more value for assessment than just a grade at the end of a unit and using assessment practices to see one's self as more directly responsible for eliciting (or not) learning from students. During part of the portfolio construction that required close assessment of student learning, Madeline from Rhode Island states:

I actually noticed things that the kids didn't understand. Under other circumstances I probably would have just gone right by it and not put it all together – but in the larger content – when I was looking at an extended unit and I was looking at the various pieces -- I noticed that there were several things the kids just didn't get. And if I hadn't spent the time to analyze it, I probably would have just gone right by it. And just said "oh they just didn't get it." But I really saw that there was definitely a problem somewhere with the way I structured the lesson or the way that I delivered the lesson or something that I did that said they didn't get it. And it caused me to step back and change the way that I'll teach that again. Normally I probably wouldn't have done that. (Group 2A-Post, Teacher #5)

Madeline is articulating an appreciation for assessment practices that did not exist prior to certification. Not only was a problematic content concept identified from an assessment, but also reasons for the lack of learning were formulated. In this case, the teacher expresses a belief that the students 'didn't get it' because of a problem with the teacher's pedagogical decisions or their delivery of the lesson in class. The teacher cites that

National Board certification provided a set of ‘circumstances’ that were in some way different than normal. These different circumstances can be interpreted to mean the additional requirements demanded of the teacher to construct the portfolio. Without the particular needs of the portfolio construction, Madeline would probably have never taken the time to explore assessment to the extent demonstrated here.

There is a sense from the qualitative data that the learning that takes place in assessment is more profound in character than that observed in scientific inquiry. For example, once the power of detailed and intensified assessment of student learning is experienced, it actually may change a way a teacher thinks about practice. For example, Rita, a teacher from Kentucky reinforces this notion by stating:

And it truly – and it has already carried over to this year – you know when kids don’t write very well – you almost dread reading their writing. But I find myself really wanting to read their lab reports and stuff. And I feel like what I say to them on their papers – I definitely give them more feedback. But my feedback is more direct. So I feel like I analyze their work better than I did before. (Group 1, Teacher #41)

In this example, Rita “looks forward” to a task that previously was “dreaded”.

Assessment has not only improved her understanding of student ideas and reasoning, but has also led to an improved appreciation for effective engagement through appropriate and complete feedback. Finally, the learning exemplified here appears to represent immediate change to the teacher’s practice that has carried over into the semester following completion of National Board certification requirements.

This idea of immediate change of practice resulting from learning associated directly with assessment procedures is found in the following quote from Marsha, a teacher from Florida. Marsha states:

I know I've changed the way I correct papers after having to go thru that process. There is that one section in your portfolio where you had to put in student work and your comments. And I pulled some student work and I started looking at it and it was just full of misconceptions. This was a physics worksheet. And I said, "My God, these would have just gone right by me if I hadn't taken the time to sit down and read every word that they wrote." And so I have now changed the way that I correct papers. The kids – there is more red on the paper when they get it back than their original writing. So I correct papers with just a real eagle eye now. And I read everything that they write. And that – and to me that's – that was the biggest eye opener I've had in a long time. (Group 2A-Post, Teacher #1)

The development of an "Eagle Eye" with regards to what students are thinking as reflected in their writing echoes many of the other ideas already explored in this section on Assessment. Marsha has changed her practice as a result of experiences with assessment that were brought about because of the requirements of the portfolio construction. This enriched assessment practice has also resulted in improved feedback or engagement with the student.

These types of self-reports suggest that for at least some of the teachers sampled, a rather profound shift has taken place. Perhaps these changes are pointing to the kind of "self-sustaining, generative" learning now recognized as a relatively rare event in the literature (see for example, Franke, et al., 1998, 2001). In this case, I cannot know how long such effects may last, nor how such reported insights actually may affect teaching practice. But in the annals of teacher learning, the reports of these teachers are remarkable in themselves, against the backdrop of so many teachers' dismal accounts of their professional development experiences. The process of Board certification appears to have been a transformative experience for at least some teachers on some dimensions of their practice.

Reflection: Evidence for Learning

The literature on 'Reflection' is as deep as it is wide. There is a consensus in the educational community that some form of reflection links effective practice with inquiry and continuous professional growth. What the reflection is focused upon and how effective practice are perceived or measured, remains highly debatable (Ferraro, 2000). John Dewey first used the term 'reflection' and defined it as "an active, persistent, and careful consideration of any belief or supposed form of knowledge" (Dewey, 1933, p. 9). In the 1980's the idea was revisited in Schön's *The Reflective Practitioner* (Schön, 1982). Schön believed that experience alone was not enough to move a novice teacher to the realm of an expert. He maintained that reflection in action and reflecting on action were intertwined means of developing expertise in teaching. Such a description of reflection allowed the distinction to be made between reflecting practitioners who use a constructivist decision making perspective and non-reflecting educators who use an instrumental problem solving approach (Ferraro, 2000). These ideas of reflection have strongly influenced the way National Board defines and uses the term.

According to the National Board's standards, 'Reflection' or the act of regularly contemplating "the effects one's actions and initiatives are having on fostering student learning" is an integral part of being an accomplished teacher and "life long learner" (NBPTS, 1997, p. 53). As Figure 4-1 indicates, Standard 12: *Reflection* garnered the majority of comments supporting learning from National Board certification. Though Standard 12 was the third highest observed gain out of the 13 standards, it had the most comments. This situation might be explained by the fact that 'reflection' applies in an indirect (sometimes direct) way to each of the other 12 standards. Teachers may reflect

upon equity, resources, assessment, scientific inquiry, engagement, and learning environment as well as others but only focus on the act of reflection itself as significant or important. In the discussion that follows, examples will be drawn from not only direct comments pertaining to the value of active reflection, but also reflection that focuses on a specific issue or problem related to practice.

A common theme that runs through many of these comments pertains to the value of reflection that is “forced” upon the teacher by the certification process. As Judy from California says:

It really makes you stop and take a look at every little nit-picky thing you do. And you see things that you didn't see before because you don't have time to see them. So it forces you to take the time to really reflect on what you are doing.
(Group 2A-Post, Teacher #15)

Kim from Maryland adds a similar voice when she states:

I think it's very good to take time out and look at what you are doing and why you are doing it. (Group 2B, Teacher #33)

This theme of taking ‘time out’ to reflect is a beneficial learning experience. In describing National Board certification, Annabelle from Alabama states that it is:

...the most beneficial thing that I've ever done in terms of real personal, professional development. Because it made you take a good hard look at yourself and your teaching practice – which otherwise a teacher never would do. Because no one every asked you to do that. (Group 2A-Post, Teacher #16)

The idea that the teacher is being ‘forced’ or ‘made to’ reflect can also be interpreted to mean that someone or (in the case of National Board certification) something's request to engage in active reflection was a new and powerful experience.

However, its not just the act of reflecting that is important, it is also the quality of what teachers mean by reflecting on practice. In terms of quality, it appears that reflection for many teachers in this study pertained to self-examination that tried to get

beneath the obvious. For example, Melinda from Virginia (who also echoes the 'required' nature of the reflection process) goes on to comment on the character of the reflection:

[It] has really required me to do more analysis of my daily teaching than I might have conducted otherwise. And it brought things to my attention that I might – that I probably wouldn't have noticed on my own. Like sitting down with students' work for the one entry and the written work and really reading it in depth and reading in-between the lines and picking out what it is trying to show me; and all of that kind of stuff. It sort of helped me see how my students were doing in a different atmosphere than I would have considered them originally. (Group 2B, Teacher #36)

Melinda indicates that reflection was effective because it forced them to 'really' read students' work 'in depth' and to 'read between the lines' in order to find out hidden or less apparent meaning. From this kind of description, one could infer that under normal (non-reflecting) circumstances, the teacher only reads, not 'really reads'. The consequences of this detailed analytical type of reading results in assessing student understanding 'in a different atmosphere' or knowing them in a way that the teacher had not considered prior to certification.

Another way to think about this reflection as in-depth analysis is represented by the comments from Kelly from Oklahoma. Kelly expressed the 'revealing' nature of the reflection process as very productive. She states:

It made me realize that some of the things that I was already doing --how profound an impact it had. And how I could do more of it. And it also showed me things that I didn't even think made a difference that do make a difference. (Group 2A-Post, Teacher #14)

In this example, the reflection process caused the teacher to rethink some prior assumptions about instruction and make connections perceived to be 'profound' in nature.

Another way to think of the ‘profound’ nature of this experience is that it increased the teacher’s awareness of the complexity of a task previous assumed to be quite simple and straight forward. For example, Carol from North Carolina states:

I didn’t realize until I did National Boards how – how much actual thought goes into a lesson. You know – after a few years you just kind of do it by instinct. But when you have to really think about managing all these kids; for example does that girl who doesn’t speak Spanish very well, get what I’m saying? It just brings it all back up to the forefront and makes you think about it. (Group 2B, Teacher #45)

Carol not only repeats the idea that reflection causes a teacher to ‘really think’ as opposed to just ‘think’, but also indicates a new appreciation for the complexity of task teaching entails. This example also points out the role reflection plays in solving problems. In this case, the teacher questions whether or not an English Language Learner comprehends the intended objectives. Finally, Carol also mentions the idea that National Board certification ‘makes’ a teacher reflect in a purposeful and meaningful manner.

Besides the opportunity to reflect and the quality of the reflection that takes place, many comments focused on the impact the reflection had on the quality or effectiveness of the teacher’s ability to bring about learning in their students. Whether a teacher mentions it specifically or not, the sense is that *it’s all about the students*. For example, Natalie from Georgia articulates this view by saying:

I could really see, what did I do? – What did I not do in my classroom right now to meet those standards? It also helps you assess how do you teach and what do you teach. Meaning are you really teaching the concepts that you are supposed to be teaching or are you kind of skirting around your science concepts? Are you teaching in a way that is useful for your students or not? So most of what I liked about National Boards was that it really made me reflect and assess what I’m doing in the classroom. And do I do it in such a way that my students can figure out what I want them to get out of each day’s lesson. (Group 2B, Teacher #39)

In this example, Natalie makes a rare comment connecting reflection to the actual teaching of content. The types of questions Natalie poses, forms a template for future circumstances with other students in other classes. These questions guide instruction and allow teachers to make alterations, as they deem necessary. If the experience of reflection from National Board certification results in new habits of mind around questions like these, then who is the likely beneficiary? One could conclude that the student would ultimately benefit from a teacher so intent on meeting the needs of both the mandated curriculum (i.e. science concepts) and the students' learning.

Reflection may lead to better teaching and learning. Markus from Washington makes this point when he states:

I think whenever you start analyzing why you are doing what you are doing – the impact on students and student learning is definitely going to be positive; because you seek a deeper meaning for each of the things that you are doing. (Group 2B, Teacher #38)

Jillian from Washington provides further insight into the connection between effective reflection and better instruction:

As you try to explain to somebody else why you think something is good for student learning – you may go thru the process of going, “Wow, maybe that’s not so good. Maybe I always thought it was good – but where is the evidence that that’s good?” And so it really made you think about why you choose to do something and what evidence you have now to suggest that that is good for students. And sometimes I think teachers – we as teachers don’t do that. We think it’s good because we think it’s good. And we like it. But it may not always be good for student learning. (Teacher #34, Group 2B)

Both Markus and Jillian express ideas that reflection caused them to rethink, reconsider, or reassess particular assumptions, ideas, or beliefs about teaching and learning science. It would appear that teacher learning associated with reflection attempts to get beneath

the surface of the apparent to question or consider the unapparent or hidden with regards to assumptions about what is taught, how it is taught, and how it is learned by the student.

This final example quote from a teacher is special. It is special not for what is says, but more for how it is said. It is as if, the teacher was caught in the act of reflection and it provides a glimpse into how the teacher's mind may work through the reflection process effectively. It is also an example of how the videotape requirements of the certification process can facilitate effective reflection. Vivian from North Carolina is describing an enzyme laboratory with a class of biology students. In her comments, Vivian describes what happened when she completely miss handled the students' test tubes over lunch by setting the incubator on too high a temperature. The teacher continues with the story by saying:

When they came back to lunch I told them "gees guys I've ruined the experiment – I've boiled these". We talked about what could affect enzymes and tried to get them to think – ok what could go wrong? And they came up with the different aspects. And then I said "Oh yea – temperature, I know I boiled your yeast to infinity."

And so it was a cool lesson at the time; but when I went back and watched it, I was thinking "Oh gees, next year if that ever happens – it would be better to have them come back from lunch, get their tubes, take down the data and realize "Oh gees, it didn't do what we thought it was going to do." And then have them try and figure out what in the world went wrong without me telling them first.

So I sort of – I tipped them off without realizing it; so I realized then that I need to be careful. What I need to let the kids discover things on their own and try to keep my mouth shut more often. So I can see that's helped me a lot. You really don't see yourself teach unless you do have a tape set up and you can go back and see what has happened in the lesson. So that part I know will help me next year. (Group 2B, Teacher #41)

With the use of the video, Vivian presents a description of what meaningful reflection looks like. In this passage, the teacher identifies a key mistake that could have been avoided. She realized that rather than telling the students about the mistake, it may have

been a more productive and effective learning experience for the students had they figured out the problem on their own. This insight on the part of the teacher goes to the heart of the standards for accomplished teaching. With this description, the teacher moves from being the giver of knowledge to the facilitator of learning. It represents a move from teacher-centered pedagogy to student-centered pedagogy. The comment also has relevance to the previous discussions on *Science Inquiry* and *Assessment* involving both of those areas as more than peripheral to the reflection.

The preceding sample of qualitative evidence illustrates some of the ways reflection could be recognized as learning. The fact that reflection is involved in every aspect of the portfolio and to a certain extent in all the other standards, makes the observation of learning in the area of *Reflection* that much more significant. One question this study set out to address is “What do teachers mean when they say they’re ‘more reflective practioners’?” The answer appears to be related to the extent and magnitude of their willingness to be self-critical. The more a teacher is willing to indicate weakness, point out mistakes in their planning or teaching, or more thoroughly understand what a student may or may not be learning; indicates how well they have learned to incorporate a reflective component into their practice. Therefore, when a teacher says, “I’m more reflective now” with regards to National Board certification, what they may mean is “I am more willing to question my own judgments, assumptions, and actions to determine if they will result in what’s in the students’ best interests. If evidence suggests that I could do something better, then I will take appropriate action to correct the situation.”

Resources for Learning

Does it make sense that the areas of greatest change coincide with the learning opportunities afforded by National Board certification in Adolescent and Young Adult Science? The short answer is: yes, it does make sense. The resources for learning available to National Board candidates in Adolescent and Young Adult Science lend themselves well to the observed learning outcomes in *Scientific Inquiry, Assessment, and Reflection*. These resources include the directions and prompts for portfolio construction, the 13 documented standards of accomplished teaching in secondary science, the videotapes, and support community. The following analysis will discuss each of these resources as a facet of the curriculum presented by National Board certification.

Portfolio Materials

If certification serves as the curriculum, then the portfolio prompts, instructions, and standards function as a textbook. However, this 'textbook' differs from the traditional notions of what a textbook should be. Kelly from Oklahoma describes the difference nicely when she states.

It [portfolio materials] wasn't like they were giving me instruction on how to be a better teacher – they were just telling me how to collect data for them – so they could see if I was a good teacher. (Group 2A-Post, Teacher #14)

In other words, the materials do not inform the candidate as to what lessons to teach or how to teach them, but rather provides a framework that informs the teacher how his or her practice can best be represented by evidence for assessment. This quality to the portfolio materials is quite important. It requires the teacher to continually make decisions and judgments pertaining to practice that address the needs of students, the alignment with the stated standards, and the requirements for certification. Serving three

masters could result in teachers commenting on how the certification process ‘forced’ or ‘made’ them reflect to a greater degree than they normally would do. This decision making process is demonstrated by Mary from Nebraska when she comments:

...trying to figure out what lessons that I do that matched the criteria they were looking for; and if they didn’t currently match, how would I fix them. So it was really preparing the portfolio [that was most helpful]. (Group 2A-Post, Teacher #11)

Mary is focused on the needs of the portfolio. When she says ‘fix them’, it could be interpreted that she needs to make adjustments to her less that make it more ‘Board acceptable’. Such a decision may or may not be good for her students. The point is that she is focused on pleasing the Board not in necessarily addressing the specific needs of her students. This type of evidence will have implications later in the discussion regarding teacher quality.

Another teacher, however, found the materials provided by the National Board as a good source of inspiration and ideas. Elli from California states:

...with National Board Certification you are evaluating your own teaching and you’re getting new ideas as you are reading thru the materials. Group 2A-Post, Teacher #4

The ‘materials’ serve as source of information that the candidate must read (and in many cases re-read) and ultimately come to understand. Wendy from Louisiana describes this process by saying:

Because when you look at [those materials] and go through the guidelines and you go through the objectives and you answer those questions – have you done this? – do you do that? – if you didn’t, it makes you more cognizant of the fact that you probably should. (Group 1, Teacher #14)

Wendy describes this process of learning as if it were a conversation between the text and the teacher. The result of this interaction is a teacher who so ‘more cognizant’ or aware of a different approach or approaches to practice.

The materials provided by the National Board include a detailed description of the 13 standards of accomplished teaching in Adolescent and Young Adult Science. This document presents a vital source of learning for the candidate. Some teachers, such as Naomi from Georgia, indicated that they felt ‘forced’ or ‘made’ to “read those national science standards’ (Teacher #39, Group 2B). However, others express a view that described the document as a rich resource for learning. John from New York states:

I bet you I read that standards book after I highlighted it 30 times – maybe not all the way through – but I’d ready this page and that page. I really thought a lot of the stuff in the standards book really made me reflect and not just the lessons that I did for part of my National Board; but you know some of the other lessons that I was doing. I actually think that that standards book should be required reading for all teachers. I thought that was excellent. (Group 2A-Post, Teacher #20)

One gets an image of a very well used and loved physical text that is worn and marked up from being referred to over and over again. Such documents become cherished by the learners as representative of the learning that takes place. The comment also hints at the notion that the learning is “not just” in the context of National Board certification, but also for the ‘other lessons’ that were not part of the portfolio construction. In other words, this is evidence that the resources for learning carry over into non-certification experiences.

The standards serve multiple purposes. Not only do they function as a text from which a teacher may acquire relevant teaching knowledge, but they also serve as a benchmark against which current practice can be compared. As Kerri from Kentucky states:

It was just a challenge for me to meet the standards that are outlined in the National Standards for Professional Teaching. Just to put yourself up against those standards was just an awesome, humbling and motivating all at the same time. They describe what the qualities of accomplished teaching look like. (Group 1, Teacher #9)

Kerri describes a mixture of emotions when she says “awesome, humbling, and motivating”. Such words reveal the power of this document to instill meaning and relevance to a teacher’s practice.

Another valuable source of learning for candidates can be found in the videotapes that they must produce and submit. As part of the portfolio construction, candidates are required to submit two 20-minute videotapes. One tape is focused upon active scientific inquiry and the other tape looks at whole class discussion in science. There is powerful and abundant evidence that the videotape portion of the assessment process was a fertile area for learning. For example, Molly from Maine states:

..videotaping and being able to see yourself in action and you know and sort of step back and look at the way you design your stuff is – you know. Looking at it thru different filters really allows you to ask whether or not you think you are the teacher that you sometimes feel that you are. (Group 1, Teacher #34)

As anyone who has had to confront his or her self on videotape may know, the experience can be difficult, painful, and unbelievable. What is observed on the tape is at times far removed from the perception of one’s self as a teacher. Molly is expressing this phenomenon when she says, “whether or not you think you are the teacher that you sometimes feel that you are”. Such an experience could easily motivate a teacher to adjust, make another tape, and re-assess the performance.

The videotape was not just a source of learning about the teacher; it was also a source of information about the students and their engagement with the teacher. For example, Daphne from New York states:

I'd never worked with video taping before and so I wanted them [the students] to be comfortable. And I videotaped like – probably about 50 hours worth of class time. And initially it was very funny because they all behaved a certain way in front of the camera – but then later on – you know – it became much more revealing because I could see what was happening. And it provided me with ways like for questioning my honor students for my bio class, last year, they wouldn't answer any questions in class. I'm not sure why; but they really had a hard time feeling secure enough to answer things. (Group 1, Teacher #37)

Daphne used the videotape to identify a problem regarding engagement with students.

She also indicates that the video analysis became 'much more revealing' about a particular issue regarding student behavior. Videotape analysis could facilitate learning in areas of engagement, assessment, learning environment, knowledge of students, and scientific inquiry.

Finally, all the resources of learning are important, but if they do not intellectually and professionally challenge the candidate or are not considered a rigorous series of tasks, then their value as resources to explain learning would be diminished. As has already been touched upon previously, there is ample evidence to suggest the process of certification is a rigorous and challenging experience. Robert from Montana says:

I thought the National Board Portfolio was the most difficult thing that I'd every done in my entire career. I consider getting National Board Certification far greater than getting my masters' degree or anything else. I thought it was just an enormous project and very worthwhile. (Group 1, Teacher #27)

Amy from Virginia gets the prize for most convincing description:

I think if I had to go back and get a Ph.D. or either to have triplets – I would do that before I'd go through National Board again. – it was almost like I was opened up, I was humbled, I saw myself, I mean the real me as a teacher. (Group 1, Teacher #39)

Both Robert and Amy provide evidence for the rigorous nature of the certification process. In addition, Amy's comment about seeing the 'real me as a teacher' indicates that one the act of critical self-reflection (when done properly) provides the teacher with a

challenging and potentially rewarding experience. Amy says that it was like she was “opened up”; meaning that the process had brought her to the point where she was not only confronting her teaching stripped of any pretense, but that it was done in a public manner. The experience was ‘humbling’. Amy may have come to a stark realization that her original definition of what an accomplished teacher should know and be able to do was entirely inadequate when held up to the Board’s definition of excellence. It is this discrepancy between the real and the ideal that may fuel the feeling of rigor in the assessment process. For most candidates, the discrepancy is too much to overcome and in the end their evidence is insufficient for them to be deemed ‘accomplished’.

Nearly 50% of all Board candidates do not achieve National Board certification and those pursuing an Adolescent and Young Adult Science certificate face an even higher (60%) failing rate (NBPTS, 2004). One candidate, Perry from Massachusetts actually found this to be an asset for the process. In describing the value of the experience separate from the ultimate outcome of certification, Perry states:

And actually even at the end of this month they tell me that I didn’t pass and that I have to re-do something I’m not going to – it won’t bother me and I won’t feel like I wasted any time. And actually, I kind of like the idea that most people don’t pass. (Group1, Teacher #4)

The resources described thus far represent learning opportunities for teachers that are best explained by an acquisition metaphor of learning (i.e., Cognitive Flexibility Theory, Conceptual Change Theory) (Sfard, 1998). The candidates’ comments all involve interacting with an artifact of the certification process. Whether that artifact is a standards document, portfolio related material, or videotape, the text for learning remains fixed and unchanging even though different teachers may interpret, learn, or experience

each piece quite differently. For example, Constance from South Carolina describes her experience with the documented resources as follows:

When you see things that are part of the standards, cause you have to know those standards so well, when you see things that you should be doing but aren't doing – when you are going through the process – you make sure that you do those things, because you know that you are supposed to be doing them. And if you haven't done them before, you start. And that's good because they are all very positive things and things we should all be doing. (Group 1, Teacher #7)

Constance is attempting to fulfill the requirements and meet the standards to the best of their ability. From this teacher's description, one gets the sense that these documents are fixed and unchanging and that it is the teacher who is trying to change to fit the standards. In the last resource to be considered (Colleagues), a participation metaphor for learning such as Situated Learning (Lave and Wenger, 1991) will be more important in explaining the observed learning outcomes.

Colleagues as Resources for Learning

One way to understand the value of a support network in relationship to the certification process is to see what someone with no support had to say. Bonnie from Ohio states:

I found National Boards to be a solitary process... For me, National Boards did not have that collaborative element. And I think that collaborative element with other educators is a huge piece. I think that analyzing the student work is an incredibly valuable experience. I mean the pieces that went into it – were powerful. I think that to analyze student work with a group would be more powerful. Or to analyze that videotape in some detail with a group of peers would be more valuable. (Group 2B, Teacher #29)

As the evidence that follows indicates, Bonnie may be correct in her assessment of the situation. A collaborative strand to the certification process does provide for an opportunity to learn in a different manner.

Take for example, Shannon from Arkansas. Shannon's comment about her experience places the emphasis on colleagues as a vital source for her learning. She states:

Pursuing National Board Certification has impacted me more than anything I've done since I've started teaching. I've learned from going thru the projects more about what it is to help my students. And I've learned more about myself than anything else has taught me. And I have met the most high caliber teachers I've ever known thru the application process. Other teachers who are applying with me last year and we were going to support groups and became friends. And we are still e-mailing each other and going to conferences together. And there were some National Board Certified teachers in Little Rock who met with us to encourage us and were readers for us. I never would have interacted with those teachers. And they are fantastic teachers. And I've been influenced by them and helped by them. And that would never have happened if I had not been going through National Boards. Just the encouragement, just the energy level and the expectation level that those teachers have has stimulated me I guess to want to do better and to try harder and it's just been great. Whether I make it or not – it has definitely impacted me. (Group 2A-Post, Teacher #7)

Shannon presents the idyllic example of National Board certification promoting teacher learning through an evolving sense of belonging to a community (Lave and Wenger, 1991). Shannon describes the relationships that arose from the experience and how those relationships shaped her experience and sense of mission in becoming a better teacher. The community was inspiring and supportive; guiding and collaborative; respectful, yet critical. The certification process for Shannon facilitated professional communications and expectation of excellence all because of their exposure to 'accomplished teachers'.

In this view, National Board becomes not only a vehicle for developing dialogue between teachers, but also an elite kind of fraternity where membership has its privileges. Among the advantages that Shannon identifies is the sense of communing with teachers who appear to have greater abilities, enthusiasm, energy, and knowledge about teaching. Such a positive group of peers may inspire or motivate a new 'member' towards higher

achievement and effectiveness in the classroom. It should be noted that Shannon's desire to 'try harder' can be interpreted in several ways. Does it mean she is trying to be a better teacher, Board candidate, or both? Her mention of the role these 'fantastic' teachers play as 'readers' hints that this support group could be focused on improving Shannon's chances of achieving certification and not necessarily improving instructional practices.

In a more specific example of how collaboration can facilitate learning, Clare from Kentucky describes her experience wrestling with the term "significant" that was used frequently by members of her support group. Clare states:

See this whole word 'significant' was something that baffled me throughout the entire National Board group. They used that word so much. I'm just saying it was so funny cause my mentor and I we were just like ponder on like significant – significant – significant. (Group 1, Teacher #16)

This is an interesting example National Board certification bringing professionals together through a support group that might not normally interact and discuss concepts that may not originate from everyday practice. Clare describes a connection between herself and her mentor that the support group nurtured. She does not say what they determined 'significant' to mean or that they ever resolved the issue. Rather, it represents a form of professional bond between the mentor and the candidate. Because Clare repeats 'significant' three times in the phrase, "we were just like ponder on like significant – significant – significant", one gets the sense that this was a form of 'inside joke' that only the two of them shared. In essence, they may have been constructing their own understanding of 'significant' quite independent of any definition from the National Board or the support group. This kind of learning is important for understanding the potential value of National Board as a professional development, but it is difficult to see

how it might contribute to the assessed changes in pre-post scores that this study focused upon. Where this type of evidence might be available to assessors for inclusion in the evaluation of transcripts remains unknown.

Another form of community that has become more available and vital to the process of certification takes on a virtual form. With the rise of Internet and web based communications, candidates are likely to find answers to questions, moral and emotional support, and guidance about portfolio and assessment issues on line. For example, Yahoo Groups has an online community just for Adolescent and Young Adult Science Candidates²⁰. Teacher-candidates can access archived messages or post one of their own. Such efforts often result in meaningful and distant relationships centered on classroom practice and the certification process. For example, Vicki from North Carolina states:

I had gone to a couple of community workshops or district workshops – but I mean I attended everything that I could attend on it – and had some good support. And I even found a lady that read my entries over the internet that – you know – lived a couple of hundred miles away from me. I did help some other teachers that were doing the advanced – which means they didn't pass part of it the first time – I even helped them – you know – even though I'm not sure that I knew what I was doing. But anyhow I felt like I had gained a lot and helped them to work on their video skits and to analyze it and help them to – you know – put the right words in their questions and that kind of thing. And see I like doing that too. I like working with other teachers and that's the collaborative thing. (Group 2B, Teacher #43)

Vicki had participated in traditional support group settings within their district, but she also found support over the Internet. The give and take Vicki describes in this passage reveals a quality of learning that is missing from descriptions of other sources for learning discussed previously. Vicki finds an intrinsic reward in helping others even when together the teachers are unsure what the correct solution may be. One gets the sense that the experience of certification facilitates common experiences that translate

²⁰ The Yahoo group can be found at NBPTS-AdolAdult-Sci@yahoogroups.com.

into professional (and possibly personal) relationships. Like strangers in a lifeboat a drift on the ocean, candidates struggling to make sense out of the demanding tasks of certification reach out and try to help one another succeed. Granted, part of this comment is disturbing, such as the reference to the videotape being a 'skit', but this will be explored later in the analysis.

The next example provides evidence that National Board certification plays a crucial role in school communities as rallying point for educators. Mike from Wyoming describes this activity by saying:

I talked seven of our department members into trying the National Boards this year – so we could all sit there and work together and help and collaborate on ideas and try and understand what in the heck they are asking us and stuff.
(Group 2B, Teacher #32)

This teacher was able to convince fellow department members to all pursue National Board certification together so that they could try and understand “what in the heck” was needed and required to complete the portfolio successfully. According to Mike, the tasks and challenges that National Board certification presents to the candidate are best addressed from multiple perspectives and ideas as represented by a group of colleagues.²¹

So far the resources for learning associated with a participatory metaphor have examined school support groups, on line virtual communities, and district workshops. Another interesting milieu of collaboration can be found at the University setting. In many places, Colleges of Education are establishing support networks between academia and local teachers pursuing National Board certification. Such networks have the potential to open lines of discourse between professional researchers, academics, and

²¹ It is interesting to speculate how this support group might influence the school community or its fate upon hearing about who passed and who did not. What would happen? How would personal and professional disappointment play out against others who felt triumphant and 'accomplished'? How would personal feelings influence professional conduct?

classroom teachers in new and possibly interesting ways. For example, Bob from Washington states:

I was the only teacher in the school [pursing certification], but there was a college that was sponsoring Saturday workshops, once a month, so we'd get together for 3 hours then with people all over the state and discuss it [National Board certification]. (Group 2B, Teacher #30)

Bob describes his efforts at over-coming isolation by participating in a statewide support group centered at a college. There is no indication in this comment about the relative value of the experience or the nature of the learning, but it remains important because it demonstrates how different components of the educational system can come together for a common purpose and create a distinct community that would not have existed had it not been for National Board certification.

Summary

In Chapter 4, the qualitative evidence for learning from National Board certification was presented. Both the quantity and quality of the candidate comments about their National Board certification experience supports the observed gains for *Science Inquiry, Assessment, and Reflection* reported in Chapter 3. In addition, teacher learning in these areas was linked with available resources associated specifically with Board certification. The resources described here support both an acquisition and participation explanation of teacher learning from the certification experience. In Chapter 5, I will address why these learning outcomes are important to classroom science teachers, teacher quality, policy makers, and the future of the National Board for Professional Teaching Standards.

CHAPTER 5: DISCUSSION

*The things that pass for knowledge
I can't understand.*

- Steely Dan, "Reelin' In The Years"

Overview

Chapter 1 presented the phenomenon and the importance of the investigation for trying to answer the question: "What are teachers learning from National Board certification?" In Chapter 2, the Methodology for the research was described including research design, population, selection of candidates, and the procedures for collecting data. Chapter 3 presented the quantitative results and described a few procedural compromises that serve as limitations to the validity of observed results. In Chapter 4, the quantitative results were examined within the context of qualitative data collected over the course of the study. In this final, I will turn my attention to questions that connect this study to larger issues in education.

Chapter 5 explores the outcomes of this study within the larger context of classroom practice and policy. More specifically, the teacher learning outcomes identified will be discussed within regards to its potential impact on changing science instruction. What could the observed and explained learning outcomes possibly mean in relation to its impact on Teacher Quality? By describing three possible explanations for observed teacher learning outcomes (Dynamic, Technical, and Deferred), the value of National Board certification as effective professional development will be discussed. After the limitations of the study are reviewed, the results from this study will be placed into a context of related research in the areas of corporate training and psychotherapy – two research domains that focus on the effectiveness of specific intervention programs

whose challenging goal is human improvement. Finally, the relevance and implications of this study to secondary science teachers, policy makers, and the National Board will be presented.

Teacher Learning and Teacher Quality

If the evidence presented from the quantitative and qualitative analyses represent teacher-learning outcomes, then the question of how this learning effects practice is a reasonable one to ask. How might these observed learning outcomes impact Teacher Quality? In the discussion that follows, “Teacher Quality” is defined as the capacity to generate and sustain effective student engagement (Mullens et al, 1996). According to the Eisenhower Grant Program for Professional Development in Math and Science:

Teaching Quality impinges directly on the efficacy of student work through professional competence in two areas:

- 1) Teachers content expertise expressed as knowledge of a specific discipline and knowledge of how to teach that discipline.
- 2) Teachers’ pedagogical expertise (expressed as ability to develop academic tasks with appropriate content and challenge) uses a variety of instructional strategies to assess students knowledge and skill and manage a classroom environment for optimal working conditions. (Mullens et al, 1996 p9).

The first area is very similar to Lee Schulman’s concept of Pedagogical Content (Shulman, 1986) while the second area is reminiscent of the types of content and skill emphasis found in teacher preparation programs (Holmes Group, 1990).

What my study reveals is that when post observations of candidates are compared with pre observations of candidates; overall mean scores demonstrate a positive effect attributable to the intervention. The observed gains are powerful in their ability to point out where interesting changes are likely to be taking place, but they are of little value in saying anything about the quality of those changes or their real value in terms of how a

teacher may be affected by National Board certification. It is up to the researcher to provide meaning to these statistical results.

What do the observed 'learning' outcomes mean in terms of change in teacher quality, teacher effectiveness, teacher knowledge, or teacher beliefs? It would be wrong, for example, to conclude that because there was a significant increase in the mean scores for *Scientific Inquiry* teachers are necessarily better at teaching with a scientific inquiry method or that they now know more about teaching with scientific inquiry. Kowalski and associates also observed what they called 'professional growth' from the certification process, but went on to conclude that the assessment process appears only to change the classroom behaviors of the candidates secondarily (Kowalski et al, 1997). Their observations indicate that teacher quality may or may not be improved as a result of National Board certification. However, the wealth of data collected from the participants in this study provides further evidence that addresses this issue. The following discussion will consider three possible interpretations of teacher learning and the affect of each upon teacher quality. They are called: Dynamic, Technical, and Deferred Learning. However, before getting to the details of these ideas, it is prudent to first discuss some of the assumptions that these ideas are based upon.

There are three important assumptions relevant to these ideas. For purposes of analysis, all three assumptions have been considered 'true' in order to focus on possible relationships with the intervention. The three assumptions identified here concern: amount of work, rate of learning, and capacity to learn or learning style.

The first assumption pertains to how much work a teacher puts into the process. It is assumed when we look at teacher learning that all teachers are trying their best to

succeed at any given task. However, such an assumption is not true. Different teachers place differing priorities within the responsibilities of their lives. For many, National Board certification may be their number one priority during the year of certification, but for others it may rank third or fifth and does not received the same focused attention and effort. As a result, it becomes problematic to compare Teacher A's learning experience with Teacher B because their learning outcomes may have nothing to do with the intervention and everything to do with the level of commitment towards the task. In practical terms, Teacher A who has set a high priority for Board certification may not be bothered or hindered by the technical requirements of the certification process; whereas Teacher B who has other more pressing responsibilities finds the technical requirements a tedious burden.

The second assumption pertains to the rate of learning. There is an assumption in this study that all teachers learn at the same rate. For example, if two teachers begin the process in September and complete it in June, then the assumption might be made that they learn the same amount of knowledge in the same amount of time. Again, this assumption is problematic. Teacher A may demonstrate all the learning outcomes in January that Teacher B will not understand until the following October. Both teachers acquired the same knowledge and skills, just in differing amounts of time.

The third and final assumption pertains to a teacher's capacity for learning (or learning style). For purposes of this study, I assume that all teachers have an equal capacity for comprehending and acquiring knowledge and skills relevant to practice. This assumption is also problematic. Not all teachers have identical capacities to learn the same knowledge and skills in the same manner. Where Teacher A may be very able

to learn concepts and skills associated with *Scientific Inquiry*, they may have a real ‘mental block’ when it comes to understanding and/or appreciating the value of reflection in practice. Where Teacher B finds the knowledge and skills associated with *Reflection* to be quite easy ‘to pick up’ they may have a history of struggling to learn particular content knowledge or laboratory skills. In addition, some teachers may be more effective learners in a community environment whereas others prefer learning from a text. Each teacher’s learning style coupled with the unequal access to different resources makes an assumption about learning styles problematic. With the understanding that these assumptions exist and present problematic consequences to any discussion about learning, teacher quality, and professional development, the following exploration of these topics is presented.

Dynamic Learning

The first interpretation of how teacher learning might relate to Teacher Quality is called ‘Dynamic Learning’. In Dynamic Learning, changes identified from pre to post translate into immediate, effective, and meaningful changes in a teachers beliefs, understandings, and actions in the classroom. For example, with the changes in *Scientific Inquiry* observed, teachers have learned to a significant degree about scientific inquiry and their practice has changed to reflect this learning. In this interpretation of the improved scores associated with *Scientific Inquiry*, Teacher Quality would be characterized as ‘improved’ or ‘increased’. Dynamic Learning may be associated with teachers who are intrinsically motivated to pursue National Board certification. For example, Daphne from New York describes her reasoning for pursuing National Board when she says:

I need to do something to get out of this rut. I had looked at National Boards since I think it was like 1998 I had considered it. But then with all the state assistance and everything, it was more financially ok to do – so I went ahead and did it.
(Group 1, Teacher #37)

Experienced teachers with more than 10 years experience often describe National Board certification as an opportunity to ‘get out of a rut’ or overcome teacher ‘burnout’. They have heard good things about the process and its ability to help with this type of professional fatigue. They may be influenced by financial incentive, but there are also important and intrinsic reasons for the decision to participate in the process. However, motivation is just a part of understanding Dynamic Learning. The following comments and analysis try to illustrate precisely what is meant by this categorization of learning.

Dynamic Learning results in immediate qualitative change to practice that is often described as an improvement in ability to foster learning in students. Penny from Hawaii provides the first piece of evidence when she states:

The analytical part of learning doesn’t just end with sending in your paperwork to National Certification. It’s something then that you can’t help but continue to do. The questions that I had to answer in written form pop into my head now all the time. (Group 2A-Post, Teacher #3)

Carina from Florida presents another example of this idea when she states that the experience of serious reflection from the certification experience is “carried over and you are just different. You think about it [teaching-learning] differently” (Group 1, Teacher #12).

Both Penny and Carina have internalized the National Board framework of reflection and action. The skills they acquired pertaining to reflection on practice and student learning persist months after the certification process is over. Carina “can’t help” but continue with the same approach that was repeatedly employed during the portfolio

construction. Penny describes the effects of learning as ‘carrying over’ into the current semester. These teachers could be described as ‘more effective’ or of ‘higher quality’ because of the reflective learning brought about by National Board certification.

For some teachers, the changes are more specific to particular aspects or standards of practice. Ron from New York, for example, describes his incorporation of rubrics as a means of communicating expectations more clearly with students. He says:

This year is going fantastic – even compared to last year – which was a very good year for me. This has been my best year in the physics classroom. One of the biggest reasons why was realizing that I wasn’t getting the quality of student work because I didn’t have standards. When I realized that I needed to give the kids the standard by which they would be judged – and I sat down and deliberately thought about everything that I thought was important as far as scientific inquiry – when I did that and I came up with my investigation rubric that I created as a result of this, it totally changed the quality of work that I get from my kids. From garbled incomplete chunks of incomprehensible garbage – really for a lot of them – to you know a more focused, a more complete, a more in depth understanding. (Group 1, Teacher #21)

Ron describes tangible and observable differences in the way he thinks about, plans for, and implements a scientific inquiry lesson. He demonstrates learning associated with the standards of *Assessment*, *Engagement*, *Scientific Inquiry*, and *Reflection*. The teacher ‘realized’ that the problems associated with the low quality of student work might be corrected by his decisions and actions. Ron ‘deliberately thought’ about how to solve or at least address the problem. This teacher is acting upon a newly acquired understanding involving the use of rubrics that are used extensively through the construction of the portfolio entries.

Not surprisingly and in agreement with observed pre to post gains in the standards, many comments from teachers focus on the new skills and knowledge gained

from certification and the impact on their teaching of scientific inquiry. For example,

Sarah from New York is still involved with portfolio-like activities. She states:

I'm still doing – you know – more inquiry based labs, more projects. My classroom has become much more student centered and more – having students be more analytical and critical thinkers. (Group 1, Teacher #36)

Sarah learned an appreciation for a more 'student centered' approach as well as encouraging more 'analytical and critical' thinking in her students. Another example is presented by Charity from California. Charity describes how becoming more self-confident provided the necessary strength to try a new type of lesson with their class.

She says:

The skills that I gained last year in focusing on good teaching and the things that they make you focus on in your portfolio – I gained a lot of confidence in those skills and they became more natural and easy for me. Whereas I might not have taken that risk had I not gone through the process. (Group 1, Teacher #40)

The interesting distinction between Charity and Sarah is that Charity hints that prior to certification the skills in question were present, but remained weak or underdeveloped. Skills associated with conducting a more student-centered class where the teacher does not dispense knowledge but helps students create their own understandings. The teacher says that these skills became "more easy" which infers that they were there before the intervention and that certification provided an opportunity for them to develop. Charity is making a direct connection between the experience of National Board certification in the previous semester and new lessons implemented in the current term.

Dynamic Learning might best be described with another teacher's description of learning from National Board certification. Perry from Massachusetts states:

If you can get a kid to think about a subject that you are teaching – if you can get a kid to internalize it – then he'll have it forever. It's the same thing I think with adults. (Group 1, Teacher #4)

Dynamic Learning may be ‘internalized’, but the important element is that the teacher acts upon that new knowledge, skill, or understanding to consciously and deliberately try and improve the learning experience in his/her class. How long will this improved teaching continue? How effective will the ‘improvements’ be regarding student-learning outcomes? What is the longevity of this type of learning? Is it forever as Perry suggests? Or, is it cast aside after a few months while the old ways (often easier ways) creep back into practice? These are interesting questions and worthy of future research.

Technical Learning

Up until now, the comments about National Board certification have taken on a very positive and productive tone. The evidence used to describe Technical Learning has a distinctively different flavor. The negative connotations of these comments are not meant to imply that Technical learning is ‘bad’ but rather different from dynamic learning. For example, Gabriella from North Carolina describes the National Board experience in the following terms:

I found the whole experience kind of humiliating. I mean the whole thing was so incredibly frustrating and humiliating. (Group 1, Teacher #38)

To clarify, most of Gabriella’s issues arose because of communication problems with the National Board and the district protocols for covering the costs of certification. However, the situation never improved from this frustrating beginning. The point is: not everyone finds the experience such a wonderful life changing professional development experience. However, just because an individual does not like or enjoy the certification process, does not necessarily mean that they did not learn from their efforts.

Technical Learning describes changes in thinking that are procedural in nature. They are linked closely with the goal of succeeding with the certification process. Teachers are learning about scientific inquiry, but only in the context of how they can best succeed at attaining certification. In other words, teachers are learning how to be better candidates for National Board certification, but not necessarily better teachers. In this interpretation, Teacher Quality remains unaffected. Becoming good at Board certification does not necessarily make a teacher more effective in the classroom. The following are some examples of technical learning.

Constance from South Carolina observed phoniness in other candidates that could result in Technical Learning. She states:

I think that while for some teachers it's going to make them better teachers, for some teachers they are going to have to do during that year and not change what they are really doing – that they are putting on a show and they just do that well. And whether you maintain [that kind of teaching] afterwards is what I question. (Group 1, Teacher #7)

The idea expressed that some teachers 'put on a show' for certification is echoed by Mark from Virginia who says:

But I haven't put on a dog and pony show this year where I'm inventing all of these terrific lessons that I didn't have before. (Group 2B, Teacher #31)

Mark would probably agree with Constance. They both perceive some of their colleagues as not being honest with the spirit of self-reflection, self-realization, and professional development that is part of the National Board certification process. These 'dog and pony' teachers put their efforts not into improving practice, but into impressing the assessors who evaluate the videotapes and portfolio artifacts. They are playing to a specific audience that does not necessarily include students and rather than be true to the standards, they attempt to manipulate them for purposes of financial gain.

One teacher in the study confessed to being one of those ‘dog and pony’ teachers.

Kim from Maryland described the certification experience as follows:

I felt like it was more of a – more of an exercise in trying to find out what they were looking for. And so I spent more of my energy doing that than in actually reflecting on my own practice and writing about it. (Group 2B, Teacher #33)

Kim does not appear to be intentionally phony or fake for the assessments, but somewhere along the line, she got some advice that ended up interfering with the quality of her experience. Kim’s focus is on what she thinks ‘they’ want—‘they’ being the National Board portfolio assessors. Kim committed valuable resources of time and energy chasing down a goal of pleasing the assessors rather than addressing the students or her own needs.

Where might a candidate receive this kind of advice or direction? According to Elli from California, the support groups, which many teachers claim enriched the certification experience through professional discourse and community, represent one such source of advice. Elli says:

I had a group that I met with once a month to discuss what we were doing. Those discussions were “Are we meeting the requirements of National Board?” They weren’t really discussions about our instruction and assessment – expect to evaluate each other’s papers and whether or not we thought they were good papers. (Group 2A-Post, Teacher #18)

Elli expected the support group to be focused upon conversations around “instruction and assessment”. Instead, she found the support groups focused on technical issues. Issues associated with writing, answering questions efficiently, and the particular requirements of the different entries in the portfolio. These types of conversations may result in a teacher learning more technical knowledge and skills on how to succeed in certification. This learning however may not translate well into changes in classroom practice.

Perry from Massachusetts voices a similar observation about his support group, but goes on to make a very insightful remark. He says:

I did sit in on three of their meetings and at least at the workshop that I attended it was all about how do we get through and how do we pass and how do we write what the readers want you to write and they were saying that they were going to give us deadlines that we had to have our video done by and they were going to do this – it was just too contrived and I think it missed the mark of what I think the heart of what the National Boards started out to be.

I think I see that as very good and I think it's kind of sad – I heard the President of the National Board mention that I guess somewhere in Virginia – Charlotte or something like that – where they have a whole bank of readers that help read the paper before they are submitted to the National Boards and I think that's kind of sad almost – that the people are trying to manipulate the system to try to find ways to you know use all the correct buzz words but learn nothing. Group 1, Teacher #4

Perry not only recognizes the inauthentic nature of this type of support, but also feels sorry for teachers that feel the need to 'manipulate the system' in order to succeed. These teachers learn what others think are good strategies for passing the process, techniques for writing the way the "readers want you to write" and other non-standards based skills and knowledge. These teachers are learning, but their learning is technical and not related to classroom practice. There must be a perceived importance to the technical knowledge regarding the certification process that so many teachers are willing to commit valuable resources to learning. The observation raises the question, "What is the value of technical learning?"

One possible answer may be found in a comment from Staci from Florida. Staci views the process of certification with a cynical perspective that is in alignment with the previous comments, but adds a valuable insight. She says:

I think a lot of it is what hoops can you jump through and how well, how good are you at writing at saying what you need to say to prove based upon the rubric. Are you good at being able to work through that? If you are, that's great. But

someone might be a very good teacher and just based upon what they submit, it might not be evidence of what they are doing. (Group 1, Teacher #29)

Staci makes a very important point. Accomplished teachers may not be good at proving they are accomplished. National Board certification may be too restrictive in formatting requirements and questioning style to fit some teacher's strengths of communication.

The comment also underlies the importance of the technical knowledge needed to succeed at communicating one's practice effectively through the portfolio. The choices for artifacts, decisions regarding lessons, actions taken during the taping of a class, and the details of how to analyze student work all contribute to technical learning. The problem would seem to be when the technical learning overwhelms and overshadows the intended text focused on self-reflection and student learning. For one teacher, this problem had no resolution. Being the good science educator, Paul from Louisiana compared the experience of certification to the Heisenberg Uncertainty Principle. Paul states:

Frankly I found that it was so difficult. It's sort of like Heisenberg's' Principle. You can either know where the electron is and not know what it's doing or know what it's doing and not know where it is. I could either teach as an effective teacher or I could go thru this procedure to prove I'm an effective teacher. (Group 2A-2, Teacher #19)

The implied conclusion being "but I can't do both". Paul could not put the time and energy required to communicate the quality of his practice effectively through the construction of the portfolio and teach with the same resource intensity that he was accustomed to without the demands of the certification process.

So for some teachers the certification process actually seemed to be a diversion from their teaching—in favor of "jumping through hoops"—rather than a stimulus for reflecting on or learning about teaching. So defined, learning from certification has value

that is narrowly instrumental at best. What percentage of teachers who fail certification would this apply to? How could the process be improved to include this kind of teacher? Or, is part of being an accomplished teacher that the technical knowledge is not a challenge? Does the technical knowledge somehow facilitate the Dynamic Learning previously discussed? These are questions all raised by this analysis, but whose answers must wait for future research.

Deferred Learning

The third interpretation of how learning might influence teacher quality is described as “Deferred Learning”. In this case, significant changes from pre to post do not translate into immediate changes in teacher practice. However, change may become apparent or take effect a few months or years after certification. In Conceptual Change Theory, Strike and Posner hint at a ‘deferred’ type of learning when they say that conceptual change learning was not intended to provide “a detailed account of learning that could be immediately applied to the classroom” (Strike & Posner, 1992). In other words, there could be a delay between learning and action that is based upon that learning. Teachers may require a certain distance from the certification experience to make sense out what they learned and apply it to practice. For example, specific ideas pertaining to *Scientific Inquiry* may require a significant gestation period, before their importance or underlying concepts are well enough understood as to result in changes to classroom practice. With Deferred Learning, Teacher Quality may improve in the future, but not immediately after the experience.

Another way to think about Deferred Learning is to include the concept of uncertainty. To the extent that a teacher is uncertain how or if learning took place as a

result of National Board certification, the possibility exists that a learning outcome might be realized sometime in the near or far future. While Mark from Virginia described whether or not National Board certification affected his practice, he made the following comment: “I’m not sure that it’s changed at this point how I taught.” By qualifying the statement with “at this point”, Mark leaves open the possibility that lessons learned from the experience will become realized at a future point in time. Such is the character of Deferred Learning.

What is it about the process that might result in uncertainty regarding the learning outcomes for a candidate? One possibility relates back to the concept of the previous discussion on Technical Learning. For example, Melissa from Kentucky describes her thinking on the topic as follows:

Now that I’ve completed everything – it’s all turned in – the stressful parts of it are gone; and I have the opportunity to sort of look back and observe and see how some of the things have been incorporated into my teaching – I think that it was particularly useful. (Teacher #12 from Group 2A-Post)

Melissa is describing the stress associated with Technical Learning interfering with the advent of Dynamic Learning. What is really interesting about this remark is the phrase “I have the opportunity to sort of look back and observe and see how some of the things have been incorporated into my teaching”. This act is a form of meta-cognition where the teacher examines her practice to identify changes and thus learning outcomes. This teacher is not claiming that they are more reflective, more student-centered, more focused on planning or assessment or engagement. No specific outcome is identified—yet. The teacher sees this kind of analysis as removed from the “self”. At this point, the teacher is unaware of how her practice may have changed. It may not have changed and then again it may have. Melissa needs distance from the intense experience of certification and time

to look down upon her work and try to recognize differences in values, decision making, and beliefs that may have been instilled from the certification experience.

Malcolm from Georgia makes a similar if more detailed point about uncertainty and learning. Malcolm, like Melissa, was overwhelmed by the technical learning requirements of the National Board certification process. In his comment made approximately 4 months after completing his portfolio and assessment center exams, Malcolm describes his learning experience as follows:

I'm just really quickly removed from it and I haven't even found out if I've gotten it yet. But I sometimes felt like I was – I felt like I – I had to put a lot of time and effort into the National Board Certification itself so I felt like sometimes there were times that it took away from the time I could have put into the overall classroom to help the students by – by me having to do some of the stuff that I was doing for National Board – such as video taping, which is not a common practice. And the kids don't act the same on videotape that they would act in normal circumstance. Getting all the kids to sign the release forms, you know – just you know the details of the National Board, I think lead me to maybe not – not think that it would benefit the students as much. Now ask me in 5 years after I've gotten the certification and I don't have to work on the specifics and don't have to videotape and don't have to jump through some of those hoops anymore. (Group 1, Teacher #20)

The first point of interest is Malcolm's use of the phrase “quickly removed” from the certification process. Four months after finishing the requirements of certification (including a summer vacation), this teacher is still racked with uncertainty about what was gained (if anything) from the experience. The second important point pertains to the comment, “and I haven't even found out if I've gotten it yet”. For Malcolm, there is a relationship between the learning experience and the status of a successful candidacy or not. If the teacher passes, they may look back on the experience in a more positive light and identify learning, if unsuccessful, the opposite might occur. This comment points to

the importance of collecting data from the post candidates prior to the announcement of results as was done in this study.

The third point of interest is the phrase, “I had to put a lot of time and effort into the National Board Certification itself”. The use of the word ‘itself’ is a direct indication of the technical dimension of learning associated with the certification process. The teacher is not identifying specific issues of pedagogy associated with a particular entry or artifact; the teacher is identifying the process of certification itself as the central issue. Malcolm goes on to describe how the ‘certification itself’ interfered with the quality of instruction for those students in class at the time of the portfolio construction.

Though Malcolm’s comment provides evidence that he may be an example of deferred learning, his comment also points to the technical learning. His comments about videos, release forms, and ‘the details of National Board’ all suggest that he learned quite a bit about the certification process. The issue is whether the technical learning Malcolm clearly experienced interfered with or contributed to the possibility of deferred learning. In other words, if the technical aspects of certification were not such a distraction for Malcolm, would his learning be more characteristic of Dynamic Learning? The relationship between Technical, Dynamic, and Deferred Learning could be further investigated in future research.

Additional Considerations for Learning Types

How often does each of these learning categories occur? What else might be helpful in understanding these possible interpretations of learning? What are the relative frequencies among candidates? I cannot answer these questions for the general population of AYA Science candidates, but I can make an educated guess for each within

the confines of the post-intervention interviews from this study. My estimation for the percent occurrence of each learning category is based upon my review of all post descriptions of the National Board certification experience and serves as a possible indicator for the relative frequency of each of the three learning types identified in this study. A review of all responses coded for dynamic, technical, and deferred learning (N=78 teachers) reveals that roughly equal numbers of teachers could be categorized as either 'Dynamic' or 'Technical' totaling a significant majority of nearly 90% of the post-interviews. A minority of 10% of the teachers could be categorized as 'Deferred'. Though not scientifically valid, these rates indicate a possible division between science teachers and the quality of their experience with National Board that will be explored further in the concluding thoughts section of this study.

With these learning types, I have categorized the expressed learning experiences in relation to their potential impact upon teacher quality. However, this is but one of many possible interpretations of the results. For example, the teacher's self-reports of learning from National Board could also be interpreted from an emotional perspective. A review of the comments classified as 'Dynamic' could be interpreted as coming from teachers who felt 'good' about the experience. For them, National Board certification was emotionally a very positive endeavor. Regardless of whether they ultimately passed or failed, these teachers connected with and appreciated the process on an intellectual, philosophical, and emotional level.

Likewise, a review of comments from teachers classified as 'Technical' could be interpreted as originating from a more negative emotion such as frustration, despair, annoyance, or futility. For these teachers, certification was a trial by fire that did not live

up to expectations or proved distasteful on an intellectual, philosophical, or emotional level. The 'Deferred' learners may simply be confused emotionally one way or the other. They remain uncertain if they liked it or not and only time will help them resolve (if ever) the situation. An emotional interpretation raises the question, "Why would some candidates react to the certification process in an emotionally positive, negative, or unsure sure fashion?" A possible answer will be discussed in the final section.

As teachers reflect on the process after the fact, many may be considering how to make use of things they learned, exploring discrepancies between their preferred methods and what they perceive to be preferred by the National Board. Such reflection can move in two directions—to reaffirm a teacher's commitment to his or her existing preferences, or to provoke some change. This study does not have data that could identify a teacher's preferred beliefs or values about their practice and how that practice compared to National Board's vision of accomplished teaching, prior to, during, or after the intervention. This investigation was focused on identifying what teachers may or may not have learned from certification, not in actual changes to practice. However, it is reasonable to conclude that to the extent that certification unsettled some teachers' thinking, the experience holds the possibility of ushering change—but only the possibility.

Study Summary

Before presenting my concluding thoughts on this research, I want to summarize the findings from this investigation and put the conclusions in a context of comparable research. Though the results from the Combined Hypothesis indicated an overall effect size 0.47 with learning identified in the areas of *Scientific Inquiry* and *Assessment*, the

methodological issues associated with data collection must qualify any conclusion drawn from the data. The limitations of this study are not numerous, but they are very important. Limitations in this study are associated with the recruitment of pre-intervention teachers in Group 2A, the small size of Group 2A, and a low inter-rater reliability measure. Taken together, these limitations explain why I failed to reject several Non-Equivalent Null Hypotheses. Though all mean differences in Non-Equivalent Hypotheses were in the predicted positive direction, their magnitude was not great enough to be significant at the 0.05 level. The most likely cause for non-significant differences can be traced to the lack of a true 'pre-intervention' status for the candidates. The lack of a true 'pre-status' was attributable to problems associated with Group 2A. Group 2A was shown to be problematic on several different accounts.

First, institutional and procedural obstacles hampered the timely and efficient recruitment of participants for Group 2A. The delays resulting from these obstacles resulted in a less than ideal 'pre-intervention' status for data collection. This problem was explored through a regression analysis between a candidate's sum score and the status of the candidate at the time of the pre-interview. Had the pre-interview occurred at an earlier point in the certification process, most likely the data collected from Group 2A-Pre would have resulted in more (if not all) Non-Equivalent Hypotheses being rejected.

Another unfortunate consequence that resulted from delays in recruitment pertains to variation in the selection and assignment of teachers to groups. In Groups 1 and 2 B, teachers were randomly selected from a list of willing candidates. However, for Groups 2 and 3 teachers were selected on a 'first come first serve' basis. In addition, Group 2 teachers were originally to be identified before the intervention and then randomly

assigned to either Group 2A or 2B. Because of the issues associated with recruitment problems, this became impossible.

Improved recruitment procedures would have allowed for more consistent use of a randomized selection process for all three groups and random assignment within Group 2 to either 2A or 2B. Because of these problems and the quasi-experimental nature of this research, the conclusions from this study are generalizable to secondary science teachers who self-select themselves for National Board certification in Adolescent and Young Adult Science. Thus, external validity is limited to this population of teachers.

Group size was another problem. The size of Group 2A was too small compared to the other groups. Because Group 2 was divided into Group 2A and 2B to check for the effect of testing, Group 2A-Pre ended up being less than half the size of Groups 1 or 3. And yet, Group 2A played a more central role in this analysis than any of the other 4 groups. Increasing Group 2's size would probably alleviate many of the methodological issues associated with this analysis. In retrospect, it would have been wiser to place 30 teachers in each of Groups 1, and 3 and 60 teachers in Group 2. With this allocation, there would be an equal distribution of teachers between Group 1, Group 2A, Group 2B, and Group 3. The study would have been the same size ($n = 120$), but Groups 2A and 2B would be larger to correspond with their greater presence in the series of Non-Equivalent and Equivalent, hypotheses.

Finally, inter-rater reliability was less than ideal for measurement instruments. Though a reliability of .43 between assessors is considered low to moderate in social research, there is reason to believe that with greater resources of time and money this reliability measure could have been improved. Had assessors met together as a group in

person for a weekend to wrestle with issues specific to this research, many of the inconsistencies observed could probably have been avoided. It is important to remember that collecting evidence on each of the 13 standards of accomplished teaching is a complex activity that could be improved with practice and discussion.

Turning to the qualitative data, this study is also significant in identifying which aspects of the National Board's standards appeared to exert the greatest influence. The consistency between identified quantitative gains and the number of teacher comments pertaining to specific standards provides support and internal confirmation about what teachers learned from the experience. Why the *Scientific Inquiry and Assessment* and not the others? Logic would suggest that the greatest learning is likely to occur where there was the largest discrepancy between "standards-based practice" and pre-existing teaching. If this is roughly true, then this study may indicate that many secondary science teachers are not emphasizing principles and practices of the scientific inquiry in their instruction, nor using assessment feedback in ongoing instructional decision-making. This conjecture points to these aspects of practice as needful of improvement in both pre-service and in-service education for science teachers.

In terms of possible impact upon Teacher Quality, the study uncovered a mix of what I call "dynamic," "technical," and "deferred" learning. This too seems quite plausible. Some teachers might regard Board certification as a genuine learning opportunity, others might undertake it for the extrinsic rewards, and still others might learn from the process in a gradually evolving manner. Mixed motives and outcomes are more nearly the norm in human affairs than singular or pristine results. In fact, the different categories of learning described in this study support the conclusion that Board

certification provides the opportunity for teachers to learn about specific aspects of their work. How that learning impacts practice remains unclear however.

Teachers in this study demonstrated significant learning in the areas of *Scientific Inquiry* and *Assessment* regardless of whether or not they were successful at achieving Board certification or the characteristics of their particular school setting. Therefore, it would appear that the benefits of Board certification go beyond the immediate financial rewards some successful candidates receive to take the form of improved knowledge and practice in science instruction for both those who achieve and those who do not achieve certification. If teacher learning is considered an important component to improving teacher quality and ultimately student achievement, then these results point to the possibility that the process of Board certification may positively impact the quality of instruction (as defined by the National Board) and students' learning experiences regarding two vital areas of instruction. Further research on this relationship is needed to pinpoint the degree to which science teaching improves, the duration of those changes, and the impact of changes in practice upon student achievement. On balance, though, I am inclined to read the overall pattern of results in support of National Board certification as a worthwhile form of professional development. The caveats, as always, are important, but so is the preponderance of the evidence.

Concluding Thoughts

So, after all the data collection, after all the analysis, and after the learning has been identified, quantified, and substantiated, what did I learn from this research experience that might be of value to the greater education community? How does the identified effect size of National Board certification compare with other science

education professional developments? How does this study's findings compare with other interventions concerned with human improvement? I will address the later questions first and end this discussion around possibilities for the future.

Determining the effects of professional development on teaching and learning is notoriously difficult as the procedural limitations of this study clearly indicate. In addition, theoretical concerns compound the problem. For example, teachers might acquire new knowledge or skills yet choose not to deploy them in their practice. Or they might make changes initially, but revert gradually to old ways. Or the changes they make might not enhance their practice. Learning identified may be attributable to some unseen variable not included in the analysis. Some prior scholarship reveals teachers importing only certain aspects of reforms into their teaching with uncertain overall and long-term effects. Describing such problems, investigators have resorted to such metaphors as "hybrids" to indicate the distinctive mix of grafting the new onto the old (see, for example, Cohen, 1990; Cuban, 1993). Furthermore, "change" does not automatically mean "improvement." The latter term requires a value judgment as well as an empirical result. In consequence, many problems attend any summary conclusions about teacher learning from professional development experiences. The study reported here cannot resolve such issues authoritatively. Results require qualified interpretation, which I offer along these lines.

First, the National Board standards represent a broad consensus within the science education community that, in Joseph Schwab's evocative terms, Science is a "narrative of inquiry," not simply a "rhetoric of conclusions" (Schwab, 1974). Instruction that aspires to teach students the methods of science is a critically important issue at the dawn of the

21st century. Consequently, the underlying values represented by the National Board standards constitute a professional consensus; what these standards “teach” about science instruction are eminently defensible.

Then, the overall effect size of 0.47 derived from multiple comparisons falls within the moderate to strong range based on several comparative criteria. In the field of science education, for example, a meta-analysis from the early 1980s serves as one comparison. Enz (1982) reviewed research projects that investigated the effects of professional development in science education on participating teachers and/or their students. In the sixteen studies gathered from 1973-1980, the overall average effect size for science in-service projects was 0.84. My results fall below this average, which would be regarded as on the high end of the range.

To gain further perspective, I examined two additional comparisons--Corporate Training and Psychotherapy—that also embrace complex interventions coupled with ambiguous outcome criteria. Companies spend billions of dollars annually to improve their employees’ ability to lead, produce, solve problems, and collaborate, and some research has examined the effects of corporate training. One research study examined eighteen training programs in one very large corporation over a four-year period; it identified effect sizes ranging from .09 to 1.11 with training focused on managerial skills resulting in an effect size of 0.31 (Morrow, et al., 1997). A meta-analysis of leadership development programs covering 83 studies from 1982 to 2001, found effect sizes for various categories of outcomes ranging from 0.35 to 1.37 (Collins & Holton, 2004). Another meta-analysis that looked at training programs in organizations found a more consistent result with effect sizes ranging from 0.60 to 0.63 (Winfred, et al., 2003).

Though the range of results varies, the evidence does suggest that the effects of corporate training generally can be described as ‘moderate’ to ‘large’ based on the conventional standard (Cohen, 1977).

Research that examines the effects of psychotherapy indicates a similarly large range. For example, a series of meta-analyses that examined different approaches to therapy and their impact upon patient improvement found effect sizes from 0.58 (Burlingame, et al., 2003) to 0.77 (Gregory, et al., 2004), to 0.84 (Bohlmeijer, et al., 2003). One meta-analysis that looked at Brief Dynamic Psychotherapy showed effect sizes ranging from 0.81 to 1.10 (Crisis-Christoph, 1992). Again, with effect sizes that can be described as ‘moderate’ to ‘large,’ these studies provide a fairly consistent picture that psychotherapy, as an intervention, is effective at addressing the short-term needs of patients.

I supply these comparisons just to bracket my findings. In practices devoted to human improvement, effects of interventions span a broad range, within which the results of this study may be placed. Generally, I conclude that my findings fall within the defined range.

I have spent the good part of the last four years focused upon this research project. This work has allowed me the privilege of conducting a prolonged deep reflection on issues of teacher learning, science education, teacher quality, and the National Board. In this section, I will share some of the ideas that this research experience has helped to shape. I do not mean to imply that the ideas that follow are a direct result of or found to be true because of the research presented in this dissertation. Rather, this discussion is meant to provoke thinking and discourse around issues underlying the work of the Board,

secondary science teachers, and the policy community. The ideas set forth in these last few pages are extrapolations and insights from the experiences that comprise every facet of this investigation. I present them as a means of informing educational stakeholders regarding issues inherent in the areas pertinent to the research. Those areas include the state of secondary science instruction, the National Board for Professional Teaching Standards, and the educational policies that can affect both.

The identification of dynamic and technical learning outcomes divided equally among candidates in this study provides insights into the confusing world of the science educator. What might explain such a clear division among science teachers concerning the quality of their learning experience with National Board? Possible answers include the role motivation plays in the teachers who opt to pursue certification and the beliefs and values teachers hold regarding their personal definition of accomplished teaching. I will consider motivation first and then professional beliefs.

Motivation plays a powerful role in the learning process. Teachers who are intrinsically motivated (i.e. a desire to improve) might tend to experience dynamic learning while those motivated by extrinsic forces (i.e. money) may tend to fall into the technical category. Since I have minimal data on motivation and 90% of my participants had some form of financial incentive, I am in no position to explore this possible relationship on any empirical grounds. However, I can provide some interesting speculation. If there were two different groups of candidates: 1) those who do pursue certification because they truly want to be considered Board certified, and 2) those who do it strictly for monetary gain, then I could infer that the former group would work hard, have an open mind, and probably be thought of as dynamic learners. The latter group

would be those pursuing certification to get the increase in salary or bonus attached to success. For folks in this group, I might infer that they would like to succeed with a minimum amount of work and sweat. It would be quite reasonable to think of these extrinsically motivated individuals as those who fall into the technical category.

However, such a distinction is flawed. Most likely, there is a range and mix of motivations responsible for individuals pursuing National Board. Just as some extrinsically motivated teachers might embrace the standards of accomplished teaching and become dynamic learners, there could be intrinsically motivated learners who never get beyond the technical aspects of certification. With this probability in mind, how should I think about the teachers in this study? Who were they? What motivated them?

I think the answer lies in the fact that these teachers self-selected themselves to participate in this study. My response rate for this study ranged from 10 to 50 percent. If these teachers belonged to the extreme end of the extrinsically motivated, then it does not make much sense that they would volunteer to participate in a time consuming educational study. On the other hand, if teachers had a high degree of intrinsic motivation (even if financial incentive was part of their decision to pursue Board certification), then I would imagine that they would be more likely to agree to an invitation to participate in a study. Therefore, I would argue that the teachers in this study could most likely be thought of as intrinsically motivated teachers. The 50-90% who never bothered to learn more about participating in this study are probably those extrinsically motivated learners whose aim was to achieve certification with as little time and effort as possible.

Why is this speculative assertion important? Because understanding the teachers in this study helps to appreciate what it is they have to say. More specifically, the identification of dynamic and technical learning outcomes divided equally among candidates in this study provides insights into the confusing world of the science educator. Secondary science teachers today are caught in bind between differing perceptions of what advanced teaching means (Strauss, 2004; Adelson, 2004). On one side are those who promote and identify excellent teachers by focusing upon the outcomes of practice (i.e. student achievement) and the teacher's content knowledge. The American Board for Certified Teaching Excellence represents this position best (ABCTE, 2005). An outcome based definition of successful science teachers does not care how teachers teach as long as they understand the content and can prove effectiveness through standardized test scores. Teachers who fulfill this definition may rely heavily (if not exclusively) on direct and undifferentiated instruction (Bishop, 2004). The role of inquiry is absent and assessment is only narrowly defined. How these teachers interact with colleagues, work with family and community, develop relationships with students, and contribute to the success of the school is absent from the picture. Also missing are the values and beliefs associated with how to prepare the way for productive student learning, how to advance student understanding, and how to establish a favorable context for student learning. Each of these areas of knowledge and skill are considered superfluous to the ultimate goal of higher student achievement.

On the other side, teachers are presented with a definition of accomplished teaching that focuses on process (the means and parameters of practice). In this view, represented by the National Board for Professional Teaching Standards, outcomes are

valued, but more broadly defined. Outcomes can be test scores but they can also be written work by students, artifacts that represent cognitive growth, as well as actions and achievements outside of class that contribute to the overall quality of teaching and learning. This complex perspective of advanced teaching defines 'accomplished' by not only considering teachers' content knowledge, but also by including the other dimensions associated with preparing, advancing, and facilitating student learning. However, the Board does not yet require standardized test scores as evidence of accomplished teaching or how standardized data could be used to improve instructional decisions²². For secondary science teachers, the messages received by representatives from both sides can be confusing and disorienting. Complicating matters, the issue has become politicized by the Bush administration and No Child Left Behind that provides federal funding for ABCTE, but has cut all funding to NBPTS. What is a teacher to do?

Teachers are in the impossible position of trying to find a way to serve two masters. On the one side, teachers feel tremendous pressure from school, district, and state agencies to improve student test scores by literally any means possible. For some teachers this means teaching for the test, which often results in dull and repetitive classroom experiences. And, on the other side, teachers must wrestle with the complex nature of practice revealed to them in teacher preparation programs, colleges of education, and advanced degrees programs. If these two opposing views were not difficult enough, teachers also face desperate parents who expect their child to not only do well on tests, but also develop a healthy self-esteem, a positive self-image as a learner,

²² It seems reasonable to consider that if the educational values shift to include a focus on standardized assessment, then the skills and knowledge required to use this new source of information to inform classroom practice should be included in the 13 standards of accomplished teaching. Possibly, in the next review cycle this idea could be considered.

and the skills and knowledge to be successful after graduation. Teachers today find themselves in a grave and perilous position of being damned if they do and damned if they don't. This dichotomy is based on the assumption that a more complex approach to teaching and learning may not result in adequate test scores or at least as good as those achieved through 'drill and kill' direct instruction. Even the National Board admits that a more complex approach to practice may "temporarily jeopardize students' performance on standardized tests (NBPTS, 1991, p. 25). However, one should consider the entire range of learning outcomes and not just standardized testing. How does this study help me understand the situation better?

National Board will not answer or resolve all the issues around effective pedagogy for science teachers. In fact, National Board certification may raise more questions than it answers. But, that's all right because in the realm of education where complexity is common and a 'silver bullet' solution is a myth, provoking reflection may be the most important outcome of any reform effort. For secondary science teachers considering National Board certification, this study provides greater awareness regarding likely learning outcomes from the endeavor. Teachers can make a more informed decision regarding whether or not to pursue National Board certification in AYA Science based upon what they are likely to learn. If a teacher wishes to align his/her practice more closely with the National Board's standards of scientific inquiry and assessment, then the certification process offers a viable option in the array of available professional development choices.

The National Board's purpose is to promote a 'peer developed' vision of what accomplished teaching looks like. If that mission is considered a positive message (that

teaching is a complex reflective practice that focuses on individual student needs in relation to the content), then the Board has been successful in getting a portion of the teaching community to investigate, consider, and even experiment with teaching by their standards. According to this study, most teachers' learning is focused on teaching science with inquiry and the assessment of student understanding.

Not everybody loves the experience. For some, the experience is a dynamic transformative learning venture and for others it is an ongoing technical task. The Board needs to appreciate the positive impact it is having on roughly half the candidates, but also needs to listen to and respect the voices of the discontent. The fact that roughly 40% of candidates learn about the standards and apply their learning immediately to the classroom is a success rate to be proud of.

However, the challenge for the Board is to figure out how best to hear the voices of those teachers who may very well be accomplished in the classroom, but just do not relate to the Board's standards for accomplished teaching. For example, Sam from West Virginia made this comment about the Board:

My practice doesn't match with standards I wanted to do what I would normally do. I did adjust to conform to the best I felt like I morally could. But I was just not going to make a contrived situation; but I did try to meet their criteria.
(Group 2B, Teacher #42)

Why did Sam not see his values or ideas of accomplished teaching reflected in the Board's vision? Sam describes a struggle between conforming to the requirements of the Board and what he believes to be best for his students. On the one hand he wants to 'try and meet their criteria' and on the other, he is 'not going to make a contrived situation'.

Melinda from Ohio had a similar experience to Sam. She states:

I felt that National Board Certification didn't value the same things that I was really good at. So I had to change my way of teaching to satisfy those requirements. (Group 1, Teacher #11)

This teacher believes that the Board did not 'value the same things' that she did regarding accomplished teaching. Though Melinda found the experience to ultimately be a positive one, she still believes that her ideas regarding good teaching are not fully represented in the Board's standards.

One possible explanation for Melinda's and Sam's struggles is that they believe in a vision of teaching with fewer complexities focused more on outcomes than on process. Maybe Sam and Melinda are fantastic lecturers who weave a tale of content that keeps his students enthralled with the content, personalities, and relevance of science to modern society. Perhaps, they have the standardized test scores, parent feedback, and student approval to back up their self-assessment. If true, Board certification would allow little opportunity for both teachers to showcase and provide evidence for their skills and accomplishments. Should the Board's definition of accomplished teaching be changed to include teachers like Sam and Melinda? If so, what would the changes look like?

If the Board were to revise its definition of accomplished science teaching to include a respect and recognition for the effective use of direct instruction, then maybe Sam would not have felt so caught in a bind. By including language in the standards that supports the effective and selective use of lecture and a portfolio entry targeting this set of skills and knowledge, the Board would promote a more balanced vision of how accomplished teaching is defined. I am not saying that teachers should not know how to assess student understanding, carry out scientific inquiry, or contribute to the community. However, I do think it is reasonable to include in the standards an aspect of science

instruction that nearly all science teachers employ at one time or another. Such an omission is quite conspicuous. Are we to assume that if a teacher knows and can do everything in the standards, then they are necessarily effective direct instructors? Such an assumption would be incorrect. If the Board's standards really are a 'broad consensus' of what accomplished teaching looks like, then the voices of teachers like Sam and Melinda need to be included in the standards re-evaluation process.

If the Board is to remain an organization run by teachers for teachers, then it must consider how differing skills and teaching contexts may promote differing ways of defining or at least identifying 'accomplished teachers'. Perhaps if candidates had a choice of completing 4 out of 5 entries or doing three mandatory entries and then a choice for a fourth, then a more inclusive definition of 'accomplished teaching' could be promoted. Such flexibility would allow for more teachers to see themselves reflected in the standards while not necessarily making it any less rigorous, productive, or valid.

Board certification offers teachers an opportunity to deeply consider a vision of accomplished teaching that may appear new, once known and forgotten, or a familiar friend. Not all teachers will be successful and not all teachers will embrace the process as professionally or personally fulfilling, but some (maybe half) will find the experience a powerful learning opportunity that has immediate and lasting impact. And the rest, those who learn but do not take their learning to heart, may be influenced by the experience in ways too subtle to observe. If they wait just a few seconds longer after asking a question or ask a couple more students what they think before giving an answer or taking a moment to consider other possibilities in planning and assessment, then maybe the experience was worthwhile for them too. Whether a teacher is ultimately successful at

achieving National Board certification is secondary to the experience itself. This study provides evidence that suggests that Board certification is a significant learning experience for AYA Science candidates.

It takes an ambitious and motivated teacher to even attempt National Board certification. Anyone who tries should be commended as honorable professionals willing to study their own practice through the magnifying glass of the Board's standards of accomplished teaching. Some teachers will already measure up and fit right into the accomplished teacher paradigm. Others will find it new and exciting work to be part of the emerging pedagogical fraternity. And still others may find the whole thing a waste of time.

If teachers have a difficult time trying to figure out what is the right thing to do, then what about the work of policy makers? What might this study mean to them? This investigation informs the discourse surrounding whether to provide financial and/or logistic support for Adolescent and Young Adult Science candidates. According to my findings, if a school, district, or state wanted to promote a greater understanding and use of scientific inquiry in their secondary classrooms or develop richer assessment skills among science teachers, then AYA Science certification provides an effective alternative to other professional development options. Whereas no policy is effective for everyone, National Board certification for AYA Science provides teachers with an opportunity to learn about a vision of accomplished teaching and make professional decisions around how best to improve their practice with students and the surrounding school community. Approximately half of the teacher reports indicate an immediate positive impact on their ability to bring forth learning in their students. For the policy-making community,

professional development that produces these types of results would seem to be of considerable value.

If policy makers only created policies that pleased everyone, nothing would happen very fast. However, a policy that provides an opportunity for every teacher to attempt Board certification and engage with the standards of accomplished teaching is one that has the potential to positively affect not only a great number of teachers who decide to accept the invitation, but their students, colleagues, and communities of those teachers too. What policy personnel should remember about this study and Board certification is that even if a candidate does not achieve certification on the first attempt, the effort and resources expended upon that candidate are not in vain.

Secondary science teachers learn about accomplished practice through Board certification. The effects of this learning upon teacher quality remain uncertain. However, in a field of faith and trust like education, where scientific principles answer few questions and intuition is overused, it is understandable why educators want something positive and dependable. Board certification offers the education community just such a promise. National Board certification exposes teachers to a vision of their profession that moves beyond knowledge and skill acquisition to embrace the beauty, complexity, and uncertainty that is this vision of teaching and learning. If change begins with learning, then National Board certification is a good place to start.

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**NATIONAL BOARD CERTIFICATION AS PROFESSIONAL
DEVELOPMENT:
WHAT ARE TEACHERS LEARNING?**

**An Empirical Investigation of the Learning Outcomes from the National Board
for Professional Teaching Standards' Certification Process**

Volume II

By

David Scott Lustick

A DISSERTATION

**Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of**

DOCTOR OF PHILOSOPHY

Department of Teacher Education

2005

Appendix A: Portfolio Prompts (Version 1.0)

Teaching a Major Scientific Idea

Overview & Context

- 1. What are the number, age(s), and grades(s) of the students in the class featured in this entry and the title and subject matter of the class?*
- 2. What are the relevant features of your teaching context (school, class, students, community) that were influential in developing your response to this entry?*
- 3. What is the major idea in science that you have chosen as the focus of your response to this entry?*
- 4. What were your goals for student learning in connection to the major idea during the featured period of instruction?*
- 5. Why do you consider this major idea in science and these goals to be important and appropriate for your students to learn about?*
- 6. What were the activities you and your students engaged in, and how were they sequenced and organized to build on student's interests, prior knowledge, and developing understandings as the sequence unfolded?*
- 7. What challenges are inherent in teaching this major idea to your students? How is your instruction designed to meet these challenges? Did you modify your planned instruction in any way to meet these challenges?*

Analysis of Instruction and Student Work

- A1. What are specific examples of ways the three activities worked together to further your students' understanding of the selected major idea in science?*
 - A2. What are specific examples of ways you provided student's with a context for the science featured in this sequence by establishing connections to student's backgrounds, experiences, and interests and/or to other disciplines and areas of study (e.g. mathematics, history, technology's impact on society, ethics, etc.) In other words, how do you help students make meaning of science and internalize its relevance?*
 - A3. What are specific examples of ways you make good use of instructional resources to support your teaching and extend student learning? Based on your students and your teaching context, why did you select these instructional resources to support your teaching?*
-
- B1. What are the educationally important characteristics of each of the three pieces of work? What does the work tell you about the students' growth in understanding of the major idea in science what does the work tell you about any challenges of misunderstandings this student is experiencing?*

Reflection

- 1. How successful was the instructional sequence in advancing student understanding of the selected major idea? What worked and what didn't work?*
- 2. What would you do differently, and why, if you were given the opportunity to teach this particular sequence with these students again?*

Whole Class Discussion

Instructional Context

What are the number, age(s), and grades(s) of the students in the class featured in this entry and the title and subject matter of the class?

What are the relevant features of your teaching context (school, class, students, community) that were influential in developing your response to this entry?

What are your goals for this lesson, including concepts, attitudes, processes, and skills you want students to develop?

Why are these important learning goals for these students?

How do these goals fit into your overall goals for the year?

Why is discussion a particularly useful teaching approach for addressing your goals for this lesson?

Videotape Analysis

How does what we see in the videotape fit into the lesson as a whole (i.e., what came before this part of the lesson, if anything, and what follows this part of the lesson, if anything)?

How well were the learning goals for the lesson achieved? What is the evidence for your answer?

How did your design and execution of this lesson affect the achievement of your instructional goals?

What interactions on the video tape show a student and/or students learning to reason and think scientifically and to communicate that reasoning and thinking?

How do interactions in the videotape illustrate your ability to help all students explore and understand the scientific concept(s) being discussed?

Reflection

As you review the videotape, what parts of the discussion were particularly effective in terms of reaching your goals with this group of students? Why?

What would you do differently if you had the opportunity to pursue this discussion in the future with a different class? Why?

Scientific Inquiry

Overview & Context

- 1. What are the number, age(s), and grades(s) of the students in the class featured in this entry and the title and subject matter of the class?*
- 2. What are the relevant features of your teaching context (school, class, students, community) that were influential in developing your response to this entry?*
- 3. What are your goals for this lesson, including concepts, attitudes, processes, and skills you want students to develop? Why are these important learning goals for these students?*
- 4. How do these goals fit into your overall goals for the year?*
- 5. Why is discussion a particularly useful teaching approach for addressing your goals for this lesson?*

The Video Tape

- 1. Citing specific evidence from the first segment of the videotape, how did you support student inquiry in order to conceptualize the primary questions and/or methodology of the investigation?*
- 2. Citing specific evidence from the second segment of the videotape, how did you support student inquiry during the collection and processing of data during the investigation?*
- 3. Citing specific evidents from the third segment of the videotape, how did you support student inquiry as they analyzed, considered, and evaluated the final results of the investigation?*
- 4. How well were the learning goals for this inquiry investigation achieved?*

5. *Cite one interaction on the videotape that shows a student and/or students learning to engage in scientific inquiry.*

6. *How did you make use of available resources to promote student learning and inquiry?*

Reflection

1. *As you review the videotape, what parts of the investigation were particularly effective in terms of reaching your goals with this group of students? Why do you think so?*

2. *What would you do differently if you had the opportunity to pursue this investigation in the future with a different class? Why?*

Assessment

Student Description

Assessment of Student B

Why did you choose this student? What instructional challenge(s) does this student represent? What is important to know about this student to understand and interpret the attached responses?

What are the educationally important characteristics of each of the pieces of work?

Taking the three pieces together, what does the work tell you about the student's growth in conceptual understanding of the concepts or skills featured in this period of instruction?

What does the work tell you about any challenges or misunderstandings this student experienced?

How did you assess these pieces of work, and what feedback or further instruction did you provide to the student based on your assessment?

How did your instruction or feedback contribute to this student's growth in understanding of the concepts or skills that were the focus of your instruction?

Reflection

1. *Taken together, what does the student work suggest about next steps for your instruction, for the class or for individual students?*

2. *What would you do differently, and why, if you were given the opportunity to teach this particular sequence with these students again?*

Context

- 1. What are the number, age(s), and grades(s) of the students in the class featured in this entry and the title and subject matter of the class?*
- 2. What are the relevant features of your teaching context (school, class, students, community) that were influential in developing your response to this entry?*

Instructional Context and Approach to Assessment

What were your goals and strategies for student learning during the featured period of instruction?

Content Goals:

Skill Oriented Goals:

Teaching Strategies:

Why do you consider these goals and strategies to be important and appropriate for your students?

What general criteria do you use to assess student work?

How are these criteria developed and how do you communicate them to your students?

What sources of evidence of student science understanding do you use in your assessment of student work?

What is your rationale for your approach to assessment? What is the relationship between your approach to assessment and the learning goals you set for your students? Why is this approach appropriate for your students?

Appendix B: Interviewee's Version of the Protocols

INTERVIEW PROTOCOLS

I. Teaching and Learning: See Artifact #1, #2, & #3

Please examine artifacts #1, 2, and 3. These artifacts are from a two-week science unit on the Kinetic Theory of Matter in a 10th grade general chemistry class. The teacher conducted pre-assessments and a post-assessments exercises. One of the pre- and post-assessments involved distributing the advertisement (Artifact #1) and asking students to write an essay that interprets the ad from a molecular point of view. Student A responded to the pre-assessment with Artifact display #2. At the end of the unit, Student A responded to the post-assessment with Artifact display #3.

Among the teacher's learning objectives for the unit were:

- 1) Students will know and understand the Kinetic Theory of Matter
- 2) Students will make connections between their background, experiences, and/or interests and the content material.

This assignment was used by the teacher to evaluate student learning of a core concept from the unit on the Kinetic Theory of Matter. More specifically, the assignment was constructed to gauge how well a student was able to describe the properties of matter at the macro level of analysis (solidity and liquidity). Furthermore, the students were expected to then explain the observable physical properties of matter from a molecular level of analysis (i.e., kinetic energy, intermolecular forces, and particle proximity).

At this time, please look over and examine Artifacts 1, 2, and 3. When you are ready, I will ask you some questions.

Imagine Something That Looks So Fluid Yet Feels So Solid.



Mercury Sable SE
Available Equipped
with Air and Design is the Fun

INTRODUCING THE ALL-NEW 1996 MERCURY SABLE
Imagine an automobile with styling so fluid it makes the word "aerodynamic" seem more quiet. Imagine the automobile is engineered to meet greater challenges and with each structural impact it feels as if it were forever from a single piece of steel. Imagine that is not only gas. **EXXON**

169999
As shown, MSRP. Excludes tax, title, license, and destination charge. Dealer sets actual price.

EXXON
The Power of Performance

Mercury

The car is sleek and aerodynamic like a drop of water. A drop of water is made of fluid molecules and it has no sharp edges. The car will flow down the road just like a drop of water will flow across a window. The car is not a fluid however. The car is made of solid materials like steel, plastic, and rubber. These things have sharp edges and are much stronger than liquids. Cars made of solid molecules are safer for the people inside because solid molecules are different than liquid molecules. It would be really hard to build a car out of liquids!

Artifact #3 --- Student A's Post-Assessment Response:

200

a liquid than in a gas. This attraction is known as intermolecular force. Since the bonds are weaker than solids, liquids, can take up any shape. If the car is liquid, the wind can go around it depending on how the liquid shapes itself. Liquids have a very low compressibility giving the viewer security as well. In the event of an accident even though the car moves so fast. Fluidity is a property that a liquid contains. If something flows, it is often seen as smooth and clean. Liquids, by having strong bonds, but relatively high molecular movement, move over surfaces like a snake in constant motion. This same idea is thought about the Mercury Sable.

When the author states “yet feels so solid”, he is trying to give the viewer comfort since the car looks like it moves so quickly. This relates to the kinetic theory of solids. The intermolecular bonds between the molecules are much greater than in liquids or gases. The molecules have much less kinetic energy and are found extremely close together. Since the car feels so solid, it gives the driver a sense control of what he is doing. Also, a solid has no compressibility and is extremely dense, giving the reader security in the event of a crash. The car will be able to withstand high amounts of impact. If something is solid, it has definite shape to it, therefore luxury. The car flows like a liquid, but is safe and comfortable at the same time.

II. Teaching and Scientific Inquiry

A teacher walks around the laboratory as students work in small groups on a lab exercise. The students are working on one of their first activities that addresses the evolutionary concept of ‘adaptation’ and Darwin’s theory of natural selection. Students are performing a version of the “Peppered Moth” adaptation lab using three different moth types. In the activity, red, white, and newspaper print moths are all set against a newspaper background. The purpose of the activity is to better understand how a range of characteristics in a species (in this case the color of the Peppered Moths’ wings) plays a role in the survival of the species.

Some of the teacher’s objectives for this activity include:

- 1) Students will understand how the environment interacts with a range of characteristics within a population through natural selection.
- 2) Students will learn to record and analyze data.
- 3) Students will experience the process of scientific inquiry and scientific reasoning.
- 4) Students will learn to work collaboratively in groups to solve problems.

The activity can best be described as a modeling of the predator-prey relationship. One student monitors the “environment” (newspaper and cutout moths) while the other students act as predators. In repeated cycles, the monitor adds new moths to the newspaper background and then other students in the group “attack” the environment, snatching the first moth they see. The monitor then replenishes the population with one of each moth type in preparation for the next round of predation. The following table provides the data for the activity after 20 rounds.

You can see the three moth types and how the numbers each of changes.

Data Table:

Predator Attack/New Generation	Number of White Moths	Number of Red Moths	Number of Newspaper moths
Before First Attack	33	34	33
After 10 th	34	14	43
After 20 th	33	1	53

A teacher listens to the group that recorded the information in the above data table have the following conversation regarding a question on the laboratory guide sheet. The question asks:

If the background for this activity were changed to a colorful type of paper such as the Sunday cartoon section or colorful wrapping paper, how might the population of moths used in this experiment change?

The group is made up of 4 students: 1 males-Evan, and 3 females—Latisha, Yanping, and Alejandra. Alejandra is from Equador and new to the class. She says nothing, but is listening and taking notes. Here is the conversation:

Evan: I don't think it would have any effect. The red ones would still get eaten the most because they are brightest and the newspaper moths would get eaten least because they blend in the most.

Yanping: Maybe, but in our experiment, the newspaper moths' population gets bigger because they are harder to see against the black and white newspaper background. But, if the background had lots of colors, then they might stick out and the red ones would be harder to see.

Latisha: O.K., but how will the population change? There are so few red ones now that I don't see how they could grow in numbers. And since there are so many newspaper ones now, I think that their population will stay the way it is.

Evan: I agree. If we change to the colorful background the population will stay the way it is. The number of newspaper moths will stop growing and the red moths will stop getting smaller.

Yanping: Well, the red can't get much smaller. Their population is already at one now. If it gets any smaller, they will disappear. When we started this experiment, there were equal numbers of all three moths. With the colorful background, couldn't the population change back to the way it was?

There is a long pause as the other group members provide no response to this question.

III. Description of a Successful Lesson

Take a moment and think of a recent class that was memorable because of the student learning that you believe took place. It should be a recent occasion from a specific class that you remember well and are comfortable discussing. When you have an example ready in your mind, I will ask you some questions.

IV. Examining a Whole class discussion in Science

The videotape (**Artifact #4**) contains a portion of a whole class discussion about science. The segment you are about to see is from an Advanced Placement Environmental Science Class made up of college bound 11th and 12th graders. They are an ethnically and linguistically diverse group of students. Countries from North and South America, Asia, and Europe are represented. English is a second language for most, though nearly all of them have been studying English since they started going to school.

They have been visiting a local ecosystem approximately once a month for the last six months with their teacher. They have worked in teams and individually to collect both biotic and abiotic data to help them answer the question: "Is this a healthy ecosystem?"

In the clip you are about to see, the teacher has just asked the students, "What is the one most important observation or finding from your individual projects that may shed some light on the health of this ecosystem?" The video clip presents several different students' individual projects focusing upon two different species: Water Cabbages and Ripple Bugs. Prior to this clip, each of the 4 teams shared their collective results on different areas of the preserve with the rest of the class. After the clip, each student was to provide a final conclusion regarding the health of the preserve. This is their last visit to the park.

The teacher has set several goals for this discussion:

- 1) Students will think and reason scientifically.
- 2) Students will communicate their ideas clearly to the group.
- 3) Students will demonstrate a sense of ownership over the discussion.
- 4) Students will come to a better understanding regarding the current status of the ecosystem under investigation.

At this time, I would ask you to please watch the videotape carefully and then I will ask you some questions. Feel free to take notes during the viewing and you may put the phone down if you so desire.

V. Accomplishments Outside of Class: The Impact on Student Learning

- a. The National Board for Professional Teaching Standards has deemed that accomplished teachers contribute to the teaching and learning of their colleagues and the quality of the professional community at large. For each of the following teacher professional development activities, please indicate whether or not you have direct experience with the item. Then, on a scale of 1-5 where 1 is 'no effect' and 5 is 'strong effect', rate each activity on its general ability to improve student learning. If you are unsure of the effect, you may enter a "3" or leave the rating blank.

Professional Activity/Accomplishment	Yes	No	Rating
a) Attending educational conferences/workshops			
b) Professional development activities at school			
c) Reading educational literature			
d) Reading scientific literature			
e) Writing educational articles (professional)			
f) Writing scientific articles			
g) Serving on an advisory committee at the school or district level			
h) Serving as a Union representative			
i) Developing science curriculum for your class, school, or district			
j) Mentoring a new/student teacher			
k) Leading a professional development workshop for your colleagues			
l) Taking a science course at a local university			
m) Collaborating with colleagues on an interdisciplinary project			
n) Pursuing National Board certification			
o) Taking an educational course at a local university			

- B. The National Board for Professional Teaching Standards has deemed that accomplished teachers know and make good use of all available resources in the community to improve student learning in the classroom. For each of the following community resources/activities, please indicate whether or not you have direct experience with the item. Then, on a scale of 1-5 where 1 is 'no effect' and 5 is 'strong effect', rate each resource/activity on its general ability to improve student learning. If you are unsure of the effect, you may leave the rating box blank.

Community Resource/Accomplishment	Yes	No	Rating
a) Participating in parent-teacher conferences			
b) Attending open house night			
c) Telephone calls to parents/guardians			
d) Emails communication with parents/guardians			
e) Assisting in scientific research with a local college			
f) Classroom observations from parents			
g) Contacting outside experts by telephone or email			
h) Recruiting guest speakers from the community			
i) Supervising after school activities			
j) Coaching sports			
k) Working with the Parent-Teacher Association			
l) Establishing a partnership with a local teachers' college			
m) Contributing time to local religious or charity groups			
n) Serving as an academic advisor to students			
o) Serving on the local Board of Education			

Appendix C: Interviewer's Structured Interview Protocols

INTERVIEW PROTOCOLS

Before we begin, do you:

- 1) Have a copy of the questions?**
- 2) Have the videotape and a VCR and television available?**
- 3) Have something to write with?**

Before we go to the handout, I have a few introductory questions I would like to ask.

Introduction Questions:

- 1) How long have you been teaching?**
- 2) What subjects and grade levels do you teach?**
- 3) How would you describe the school in which you teach?**
- 4) How would you generally describe your students?**
- 5) What is your average class size?**
- 6) Describe your current status with National Board regarding the Portfolio and assessment center exercises.**

I want to remind you again that our conversation is confidential and has no impact upon your assessment exercises or the National Board's evaluation of your work. I remind you of this so that, you will feel free to speak your mind in response to the questions in the handout.

I. Teaching and Learning: See Artifact #1, #2, & #3

Please examine artifacts #1, 2, and 3. These artifacts are from a two-week science unit on the Kinetic Theory of Matter in a 10th grade general chemistry class. The teacher conducted pre-assessments and a post-assessments exercises. One of the pre- and post-assessments involved distributing the advertisement (Artifact #1) and asking students to write an essay that interprets the ad from a molecular point of view. Student A responded to the pre-assessment with Artifact display #2. At the end of the unit, Student A responded to the post-assessment with Artifact display #3.

Among the teacher's learning objectives for the unit were:

- 3) Students will know and understand the Kinetic Theory of Matter**
- 4) Students will make connections between their background, experiences, and/or interests and the content material.**

This assignment was used by the teacher to evaluate student learning of a core concept from the unit on the Kinetic Theory of Matter. More specifically, the assignment was constructed to gauge how well a student was able to describe the properties of matter at the macro level of analysis (solidity and liquidity). Furthermore, the students were expected to then explain the observable physical properties of matter from a molecular level of analysis (i.e., kinetic energy, intermolecular forces, and particle proximity).

At this time, please look over and examine Artifacts 1, 2, and 3. When you are ready, I will ask you some questions.

Artifact #2 --- Student A's Pre-Assessment Response:

The car is sleek and aerodynamic like a drop of water. A drop of water is made of fluid molecules and it has no sharp edges. The car will flow down the road just like a drop of water will flow across a window. The car is not a fluid however. The car is made of solid materials like steel, plastic, and rubber. These things have sharp edges and are much stronger than liquids. Cars made of solid molecules are safer for the people inside because solid molecules are different than liquid molecules. It would be really hard to build a car out of liquids!

Two weeks later at the end of the unit on the Kinetic Theory of Matter, the same student responded to the same question with the following response:

Artifact #3 --- Student A's Post-Assessment Response:

The phrase used has much to do with chemistry, and has many little details to make the car sound so unique. First of all, the author of the quote wants the viewer to imagine the car as a liquid. According to the kinetic theory of a liquid; the molecules move faster than in a solid, but not as fast as gas. They are always in constant motion, relating to the car. The attraction between the liquids is greater in a liquid than in a gas. This attraction is known as intermolecular force. Since the bonds are weaker than solids, liquids, can take up any shape. If the car is liquid, the wind can go around it depending on how the liquid shapes itself. Liquids have a very low compressibility giving the viewer security as well. In the event of an accident even though the car moves so fast. Fluidity is a property that a liquid contains. If something flows, it is often seen as smooth and clean. Liquids, by having strong bonds, but relatively high molecular movement, move over surfaces like a snake in constant motion. This same idea is thought about the Mercury Sable.

When the author states "yet feels so solid", he is trying to give the viewer comfort since the car looks like it moves so quickly. This relates to the kinetic theory of solids. The intermolecular bonds between the molecules are much greater than in liquids or gases. The molecules have much less kinetic energy and are found extremely close together. Since the car feels so solid, it gives the driver a sense control of what he is doing. Also, a solid has

no compressibility and is extremely dense, giving the reader security in the event of a crash. The car will be able to withstand high amounts of impact. If something is solid, it has definite shape to it, therefore luxury. The car flows like a liquid, but is safe and comfortable at the same time.

Questions:

- 1) Based upon this student's two responses, how would you describe the student's growth in understanding about the kinetic theory of matter?
- 2) What evidence can you identify from the responses that supports your conclusion?
- 3) What does the work tell you about any misconceptions or gaps in understanding this student may be experiencing?
- 4) Based upon your comments and Artifacts 1, 2, & 3, describe the feedback or further instruction (if any) that the teacher should provide the student?
- 5) Do you think the car advertisement is an effective instructional resource in establishing a connection between the student's background, experiences, and/or interests and the content material? Why or Why not?
- 6) Based upon your comments and the artifacts provided, what advice might you give this teacher to improve this lesson/assignment in the future?

II. Teaching and Scientific Inquiry

A teacher walks around the laboratory as students work in small groups on a lab exercise. The students are working on one of their first activities that addresses the evolutionary concept of 'adaptation' and Darwin's theory of natural selection. Students are performing a version of the "Peppered Moth" adaptation lab using three different moth types. In the activity, red, white, and newspaper print moths are all set against a newspaper background. The purpose of the activity is to better understand how a range of characteristics in a species (in this case the color of the Peppered Moths' wings) plays a role in the survival of the species.

Some of the teacher's objectives for this activity include:

- 5) Students will understand how the environment interacts with a range of characteristics within a population through natural selection.
- 6) Students will learn to record and analyze data.
- 7) Students will experience the process of scientific inquiry and scientific reasoning.
- 8) Students will learn to work collaboratively in groups to solve problems.

The activity can best be described as a modeling of the predator-prey relationship. One student monitors the "environment" (newspaper and cutout moths) while the other students act as predators. In repeated cycles, the monitor adds new moths to the newspaper background and then other students in the group "attack" the environment, snatching the first moth they see. The monitor then replenishes the population with one

of each moth type in preparation for the next round of predation. The following table provides the data for the activity after 20 rounds.

You can see the three moth types and how the numbers each of changes.

Data Table:

Predator Attack/New Generation	Number of White Moths	Number of Red Moths	Number of Newspaper moths
Before First Attack	33	34	33
After 10 th	34	14	43
After 20 th	33	1	53

A teacher listens to the group that recorded the information in the above data table have the following conversation regarding a question on the laboratory guide sheet. The question asks:

If the background for this activity were changed to a colorful type of paper such as the Sunday cartoon section or colorful wrapping paper, how might the population of moths used in this experiment change?

The group is made up of 4 students: 1 males-Evan, and 3 females—Latisha, Yanping, and Alejandra. Alejandra is from Ecuador and new to the class. She says nothing, but is listening and taking notes. Here is the conversation: **(I can read this passage to you or you may read it yourself. Which would you prefer?)**

Evan: I don't think it would have any effect. The red ones would still get eaten the most because they are brightest and the newspaper moths would get eaten least because they blend in the most.

Yanping: Maybe, but in our experiment, the newspaper moths' population gets bigger because they are harder to see against the black and white newspaper background. But, if the background had lots of colors, then they might stick out and the red ones would be harder to see.

Latisha: O.K., but how will the population change? There are so few red ones now that I don't see how they could grow in numbers. And since there are so many newspaper ones now, I think that their population will stay the way it is.

Evan: I agree. If we change to the colorful background the population will stay the way it is. The number of newspaper moths will stop growing and the red moths will stop getting smaller.

Yanping: Well, the red can't get much smaller. Their population is already at one now. If it gets any smaller, they will disappear. When we started this experiment, there were

equal numbers of all three moths. With the colorful background, couldn't the population change back to the way it was?

There is a long pause as the other group members provide no response to this question.

Questions:

- 1) How do you think the teacher should respond to this group of students in order to support scientific inquiry? (If the teacher responds by saying "do the experiment", ask what is recommended if time is a limiting factor.)
- 2) Do you think your suggestion(s) supports student scientific inquiry? Would there be another one that might do more toward that goal?
- 3) Another one of the teacher's goals was to help students understand how the environment interacts with a species' population through natural selection. Do you think your suggestion(s) helps achieve that goal?
- 4) Suppose this teacher also said she had a professional goal of ensuring fairness, equity and access for all students. What steps (if any) should the teacher take to fulfill this objective?
- 5) From their discussion, what aspects of the interaction between the environment and species' characteristics do any or all of the students appear to understand and what misconceptions may still remain?
- 6) Do you see any evidence that any of these students are learning to engage in scientific inquiry? What evidence do you see?
- 7) If you had observed this lesson, and were a mentor to this teacher, what advice or guidance would you give this teacher regarding the planning or teaching of this lesson to this group of students?

III. Description of a Successful Lesson

Take a moment and think of a recent class that was memorable because of the student learning that you believe took place. It should be a recent occasion from a specific class that you remember well and are comfortable discussing. When you have an example ready in your mind, I will ask you some questions.

1. Please describe for me the setting for the class you will share. (What was the subject?, length of class?, when did this class take place?)
2. How many students were in the class and what grade levels were represented?
3. What were the student learning goals for this lesson?
4. Why were these goals important for these students?
5. How did these goals fit into your overall goals for the year?
6. What about this particular example of teaching and learning is most significant to you? (What happened in this class that was particularly memorable for you?)
7. What specific evidence helped you determine that you were successful at achieving the identified learning goals with your students?

8. Were there any ethnic, cultural, or linguistic diversity circumstances you considered in the planning and/or teaching of this class?
9. Did the range of abilities of the students (e.g., exceptional needs, cognitive, social/behavioral, attentional, sensory, and or physical challenges) and/or the personality of the class affect your planning? If so, how?
10. In the teaching of this lesson, did spontaneity play a role in the success of this class? If so, how?
11. What (if anything) would you do differently if you had the opportunity to pursue this lesson in the future? Why?

IV. Examining a Whole class discussion in Science

The videotape (**Artifact #4**) contains a portion of a whole class discussion about science. The segment you are about to see is from an Advanced Placement Environmental Science Class made up of college bound 11th and 12th graders. They are an ethnically and linguistically diverse group of students. Countries from North and South America, Asia, and Europe are represented. English is a second language for most, though nearly all of them have been studying English since they started going to school.

They have been visiting a local ecosystem approximately once a month for the last six months with their teacher. They have worked in teams and individually to collect both biotic and abiotic data to help them answer the question: “Is this a healthy ecosystem?”

In the clip you are about to see, the teacher has just asked the students, “What is the one most important observation or finding from your individual projects that may shed some light on the health of this ecosystem?” The video clip presents several different students’ individual projects focusing upon two different species: Water Cabbages and Ripple Bugs. Prior to this clip, each of the 4 teams shared their collective results on different areas of the preserve with the rest of the class. After the clip, each student was to provide a final conclusion regarding the health of the preserve. This is their last visit to the park.

The teacher has set several goals for this discussion:

- 5) Students will think and reason scientifically.
- 6) Students will communicate their ideas clearly to the group.
- 7) Students will demonstrate a sense of ownership over the discussion.
- 8) Students will come to a better understanding regarding the current status of the ecosystem under investigation.

At this time, I would ask you to please watch the videotape carefully and then I will ask you some questions. Feel free to take notes during the viewing and you may put the phone down if you so desire.

Questions:

- 1) How do you describe the academic atmosphere (learning environment) created by the teacher?
- 2) Suppose you were watching this classroom as a representative of an advisory committee focused on a school wide concern regarding teachers treating their students fairly and equitably. What evidence (if any) can you site from the tape that indicates that this teacher was, or was not, fair and equitable with learners?
- 3) How would you describe the level of student engagement in this clip?
- 4) According to the National Board's standards, accomplished science teachers facilitate and support meaningful scientific discussion. Do you think the teacher helps students explore and understand important scientific ideas? (What does this teacher do or not do that supports your answer?)
- 5) How would you describe the quality of student-to-student interactions with regards to scientific, analytical and/or critical thought?
- 6) Based upon the students who participated in this clip, how would you describe the level of student understanding regarding the process of scientific inquiry and content related to environmental sciences?
- 7) If this teacher were a colleague of yours and approached you for some input into this lesson, what advice, guidance, or insights would you offer that might improve the teaching and learning in this class?
- 8) In your opinion, what is the proper role(s) of the teacher in a whole class discussion about science?

If the teacher asks about the identity of the teacher or students, say: Due to confidentiality agreements with the National Board and Michigan State University, I am not allowed to comment on the identity of anyone appearing in the tape.

V. Accomplishments Outside of Class: The Impact on Student Learning

- b. The National Board for Professional Teaching Standards has deemed that accomplished teachers contribute to the teaching and learning of their colleagues and the quality of the professional community at large. For each of the following teacher professional development activities, please indicate whether or not you have direct experience with the item. Then, on a scale of 1-5 where 1 is 'no effect' and 5 is 'strong effect', rate each activity on its general ability to improve student learning. If you are unsure of the effect, you may enter a "3" or leave the rating blank.

Professional Activity/Accomplishment	Yes	No	Rating
o) Attending educational conferences/workshops			
p) Professional development activities at school			
q) Reading educational literature			
r) Reading scientific literature			
s) Writing educational articles (professional)			
t) Writing scientific articles			
u) Serving on an advisory committee at the school or district level			
v) Serving as a Union representative			
w) Developing science curriculum for your class, school, or district			
x) Mentoring a new/student teacher			
y) Leading a professional development workshop for your colleagues			
z) Taking a science course at a local university			
aa) Collaborating with colleagues on an interdisciplinary project			
bb) Pursuing National Board certification			
o) Taking an educational course at a local university			

1. Is there any other activity missing from this list that you think is especially helpful in improving student learning?

- B. The National Board for Professional Teaching Standards has deemed that accomplished teachers know and make good use of all available resources in the community to improve student learning in the classroom. For each of the following community resources/activities, please indicate whether or not you have direct experience with the item. Then, on a scale of 1-5 where 1 is 'no effect' and 5 is 'strong effect', rate each resource/activity on its general ability to improve student learning. If you are unsure of the effect, you may leave the rating box blank.

Community Resource/Accomplishment	Yes	No	Rating
a) Participating in parent-teacher conferences			
b) Attending open house night			
c) Telephone calls to parents/guardians			
d) Emails communication with parents/guardians			
e) Assisting in scientific research with a local college			
f) Classroom observations from parents			
g) Contacting outside experts by telephone or email			
h) Recruiting guest speakers from the community			
i) Supervising after school activities			
j) Coaching sports			
k) Working with the Parent-Teacher Association			
l) Establishing a partnership with a local teachers' college			
m) Contributing time to local religious or charity groups			
n) Serving as an academic advisor to students			
o) Serving on the local Board of Education			

4. Is there any other activity missing from this list that you think is especially helpful in improving student learning?
5. Based upon both of the above lists, which **one** activity do you think is most important to helping a teacher become more effective at improving student learning? Please explain your reasons for making this choice. (If they don't choose board certification, ask about why they rated NBC a _____.)

This concludes our conversation. I want to thank you for your time and participation in this study. Your thoughtful answers are greatly appreciated. There are a few final reminders I would like to leave you with:

Final Reminders:

- 1) Please fill out the top of page 1 and send the handout and videotape back to me in the SASE at your earliest convenience.
- 2) After I receive the handout and videotape, you should expect to receive your \$25 gift certificate to Amazon.com in 8-12 weeks. I will send you an email heads up when it will arrive.
- 3) Once again, on behalf of the National Board and Michigan State University, I want to thank you for your valuable contributions to this study. Good Luck with National Board certification and your teaching!

Appendix D: The NBPTS Standards for Accomplished Teaching in AYA Science

I. Preparing the Way for Productive Student Learning

I. Understanding Students- This scale pertains to Teacher Knowledge of students. More specifically, teachers know how students learn, actively get to know students as individuals, and determine students' understandings of science as well as their individual learning backgrounds.

II. Knowledge of Science- This scale pertains to teachers broad and current knowledge of science and science education, along with in-depth knowledge of one of the subfields of science, which they use to set important appropriate learning goals.

III. Instructional Resources- This scale pertains to teachers ability to select and adapt instructional resources, including technology and laboratory and community resources, and create their own to support active student explorations of science.

II. Advancing Student Learning

IV. Science Inquiry- This scale pertains to a teacher's ability to develop in students the mental operations, habits of mind, and attitudes that characterize the process of scientific inquiry.

V. Conceptual Understandings- This scale pertains to teacher's use of a variety of instructional strategies to expand students' understandings of the major ideas of science.

VI. Contexts of Science- This scale pertains to the ability of a teacher to create opportunities for students to examine the human contexts of science, including its history, reciprocal relationship with technology, ties to mathematics, and impacts on society so that students make connections across the disciplines of science and into other subject areas.

III. Establishing a Favorable Context for Student Learning

VII. Engagement- This scale pertains to teachers ability to stimulate interest in science and technology and elicit all their students' sustained participation in learning activities.

VIII. Equitable Participation – This scale pertains to ability of a teacher to take steps that ensure that all students, including those from groups which have historically not been encouraged to enter the world of science, participate in the study of science.

IX. Learning Environment- This scale pertains a teachers ability to create safe and supportive learning environments that foster high expectations for the success of all students and in which students experience the values inherent in the practice of science.

IV. Supporting Teaching and Student Learning

X. Family and Community Outreach- This scale pertains to the teacher's ability to proactively work with families and communities to serve the best interests of each student.

XI. Assessment- This scale pertains to a teacher's ability to assess student learning through a variety of means that align with stated learning goals.

XII. Reflection- This scale pertains to a teacher's ability to constantly analyze, evaluate, and strengthen their practice in order to improve the quality of their students' learning experiences.

XIII. Collegiality and Leadership- This scale pertains to a teacher's willingness and ability to contribute to the quality of the practice of their colleagues, to the instructional program of the school, and to the work of the larger professional community.

Appendix E: Portfolio Prompts and Interview Protocols Comparison

NBPTS Portfolio Entry	NBPTS Portfolio Prompt	Interview Prompt	Supported Standard in AYA Science
Context	What are the relevant features of your teaching context (school, class, students, community) that were influential in developing your response to this entry?	What subjects and grade levels do you teach? How would you describe the school in which you teach? What is your average class size?	I. Understanding Students
	What are the number, age(s), and grades(s) of the students in the class featured in this entry and the title and subject matter of the class?	How would you generally describe your students? What subjects and grade levels do you teach?	I. Understanding Students
I. Teaching a Major Idea over Time	What are the educationally important characteristics of each of the three pieces of work? What does the work tell you about the students' growth in understanding of the major idea in science?	Based upon this student's two responses, how would you describe the student's growth in understanding about the kinetic theory of matter?	X. Assessment
	How successful was the instructional sequence in advancing student understanding of the selected major idea? What worked and what didn't work?	What evidence can you identify from the responses that supports your conclusion?	X. Assessment
	What does the work tell you about any challenges of misunderstandings this student is experiencing?	What does the work tell you about any misconceptions or gaps in understanding this student may be experiencing?	II. Knowledge of Science
	Taken together, what does the student work suggest about next steps for your instruction, for the class or for individual students?	Based upon your comments and Artifacts 1,2, & 3, describe the feedback or further instruction (if any) that the teacher should provide the student?	VIII. Conceptual Understandings
	What are specific examples of ways you provided student's with a context for the science featured in this sequence by establishing connections to student's backgrounds, experiences, and interests and/or to other disciplines and areas of study (e.g. mathematics, history, technology's impact on society, ethics, etc.) In other words, how do you help students make meaning of science and internalize its relevance?	Do you think the car advertisement is an effective instructional resource in establishing a connection between the student's background, experiences, and/or interests and the content material? Why or Why not?	III. Instructional Resources

	What are specific examples of ways you make good use of instructional resources to support your teaching and extend student learning? Based on your students and your teaching context, why did you select these instructional resources to support your teaching?		
	What would you do differently, and why, if you were given the opportunity to teach this particular sequence with these students again?	Based upon your comments and the artifacts provided, what advice might you give this teacher to improve this lesson/assignment in the future?	XII. Collegiality and Leadership
II. Active Scientific Inquiry	How did you support student inquiry as they analyzed, considered, and evaluated the final results of the investigation?	How do you think the teacher should respond to this group of students in order to support scientific inquiry?	VII. Science Inquiry IV. Engagement
	How did you support student inquiry in order to conceptualize the primary questions and/or methodology of the investigation?	Do you think your suggestion(s) supports student scientific inquiry? Would there be another one that might do more toward that goal?	VII. Science Inquiry XIII. Reflection
	How did you support student inquiry during the collection and processing of data during the investigation?	Another one of the teacher's goals was to help students understand how the environment interacts with a species' population through natural selection. Do you think your suggestion(s) helps achieve that goal?	IX. Contexts of Science II. Knowledge of Science
	How do interactions in the videotape illustrate your ability to help all students explore and understand the scientific concept(s) being discussed?	Suppose this teacher also said she had a professional goal of ensuring fairness, equity and access for all students. What steps (if any) should the teacher take to fulfill this objective?	VI. Equitable Participation
	How well were the learning goals for this inquiry investigation achieved?	From their discussion, what aspects of the interaction between the environment and species' characteristics do any or all of the students appear to understand and what misconceptions may still remain?	X. Assessment
	Cite one interaction on the videotape that shows a student and/or students learning to engage in scientific inquiry.	Do you see any evidence that any of these students are learning to engage in scientific inquiry? What evidence do you see?	VII. Science Inquiry
	What parts of the investigation were particularly effective in terms of reaching your goals with this group of students? Why do you think so? What would you do differently if	If you had observed this lesson, and were a mentor to this teacher, what advice or guidance would you give this teacher regarding the planning or teaching of this lesson to this group of students?	XIII. Reflection XII. Collegiality and Leadership

	you had the opportunity to pursue this investigation in the future with a different class? Why?		
III. Whole Class Discussion	As you review the videotape, what parts of the discussion were particularly effective in terms of reaching your goals with this group of students? Why?	How do you describe the academic atmosphere (learning environment) created by the teacher?	V. Learning Environment
	Describe a specific example from this lesson as seen on the videotape that shows how you ensure fairness, equity, and access for all students in your class.	Suppose you were watching this classroom as a representative of an advisory committee focused on a school wide concern regarding teachers treating their students fairly and equitably. What evidence (if any) can you site from the tape that indicates that this teacher was, or was not, fair and equitable with learners?	VI. Equitable Participation
	What interactions on the video tape show a student and/or students learning to reason and think scientifically and to communicate that reasoning and thinking?	How would you describe the level of student engagement in this clip?	IV. Engagement
	What interactions on the video tape show a student and/or students learning to reason and think scientifically and to communicate that reasoning and thinking?	According to the National Board's standards, accomplished science teachers facilitate and support meaningful scientific discussion. Do you think the teacher helps students explore and understand important scientific ideas? (What does this teacher do or not do that supports your answer?)	VIII. Conceptual Understandings II. Knowledge of Science

IV. Community and Professional Development	In your work outside the classroom, what was most effective in impacting student learning? Why?	5. Based upon both of the above lists, which one activity do you think is most important to helping a teacher become more effective at improving student learning? Please explain your reasons for making this choice.	XII. Collegiality and Leadership XI. Family and Community Outreach
	Considering the patterns evident in all of your accomplishments taken together, what is your plan to further impact student learning in the future?	4. Is there any other activity missing from this list that you think is especially helpful in improving student learning?	XIII. Reflection III. Instructional Resources
Successful Lesson (Interview Only)	What are the relevant features of your teaching context (school, class, students, community) that were influential in developing your response to this entry?	Please describe for me the setting for the class you will share. (What was the subject?, length of class?, when did this class take place?)	I. Understanding Students
	What are the number, age(s), and grades(s) of the students in the class featured in this entry and the title and subject matter of the class?	How many students were in the class and what grade levels were represented?	I. Understanding Students
	What are your goals for this lesson, including concepts, attitudes, processes, and skills you want students to develop? Why are these important learning goals for these students?	What were the student learning goals for this lesson?	VIII. Conceptual Understandings
	Why are these important learning goals for these students?	Why were these goals important for these students?	I. Understanding Students
	How do these goals fit into your overall goals for the year?	How did these goals fit into your overall goals for the year?	IX. Contexts of Science

Appendix F: Assessor Training Materials

**Assessor Training Materials for the Research Project on
National Board Certification**

Principal Investigator: David Lustick

lustick1@msu.edu

**Institution: Michigan State University
Spring, 2003**

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- 7. Guide for using Scoring Rubric**
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- 9. Example #2**
- 10. Example #3**
- 11. Trial Transcript A**
- 12. Trial Transcript B**

National Board



AGREEMENT FOR THE CONFIDENTIAL AND APPROPRIATE USE OF NBPTS DATA

The National Board for Professional Teaching Standards (NBPTS) welcomes your willingness to engage in an important research study related to the NBPTS assessments and assessment process. In permitting you access to NBPTS data however, it is critical that the confidentiality of individuals and institutions not be compromised. It is also critical that NBPTS be informed of research initiatives for which NBPTS data will be used. Therefore, we ask for your signature to indicate your agreement to the following terms of confidentiality and data use:

1. You will have access to NBPTS data collected for and derived from a research study of the professional development learning of high school science teachers who participate in the National Board certification process (hereafter referred to as "THE DATA") being carried out by Mr. David Lustick at Michigan State University. Use of the data for any other studies will be considered as a separate request and will be governed by the National Board for Professional Teaching Standards' *Policy and Guidelines for Release of NBPTS Data for Educational Research* (see attached).
2. You will be responsible for maintaining confidentiality and appropriate use of the data by any and all colleagues who may come into contact with the data in the context of doing the aforementioned research.
3. You will be responsible for ensuring that the data are not shared with any other individuals, without express written consent from NBPTS.
4. You will be responsible for protecting all NBPTS data by ensuring that the data are stored in a secure manner.
5. You will be responsible for ensuring that all NBPTS data collected for, derived from and used in carrying out the aforementioned research are returned to NBPTS at the conclusion of the study.
6. The terms and conditions of this agreement shall remain in effect in perpetuity unless amended in writing by the National Board for Professional Teaching Standards.

Agreed to by:

David Lustick
Principal Investigator

Date

Barron D. Thatch
Project Manager

Date

Dear Assessors,

Scoring these 'entries' is quite similar to our work during the summer, however there are some key differences that I will elaborate upon here. Every effort has been taken to make these entries visually resemble the real thing. All of them have 12 point NY Times font and are double spaced. I have increased the margins slightly to reduce the number of pages. The prompt questions are all in bold font, while the answers are not.

The key difference with regard to the real thing, involves the fact that these entries address all of the standards for accomplished science teaching and not just those specific to one entry. This means that you will have to familiarize your self with some of the different entries and the 'foreign' standards such as those dealing with Professional Accomplishments and Community Outreach.

Once familiar with all the standards and what type of evidence to collect for each, the actual scoring should follow this routine:

- 1) Make sure that the ID number on the Scoring Rubric matches the ID number on the entry and envelope.
- 2) After reading each of the six parts to each entry, stop and write down any pertinent evidence in the space provided. The six parts include the Introductory questions and then the 5 problems. Since each question represents the focus of an entire portfolio entry, it helps to stop after each one. I would **not** read the whole thing and then do evidence. Since the questions, artifacts, and video are the same for every entry, you will soon be able to skip over all the bold parts cutting your working time significantly.
- 3) When writing evidence, try to include specific examples and generalized impressions. What does the preponderance of evidence suggest about a particular standard? Though I have done my best to align specific questions with specific standards, much overlap remains. **Evidence from any response can be used to support any standard.**
- 4) Once you have gone through all the questions and written down evidence, look over your work and fill in any gaps or forgotten evidence. Then, write down your score in the space provided for each standard. Your lowest score should be a "1.0". Write a "1" if its really terrible or no evidence is presented.
- 5) Make sure and initial your Scoring Sheet in the upper right hand corner, use the paper clip to attach it to the entry, and place both items into the properly marked envelope.

I have included a disk with the Scoring Rubric as a Word file. I found writing the comments on the computer and then printing it out, to be easier than doing it by hand. However, the choice is up to you. If at any time you have questions or issues, don't hesitate to email me. One more suggestion, make this experience as pleasurable as possible. Don't try and do to many at once. Take breaks. Once you start one, do your best to finish it at that sitting.

Thanks for your contributions to this study and please let me know how I can help.

David Lustick, lustick1@msu.edu

AYA Science Standards

Preparing the Way for Productive Student Learning

I. Understanding Students (p. 7)

Accomplished science teachers know how students learn, actively come to know their students as individuals, and determine students' understandings of science as well as their individual learning backgrounds.

II. Knowledge of Science (p. 11)

Accomplished science teachers have a broad and current knowledge of science and science education, along with in-depth knowledge of one of the subfields of science, which they use to set important appropriate learning goals.

III. Instructional Resources (p. 17)

Accomplished science teachers select and adapt instructional resources, including technology and laboratory and community resources, and create their own to support active student explorations of science.

Advancing Student Learning

IV. Science Inquiry (p. 33)

Accomplished science teachers develop in students the mental operations, habits of mind, and attitudes that characterize the process of scientific inquiry.

V. Conceptual Understandings (p. 37)

Accomplished science teachers use a variety of instructional strategies to expand students' understandings of the major ideas of science.

VI. Contexts of Science (p. 41)

Accomplished science teachers create opportunities for students to examine the human contexts of science, including its history, reciprocal relationship with technology, ties to mathematics, and impacts on society so that students make connections across the disciplines of science and into other subject areas.

Establishing a Favorable Context for Student Learning

VI. Engagement (p. 21)

Accomplished science teachers stimulate interest in science and technology and elicit all their students' sustained participation in learning activities.

VII. Equitable Participation (p. 29)

Accomplished science teachers take steps to ensure that all students, including those from groups which have historically not been encouraged to enter the world of science, participate in the study of science.

VIII. Learning Environment (p. 25)

Accomplished science teachers create safe and supportive learning environments that foster high expectations for the success of all students and in which students experience the values inherent in the practice of science.

**Supporting Teaching
and Student Learning****X. Family and Community Outreach (p. 49)**

Accomplished science teachers proactively work with families and communities to serve the best interests of each student.

XI. Assessment (p. 45)

Accomplished science teachers assess student learning through a variety of means that align with stated learning goals.

XII. Reflection (p. 53)

Accomplished science teachers constantly analyze, evaluate, and strengthen their practice in order to improve the quality of their students' learning experiences.

XIII. Collegiality and Leadership (p. 51)

Accomplished science teachers contribute to the quality of the practice of their colleagues, to the instructional program of the school, and to the work of the larger professional community.

INTERVIEW PROTOCOLS and Associated Standards

Introduction Questions:

These first 5 questions are meant correspond with each Teacher's coverage page to the entry. It should provide some context for the reviewer to better understand the answers that follow.

7) How long have you been teaching?

8) What subjects and grade levels do you teach?

9) How would you describe the school in which you teach?

I. Understanding Students (p. 7)

Accomplished science teachers know how students learn, actively come to know their students as individuals, and determine students' understandings of science as well as their individual learning backgrounds.

10) How would you generally describe your students?

I. Understanding Students (p. 7)

Accomplished science teachers know how students learn, actively come to know their students as individuals, and determine students' understandings of science as well as their individual learning backgrounds.

11) What is your average class size?

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I. Teaching and Learning: See Artifact #1, #2, & #3

This Question focuses on the standards addressed in the following entry:

Teaching A Major Idea Over Time - Teachers demonstrate how the design and actual practice of their teaching over time works to further students' understanding of a major idea in science. Teacher demonstrate their ability to select and justify the appropriateness of a major idea in science for their students, and to plan and implement sequenced instruction to facilitate their students understanding of that idea. Teachers submit a written commentary and activities that provide the context for their instructional choices and describe, analyze, and reflect on the student work and their teaching.

Overview:

Please examine artifacts #1, 2, and 3. These artifacts are from a two-week science unit on the Kinetic Theory of Matter in a 10th grade general chemistry class. The teacher conducted a pre-assessment and a post-assessment exercise. Both the pre- and post-assessments involved distributing the advertisement (Artifact #1) and asking students to write an essay that interprets the ad from a molecular point of view. Student A responded to the pre-assessment with Artifact display #2. Two weeks later, Student A responded to the post-assessment with Artifact display #3.

Two of the teacher's learning objectives for the unit were:

- 5) Students will know and understand the Kinetic Theory of Matter
- 6) Students will make connections between their background, experiences, and/or interests and the content material.

This assignment was used by the teacher to evaluate student learning of a core concept from the unit on the Kinetic Theory of Matter. More specifically, the assignment was constructed to gauge how well a student was able to describe the properties of matter at the macro level of analysis (solidity and liquidity). Furthermore, the students were expected to then explain the observable physical properties of matter from a molecular level of analysis (i.e., molecular bonds, intermolecular forces, and particle proximity).

Artifact #2 --- Student A's Pre-Assessment Response:

The car is sleek and aerodynamic like a drop of water. A drop of water is made of fluid molecules and it has no sharp edges. The car will flow down the road just like a drop of water will flow across a window. The car is not a fluid however. The car is made of solid materials like steel, plastic, and rubber. These things have sharp edges and are much stronger than liquids. Cars made of solid molecules are safer for the people inside because solid molecules are different than liquid molecules. It would be really hard to build a car out of liquids!

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Two weeks later at the end of the unit on the Kinetic Theory of Matter, the same student responded to the same question with the following response:

Artifact #3 --- Student A's Post-Assessment Response:

The phrase used has much to do with chemistry, and has many little details to make the car sound so unique. First of all, the author of the quote wants the viewer to imagine the car as a liquid. According to the kinetic theory of a liquid; the molecules move faster than in a solid, but not as fast as gas. They are always in constant motion, relating to the car. The attraction between the liquids is greater in a liquid than in a gas. This attraction is known as intermolecular force. Since the bonds are weaker than solids, liquids, can take up any shape. If the car is liquid, the wind can go around it depending on how the liquid shapes itself. Liquids have a very low compressibility giving the viewer security as well. In the event of an accident even though the car moves so fast. Fluidity is a property that a liquid contains. If something flows, it is often seen as smooth and clean. Liquids, by having strong bonds, but relatively high molecular movement, move over surfaces like a snake in constant motion. This same idea is thought about the Mercury Sable.

When the author states "yet feels so solid", he is trying to give the viewer comfort since the car looks like it moves so quickly. This relates to the kinetic theory of solids. The intermolecular bonds between the molecules are much greater than in liquids or gases. The molecules have much less kinetic energy and are found extremely close together. Since the car feels so solid, it gives the driver a sense of control of what he is doing. Also, a solid has no compressibility and is extremely dense, giving the reader security in the event of a crash. The car will be able to withstand high amounts of impact. If something is solid, it has definite shape to it, therefore luxury. The car flows like a liquid, but is safe and comfortable at the same time.

Questions:

- 7) Based upon this student's two responses, how would you describe the student's growth in understanding about the kinetic theory of matter?

X. Assessment (p. 45)

Accomplished science teachers assess student learning through a variety of means that align with stated learning goals.

- 8) What evidence can you identify from the responses that supports your conclusion?

X. Assessment (p. 45)

Accomplished science teachers assess student learning through a variety of means that align with stated learning goals.

9) What does the work tell you about any challenges or misunderstandings this student is experiencing?

II. Knowledge of Science (p. 11)

Accomplished science teachers have a broad and current knowledge of science and science education, along with in-depth knowledge of one of the subfields of science, which they use to set important appropriate learning goals.

10) Describe the feedback or further instruction (if any) that the teacher should provide the student based upon Artifacts 1, 2, & 3?

VIII. Conceptual Understandings (p. 37)

Accomplished science teachers use a variety of instructional strategies to expand students' understandings of the major ideas of science.

11) Do you think the car advertisement is an effective instructional resource in establishing a connection between the student's background, experiences, and/or interests and the content material? Why or Why not?

III. Instructional Resources (p. 17)

Accomplished science teachers select and adapt instructional resources, including technology and laboratory and community resources, and create their own to support active student explorations of science.

12) Based upon the artifacts provided, what advice might you give this teacher to improve this lesson in the future?

XII. Collegiality and Leadership (p. 51)

Accomplished science teachers contribute to the quality of the practice of their colleagues, to the instructional program of the school, and to the work of the larger professional community.

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II. Teaching and Scientific Inquiry

The focus of this question is to address the standards covered by the following entry:

- **Active Scientific Inquiry** - Teachers demonstrate how they engage their students in active scientific inquiry. Teachers demonstrate how they use discussion to support their students through different stages of the inquiry process. Teachers demonstrate their ability to assist students to conceptualize an investigation prior to the collection of data to help students inquire about the data as it is being collected and processed, and to analyze, interpret and synthesize the results of their investigations. Teachers submit a twenty-minute videotape and written commentary that contextualizes, analyzes, and evaluates their teaching throughout this process of scientific inquiry.

Overview:

A teacher walks around the laboratory as students work in small groups on a lab exercise. The students are working on one of their first activities that addresses the evolutionary concept of 'adaptation' and Darwin's theory of natural selection. Students are performing the "Peppered Moth" adaptation lab using red, white, and newspaper print moths set against a newspaper background. The purpose of the activity is to better understand how a range of characteristics in a species (in this case the color of the Peppered Moths' wings) plays a role in the survival of the species.

The teacher has several objectives in mind for this activity:

- 9) **Students will understand how the environment interacts with a range of characteristics within a population through natural selection.**
- 10) **Students will learn to record and analyze data.**
- 11) **Students will experience the process of scientific inquiry and scientific reasoning.**
- 12) **Students will learn to work collaboratively in groups to solve problems.**

Activity Description:

For the activity, students work in groups of 4 or 5. One student monitors the "environment" (newspaper and cutout moths) while the other students act as predators. In repeated cycles, the monitor adds new moths to the newspaper background and then other students in the group "attack" the environment, snatching the first moth they see (predation). The monitor then replenishes the population with one of each moth type in preparation for the next round of predation. The following table provides the data for the activity after 20 rounds of predation.

Data Table:

Predator Attack/New Generation	Number of White Moths	Number of Red Moths	Number of Newspaper moths
Before First Attack	33	34	33
After 10th	34	14	43
After 20th	33	1	53

The Situation:

A teacher listens to one group have the following conversation regarding a question on the Laboratory guide sheet. The question are asked to address is:

If the background for this activity were changed to a colorful type of paper such as the Sunday cartoon section or pages from a comic book, how might the population of moths used in this experiment change?

The group is made up of 4 students (1 males-Evan, and 3 females—Latisha, Yanping, and Alejandra). Alejandra is from Equador and new to the class. She says nothing, but is listening and taking notes. Here is the conversation:

Evan: I don't think it would have any effect. The red ones would still get eaten the most because they are brightest and the newspaper moths would get eaten least because they blend in the most.

Yanping: Maybe, but in our experiment, the newspaper moths' population gets bigger because they are harder to see against the black and white newspaper background. But, if the background had lots of colors, then they might stick out and the red ones would be harder to see.

Latisha: O.K., but how will the population change? There are so few red ones now that I don't see how they could grow in numbers. And since there are so many newspaper ones now, I think that their population will stay the way it is.

Evan: I agree. If we change to the colorful background the population will stay the way it is. The number of newspaper moths will stop growing and the red moths will stop getting smaller.

Yanping: Well, the red can't get much smaller. Their population is already at one now. If it gets any smaller, they will disappear. When we started this experiment, there were equal numbers of all three moths. With the colorful background, couldn't the population change back to the way it was?

There is a long pause as the other group members provide no response to this question.

Questions:

- 8) How do you think the teacher should respond to this group of students in order to support scientific inquiry?**

VII. Science Inquiry (p. 33)

Accomplished science teachers develop in students the mental operations, habits of mind, and attitudes that characterize the process of scientific inquiry.

- 9) Recall that one of the teachers' goals was to support student scientific inquiry. Do you think your idea supports student scientific inquiry? Would there be another one that might do more toward that goal?**

VII. Science Inquiry (p. 33)

Accomplished science teachers develop in students the mental operations, habits of mind, and attitudes that characterize the process of scientific inquiry.

XIII. Reflection (p. 53)

Accomplished science teachers constantly analyze, evaluate, and strengthen their practice in order to improve the quality of their students' learning experiences.

- 10) Another one of the teacher's goals was to help students understand how the environment interacts with a species' population through natural selection. Do you think your idea helps achieve that goal? Would there be another response that might do more toward that goal?**

IX. Contexts of Science (p. 41)

Accomplished science teachers create opportunities for students to examine the human contexts of science, including its history, reciprocal relationship with technology, ties to mathematics, and impacts on society so that students make connections across the disciplines of science and into other subject areas.

II. Knowledge of Science (p. 11)

Accomplished science teachers have a broad and current knowledge of science and science education, along with in-depth knowledge of one of the subfields of science, which they use to set important appropriate learning goals. ties to mathematics, and impacts on society so that students make connections across the disciplines of science and into other subject areas.

- 11) Suppose this teacher also said she had a goal of ensuring fairness, equity and access for all students. What steps should the teacher take to fulfill this objective?**

VI. Equitable Participation (p. 29)

Accomplished science teachers take steps to ensure that all students, including those from groups which have historically not been encouraged to enter the world of science, participate in the study of science.

- 12) From their discussion, what aspects of the interaction between the environment and species' characteristics do the students appear to understand and what misconceptions still remain?**

X. Assessment (p. 45)

Accomplished science teachers assess student learning through a variety of means that align with stated learning goals.

- 13) Do you see any evidence that any of these students are learning to engage in scientific inquiry? What evidence do you see?**

VII. Science Inquiry (p. 33)

Accomplished science teachers develop in students the mental operations, habits of mind, and attitudes that characterize the process of scientific inquiry.

- 14) If you had observed this lesson, and were a mentor to this teacher, what advice or guidance would you give this teacher regarding the planning or teaching of this lesson to this group of students?**

XIII. Reflection (p. 53)

Accomplished science teachers constantly analyze, evaluate, and strengthen their practice in order to improve the quality of their students' learning experiences.

XII. Collegiality and Leadership (p. 51)

Accomplished science teachers contribute to the quality of the practice of their colleagues, to the instructional program of the school, and to the work of the larger professional community.

VI. Description of a Successful Lesson

This question address most of the standards examined in the Assessment Center Exercises:

Exercise 1: Data Analysis-Teachers will demonstrate an ability to use sound principles of data analysis. Teachers will be asked to analyze, interpret, predict (extrapolate, interpolate), or infer using graphs or other data.

Exercise 2: Interrelationships-Teachers will show their knowledge of an understanding of the interrelationships that exist within their discipline. They will describe, provide specific examples, and analyze interrelationships.

Exercise 3: Fundamental Concepts-Teachers will be asked to demonstrate a depth of content knowledge in their specialized field. They will be given a visual or graphical representation of a concept and will give a description of the concept, analyze relationships, and discuss consequences of changes.

Exercise 4: Change over Time (Biological, Physical, and Earth Sciences)-Teachers will exhibit their knowledge of changes that occur over time in science. Teachers will explain changes that occur over time through a discussion of the underlying concepts or principles, a description of the mechanisms of change, and a discussion of the variables involved.

Exercise 5: Connections in Science-Teachers will show their ability to relate science content in their area of specialization to another context of science. They will describe a fundamental concept from their own specialty and relate the concept to other areas of science or to historical context, technology, or society.

Exercise 6: Breadth of Knowledge-Teachers will demonstrate knowledge across the science disciplines. Teachers will describe a major idea in science. They will then explain a concept in each of the three major sciences not in their specialty and relate the concepts to the major idea.

Take a moment and think of a recent class that was memorable because of the student learning that you believe took place.

- 1. Please describe for me the setting, subject matter, and context (school/ community) of this class.**
- 2. How many students were in the class and what grade levels were represented?**
- 3. What were the student learning goals for this lesson?**

VIII. Conceptual Understandings (p. 37)

Accomplished science teachers use a variety of instructional strategies to expand students' understandings of the major ideas of science.

4. Why were these goals important for these students?

I. Understanding Students (p. 7)

Accomplished science teachers know how students learn, actively come to know their students as individuals, and determine students' understandings of science as well as their individual learning backgrounds.

5. How did these goals fit into your overall goals for the year?

IX. Contexts of Science (p. 41)

Accomplished science teachers create opportunities for students to examine the human contexts of science, including its history, reciprocal relationship with technology, ties to mathematics, and impacts on society so that students make connections across the disciplines of science and into other subject areas.

6. How did (if at all) the characteristics of this class influence your planning or instructional strategies for this particular lesson? For example, were there any ethnic, cultural, or linguistic diversity circumstances you considered?

I. Understanding Students (p. 7)

Accomplished science teachers know how students learn, actively come to know their students as individuals, and determine students' understandings of science as well as their individual learning backgrounds.

VI. Equitable Participation (p. 29)

Accomplished science teachers take steps to ensure that all students, including those from groups which have historically not been encouraged to enter the world of science, participate in the study of science.

7. Did the range of abilities of the students (e.g., exceptional needs, cognitive, social/behavioral, attentional, sensory, and or physical challenges) and/or the personality of the class affect your planning? If so, how?

I. Understanding Students (p. 7)

Accomplished science teachers know how students learn, actively come to know their students as individuals, and determine students' understandings of science as well as their individual learning backgrounds.

- 8. In the teaching of this lesson, did spontaneity play a role in the success of this class? If so, how?**

XIII. Reflection (p. 53)

Accomplished science teachers constantly analyze, evaluate, and strengthen their practice in order to improve the quality of their students' learning experiences

- 9. What about this particular example of teaching and learning is most significant to you?**

V. Learning Environment (p. 25)

Accomplished science teachers create safe and supportive learning environments that foster high expectations for the success of all students and in which students experience the values inherent in the practice of science.

XIII. Reflection (p. 53)

Accomplished science teachers constantly analyze, evaluate, and strengthen their practice in order to improve the quality of their students' learning experiences

IV. Engagement (p. 21)

Accomplished science teachers stimulate interest in science and technology and elicit all their students' sustained participation in learning activities.

- 10. What specific evidence helped you determine that you were successful at achieving the identified learning goals with your students?**

X. Assessment (p. 45)

Accomplished science teachers assess student learning through a variety of means that align with stated learning goals.

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11. What would you do differently if you had the opportunity to pursue this lesson in the future? Why?

XIII. Reflection (p. 53)

Accomplished science teachers constantly analyze, evaluate, and strengthen their practice in order to improve the quality of their students' learning experiences

VII. Examining a Whole class discussion in Science

This question addresses the standards covered in the following entry:

Whole Class Discussions About Science - Teachers demonstrate how they engage a whole class of students in a discussion that increases their understanding of science and scientific thinking as the teacher facilitates a discussion that is interesting, accessible and relevant. Teachers demonstrate how they create a positive classroom environment to develop student conceptual understanding and their ability to engage in scientific thinking and reasoning. Teachers submit a twenty-minute videotape to show how they and their students engage in scientific discourse as the whole class explores a scientific theory, concept, principle, issue or methodological approach. Teachers also submit written commentary that contextualizes, analyzes, and evaluates their teaching through whole class discussion.

The videotape (Artifact #4) contains a portion of a whole class discussion about science. The segment you are about to see is from an Advanced Placement Environmental Science Class made up of college bound 11th and 12th graders. They are an ethnically and linguistically diverse group of students. Countries from North and South America, Asia, and Europe are represented. English is a second language for most. They have been visiting studying a local ecosystem approximately once a month for the last six months with their teacher. They have worked in teams and individually to collect both biotic and abiotic data to help them answer the question: "Is this a healthy ecosystem?" The videotape shows the students and their teacher discussing how their individual research projects may help address this question by sharing the one most important observation they each have made in their work. The video clip presents several different students' individual projects that focus upon two different species: Water Cabbages and Ripple Bugs. Prior to this clip, each of the 4 groups had just finished discussing their collective results on different areas of the preserve. After the clip, each student was to provide a final conclusion regarding the health of the preserve. This is their final visit to the park.

The teacher has set several goals for this discussion:

- 1) Students will think and reason scientifically.**
- 2) Students will communicate their ideas clearly to the group.**
- 3) The teacher will support and facilitate the discussion.**

- 4) Students will come to a better understanding regarding the current status of the ecosystem under investigation.**

Please watch carefully and then I will ask you some questions. Feel free to take notes during the viewing.

Questions:

- 9) How do you describe the learning environment created by the teacher?**

V. Learning Environment (p. 25)

Accomplished science teachers create safe and supportive learning environments that foster high expectations for the success of all students and in which students experience the values inherent in the practice of science.

- 10) What evidence (if any) can you site from the tape that indicates that this teacher is fair and equitable with learners?**

VI. Equitable Participation (p. 29)

Accomplished science teachers take steps to ensure that all students, including those from groups which have historically not been encouraged to enter the world of science, participate in the study of science.

- 11) How would you describe the level of student engagement in the class?**

IV. Engagement (p. 21)

Accomplished science teachers stimulate interest in science and technology and elicit all their students' sustained participation in learning activities.

- 12) Do you think that the teacher has been effective in facilitating and supporting meaningful scientific discussion where students explore and have the opportunity to understand important scientific ideas? What does this teacher do or not do that supports your answer?**

VIII. Conceptual Understandings (p. 37)

Accomplished science teachers use a variety of instructional strategies to expand students' understandings of the major ideas of science.

13) How would you describe the quality of student-to-student interactions with regards to scientific, analytical and/or critical thought?

X. Assessment (p. 45)

Accomplished science teachers assess student learning through a variety of means that align with stated learning goals.

14) Based upon the discussion presented in this clip, how would you describe the level of student understanding regarding pertinent scientific ideas?

I. Understanding Students (p. 7)

Accomplished science teachers know how students learn, actively come to know their students as individuals, and determine students' understandings of science as well as their individual learning backgrounds.

15) If this teacher were a colleague of yours and approached you for some input into this lesson, what advice, guidance, or insights would you offer that might improve the teaching and learning in this class?

XII. Collegiality and Leadership (p. 51)

Accomplished science teachers contribute to the quality of the practice of their colleagues, to the instructional program of the school, and to the work of the larger professional community.

XIII. Reflection (p. 53)

Accomplished science teachers constantly analyze, evaluate, and strengthen their practice in order to improve the quality of their students' learning experiences.

8) And what is the teachers' role in that discussion?

IV. Engagement (p. 21)

Accomplished science teachers stimulate interest in science and technology and elicit all their students' sustained participation in learning activities.

VIII. Accomplishments Outside of Class: The Impact on Student Learning

This question addresses the standards from the following entry:

Documented Accomplishments: Contributions to Student Learning - Teachers demonstrate their commitment to student learning through their work with students' families and community, their development as learners and as leaders/collaborators. This entry is designed to capture evidence of the way in which the role of a teacher is broader than what the teacher does in his or her classroom. Teachers submit descriptions and analysis of activities and accomplishments that clearly and specifically describe why they are significant in their particular teaching context and what impact they had on student learning. In addition, teachers are asked to compose a brief interpretive summary related to these accomplishments.

- a. **The National Board for Professional Teaching Standards has deemed that accomplished teachers contribute to the teaching and learning of their colleagues and the quality of the professional community at large. On a scale of 0-5 where 0 is no effect and 5 is strong effect, how do you rate each of the following professional activities for a teacher in their general effect at improving student learning?**

Professional Activity/Accomplishment	Yes	No	Rating
cc) Attending educational conferences/workshops			
dd) Professional development activities at school			
ee) Reading educational literature			
ff) Reading scientific literature			
gg) Writing educational articles (professional)			
hh) Writing scientific articles			
ii) Serving on an advisory committee at the school or district level			
jj) Serving as a Union representative			
kk) Developing science curriculum for your class, school, or district			
ll) Mentoring a new/student teacher			
mm) Leading a professional development workshop for your colleagues			
nn) Taking a science course at a local university			
oo) Collaborating with colleagues on an interdisciplinary project			
pp) Pursuing National Board certification			
o) Taking an educational course at a local university			

XII. Collegiality and Leadership (p. 51)

Accomplished science teachers contribute to the quality of the practice of their colleagues, to the instructional program of the school, and to the work of the larger professional community.

- b. Is there any other activity missing from this list that you think is important to improving student learning?**

XIII. Reflection (p. 53)

Accomplished science teachers constantly analyze, evaluate, and strengthen their practice in order to improve the quality of their students' learning experiences.

Community Resource/Accomplishment	Yes	No	Rating
a) Participating in parent-teacher conferences			
b) Attending open house night			
c) Telephone calls to parents/guardians			
d) Emails communication with parents/guardians			
e) Assisting in scientific research with a local college			
f) Classroom observations from parents			
g) Contacting outside experts by telephone or email			
h) Recruiting guest speakers from the community			
i) Supervising after school activities			
j) Coaching sports			
k) Working with the Parent-Teacher Association			
l) Establishing a partnership with a local teachers' college			
m) Contributing time to local religious or charity groups			
n) Serving as an academic advisor to students			
o) Serving on the local Board of Education			

XI. Family and Community Outreach (p. 49)

Accomplished science teachers proactively work with families and communities to serve the best interests of each student.

- 6. Is there any other activity missing from this list that you think is important to improving student learning?**

XI. Family and Community Outreach (p. 49)

Accomplished science teachers proactively work with families and communities to serve the best interests of each student.

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XIII. Reflection (p. 53)

Accomplished science teachers constantly analyze, evaluate, and strengthen their practice in order to improve the quality of their students' learning experiences.

- 7. Based upon the above lists, which one activity do you think is most important to helping a teacher become more effective at improving student learning? Please explain your reasons for making this choice.**

III. Instructional Resources (p. 17)

Accomplished science teachers select and adapt instructional resources, including technology and laboratory and community resources, and create their own to support active student explorations of science.

Notes to Assessors: Suggestions on Each Part of the Entry:

Introductory Questions

Gives you a sense of the context this teacher works in. What are their students like? Their school? How long have they been teaching? Additionally, evidence can be found regarding their knowledge of students and learning environment.

I. Teaching and Learning: See Artifact #1, #2, & #3

This question is modeled after Entry 1 Teaching a Major Idea over Time. I think it is important to look for balance in these responses. When all the answers to this section are viewed, a good analysis would not be limited to an assessment that is completely positive or completely negative.

II. Teaching and Scientific Inquiry

This question is modeled after Entry 2 Scientific Inquiry. Once again, balanced responses I think are best. For each part, there is plenty to criticize and commend. The best answers do both. Though teachers are told there is no 'right or wrong' answers to any question, there are some things which are more important than others. For example, in this scenario, Alejandra represents a real challenge to the teacher and the issue of equity and fairness. If the teacher ignores this, it is a problem.

III. Description of a Successful Lesson

This question is a combination of Entries 1, 2 and 3. Where the first two questions ask teachers to analyze a third part situation, Question III allows the teacher to discuss an example of their own practice. It also gives a second window of opportunity for the assessor to find additional evidence for any of the standards. Answers to these prompts also provide evidence to the consistency of a teachers responses. Do their answers correspond to other answers in the entry?

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IV. Examining a Whole class discussion in Science (Artifact #4)

Of course this question is most similar to Entry 4 on Whole class discussion on science. I would watch the tape for the practice pieces. By the time you are done with the first few, you should know it well enough to not watch it again. The video clip is from our summer training exercises. I used a six minute portion of my own entry. It is the same video used as a #4 Benchmark in our training. Though used as a “4”, the 6 minute clip I chose is far from perfect. There is plenty of good things happening, but also lots of room for improvement and criticism. Once again, a balance response in the entries is strongest.

V. Accomplishments Outside of Class: The Impact on Student Learning

This question is modeled after Entry 4 Professional Accomplishments and Community Outreach. For most cases, this Question V will be the only opportunity to assess the standards of Professional Accomplishments and Community Outreach. In many ways, this is the trickiest to assess. Basically, there are two parts to each section: The tables and the short answers. Look at each section separately.

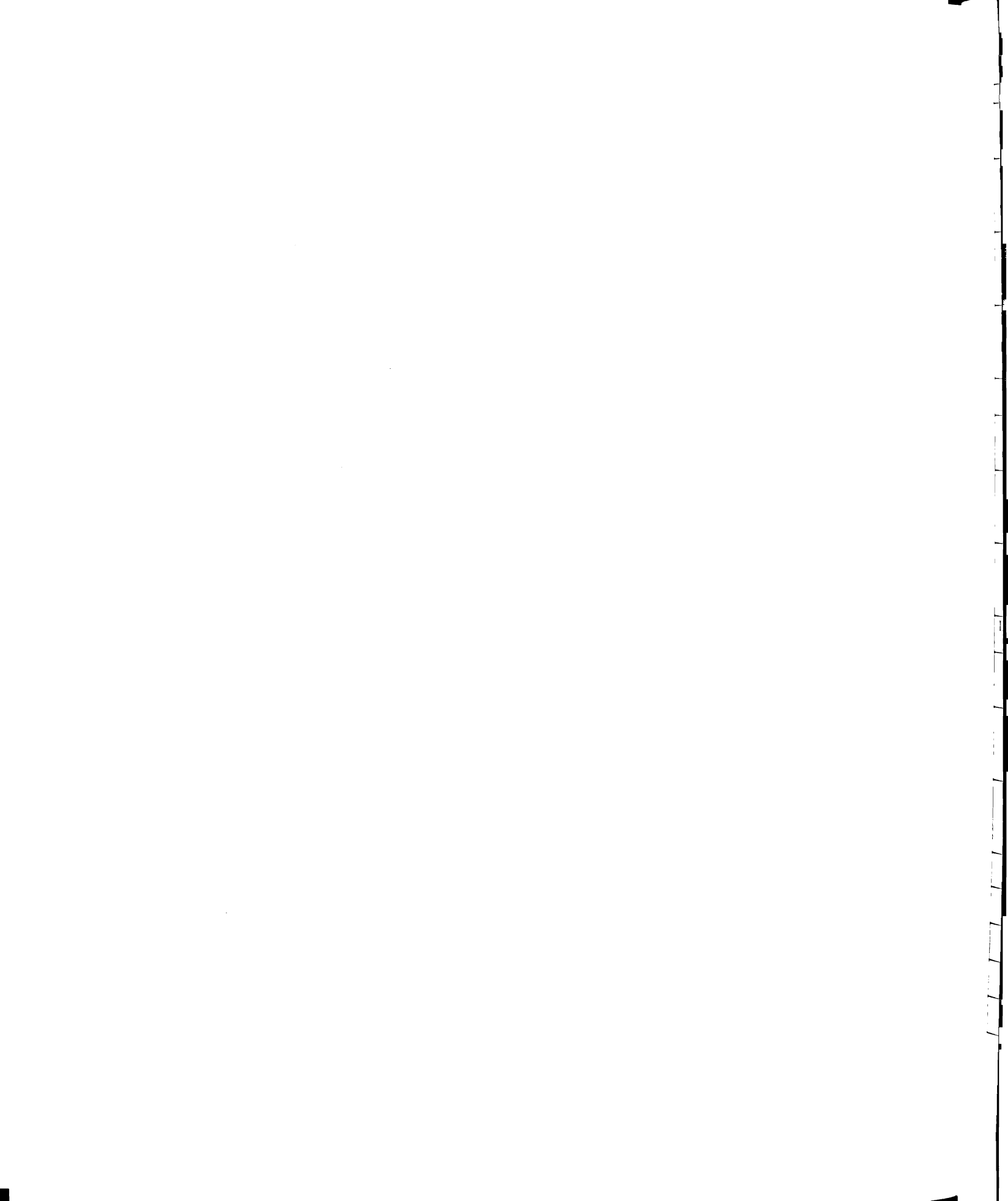
The first table shows responses to Professional Activities. Use this table to get an idea of where this teacher has experience and where they do not. Where are their priorities? Do they prefer structured or unstructured Teacher Professional Development (TPD) experiences? Do they value pedagogy? Content knowledge? Collaboration? What do they rate the highest? Lowest? What does this say about their Collegiality and leadership? Do they have something to add to the list? The list is NOT comprehensive. If they don't have something to add, this should count against them in scoring. If they do provide an additional activity to this list, do they also explain how it is related to student learning? Is their explanation clear and thorough?

For the second table, the teacher is reporting on their experiences and ideas about Community Resources and Outreach. Look to see how they value and interact with parents here. Do they rate encounters with parents relatively high (compared to their other ratings)? What are their extracurricular activities? How do they perceive the community? What do they rate the highest? Lowest? What does it say about their vision of community and outside resources to student learning? Do they have something to add to the list? The list is NOT comprehensive. For example, technology is completely absent from both lists. If they don't have something to add, this should count against them in scoring. If they do provide an additional activity to this list, do they also explain how it is related to student learning? Is their explanation clear and thorough?

Finally, the last question about which is most important and why, gives the assessor one last opportunity to find out where the teachers priorities/values/experiences lie and how they connect it to student learning. Use these answers to enrich the evidence for these two standards.

Standard to Assess	Evidence to Support Standard	Score
I. Preparing the Way for Productive Student Learning		
a) Knowledge of Students		
b) Knowledge of Science and Pedagogy		
c) Instructional Resources		
II. Advancing Student Learning		
d) Science Inquiry		
e) Goals and Conceptual Understanding		
f) Contexts of Science		
III. Establishing a Favorable Context for Student Learning		
g) Engagement		
h) Equitable Participation		
i) Learning Environment		
IV. Supporting Teaching and Student Learning		
j) Family and Community Outreach		
k) Assessment		
l) Reflection		
m) Collegiality and Leadership		

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Standard to Assess	Evidence to Support Standard	Score
I. Preparing the Way for Productive Student Learning		
a) Knowledge of Students	Does the teacher know how their students learn, actively come to know them as individuals, and determine students' understanding of science as well as their individual learning backgrounds?	
b) Content/Pedagogical Knowledge	Does the teacher have a broad/current knowledge of science and science education along with in depth knowledge of a subfield of science which they use to set important learning goals?	
c) Instructional Resources	Does the teacher select and adapt instructional resources including technology, laboratory, and community resources and create their own to support active student explorations in science?	
II. Advancing Student Learning		
d) Science Inquiry	Does the teacher develop in students the mental operations, habits of mind, and attitudes that characterize the process of scientific inquiry?	
e) Goals for Conceptual Understanding	Does the teacher set learning goals that are aligned, appropriate, and central to students and are a variety of instructional strategies used to expand students' understanding of major scientific ideas?	
f) Connections and Contexts of Science	Does the teacher create opportunities for students to examine the human contexts of science, relationships with technology, ties to math, impact upon society, and connections across disciplines?	
III. Establishing a Favorable Context for Student Learning		
g) Engagement	Does the teacher stimulate interest in science and technology and elicit all their students' sustained participation in learning activities?	
h) Equitable Participation	Does the teacher take steps to ensure that all students, including those from groups which have historically not been encouraged to enter the world of science, participate in the study of science?	
i) Learning Environment	Does the teacher create/promote a safe supportive learning environment that fosters high expectations for the success of all students and reflects values inherent in the practice of science?	

IV. Supporting Teaching and Student Learning		
j) Family and Community Outreach	Does the teacher proactively work with families and communities to facilitate ongoing mutually beneficial interactions that serve the best interests of each student's development and education?	
k) Assessment	Does the teacher assess student learning through a variety of means that align with, enhance the learning of, and further stated learning goals?	
l) Reflection	Does the teacher accurately and insightfully analyze, evaluate, modify, and/or strengthen teaching by suggesting next steps or alternative approaches that may improve students' learning?	
m) Collegiality and Leadership	Does the teacher contribute to the quality of their colleagues' practice, the instructional program, and the work of the professional community through collaboration or leadership?	

TRAINING ENTRY #1

Introduction Questions:

12) How long have you been teaching?

10 years

13) What subjects and grade levels do you teach?

Earth science and environmental science – 9th thru 12th

14) How would you describe the school in which you teach?

Well it's extremely multi-cultural – it's large, we have around 3400 students. It's in suburban area. We have – it's from Florida – we've got people from all over the place

15) How would you generally describe your students?

Right now – not in very good terms –Generally they are behind in reading – I teach regular kids. And they can't read. They can not write. They have very poor comprehension of what they read. They come from a lower middle class – it's a middle class type family. We have had an influx this year of students from the Glades – which is poor. We have -- I'm not sure how many on free lunch and free breakfast – probably not as many as used to be at – I'd say probably around 10 – 15%. It may have gone up this year

16) What is your average class size?

Well because we are going thru accreditation they are all 35

I. Teaching and Learning: See Artifact #1, #2, & #3

- 13) Based upon this student's two responses, how would you describe the student's growth in understanding about the kinetic theory of matter?**

He goes into a lot more detail in the 2nd response. He seems to understand more of the attraction between the molecules – how it works – how the molecules move – the fluidity of them. And also the fact the solids, of course, don't move as quickly and are closer together – extremely dense – was the term used. So it seems too that he has gained much greater understanding of the kinetic theory of matter.

- 14) What evidence can you identify from the responses that supports your conclusion?**

- 15) What does the work tell you about any challenges or misunderstandings this student is experiencing?**

Reading it as quickly as I did I didn't really notice that....It says it has sharp edges and that's not necessarily true.

- 16) Describe the feedback or further instruction (if any) that the teacher should provide the student based upon Artifacts 1, 2, & 3?**

Well – that's kind of difficult because I don't know what he was looking for to begin with really. I think that if I had a rubric going for it I would want to know the oh – the attraction between the molecules – being between the solid and the liquid molecule. And you know the bonds and all that – which he seems to have gotten. He says in here something about – the car is liquid, the wind can go around it depending on the liquid shape itself – have a low compressibility – where is what I'm looking for – in the event of an accident even though the car moves so fast – that's well anyway – talking about the security if it were a liquid – in the event of an

accident even though the car moves so fast – but then he talks down here and said – the solid is extremely dense and gives the reader greater security in the event of a crash. So he's saying that they are both secure. Well I would want to know which one would have the greater security. I mean can the liquid be punctured you know? Well he has definitely got the point between the attraction between the molecules and the gas – so that would be a positive thing. The gases- they are staged further apart – liquids are greater than a gas – I mean less than a gas than a solid thing more dense – so he has definitely got that and that's a good thing. He talks about the bonds. That's good. And he has got the point that there is a greater flow with liquids than there is obviously with a solid. They move – they are more fluid. It moves more quickly. And the intermolecular bonds between molecules greater in liquid than in gases. Wait a minute am I reading that right? The intermolecular bonds between the molecules are much greater than in liquid or gases. Ok. He's got the kinetic energy in there.

- 17) Do you think the car advertisement is an effective instructional resource in establishing a connection between the student's background, experiences, and/or interests and the content material? Why or Why not?**

Yea – I think it's an interesting way to look at it. Well because I think it will get the kids' attention. They are interested in cars.

- 18) Based upon the artifacts provided, what advice might you give this teacher to improve this lesson in the future?**

I don't know – I think it – probably if he could – I don't know if you could do it or not but I was thinking maybe try to show using something that were not as solid – you know a mold of some sort not a solid – like a jello or something and moving that and a car through you different things and showing how they move. That might

have a little bit you know – I don't know just right off the top of my head I don't know. Some kind of a demonstration – you know prior to giving them this advertisement – you know maybe punching it with a pen or like a solid and showing that the pen didn't go through that but I mean water – something like that -- some kind of a demonstration probably.

II. Teaching and Scientific Inquiry

c. How do you think the teacher should respond to this group of students in order to support scientific inquiry?

Evan thinks the red one will get eaten the most because they are the brightest and the newspaper moths will get eaten least because they are blended most. Ok well if they are – you should probably ask if they stand out more – wouldn't there be a greater change. In other words if the red ones – we'll go down to Latisha – there are so few red ones now I don't see how they can grow in numbers since there are so many newspaper ones now I think there population will stay the way it is. Couldn't she say well what if the newspaper moths stood out more now? You know – because then the red ones would blend in more and they might come back.

d. Recall that one of the teachers' goals was to support student scientific inquiry. Do you think your idea supports student scientific inquiry?

Well, if you are asking them – I mean I would put it in a question form and let them give me the answer. I mean Latisha is hypothesizing that that the red ones are going to die off. She doesn't think that they are going to be able to grow in numbers. But you are asking them to think about – you are asking them to hypothesize about what would happen if the newspaper moth/ones started standing out. And then if you change the colorful background, you are asking the same thing. It says the number

of newspaper – they think the number of newspaper moth will stop growing and the red moths will stop getting smaller. So they are hypothesizing that if we change the colorful background population it will stay the way it is – ok – so you could ask Evan to explain why he believes that the population will stay the way it is and you know substantiate his hypothesis.

Another one of the teacher's goals was to help students understand how the environment interacts with a species' population through natural selection. Do you think your idea helps achieve that goal?

Yes I do. Because I'm asking them to look at this and see what's going to happen if the background changes. And the moth – you know different moths stand more. If you look at the peppered moth experiment – you know – two different areas – the darker one survived one area and the lighter survived the other. You know. So yea.

- e. **Suppose this teacher also said she had a goal of ensuring fairness, equity and access for all students. What steps should the teacher take to fulfill this objective?**

Probably make sure that Alejandra is included in the group, which she hasn't been.

Perhaps she could draw one of the other kids aside and say – bring her into the group somehow. I've done that and that works – kids are always wanting to help each other if you suggest it – or perhaps the teacher could even bring her into the group.

But usually better to let the peer do it.

- f. **From their discussion, what aspects of the interaction between the environment and species' characteristics do the students appear to understand and what misconceptions still remain?**

Well it looks like they understand to a certain extent that the moth camouflage on the news print. So they understand that. And they understand that the population is going to get larger if they are harder to see. So they would understand that. But I

don't know that they understand the population change – cause they are taking about – they think the red ones will die out completely – which they might – but I mean – I don't think they are real sure about that.

- g. Do you see any evidence that any of these students are learning to engage in scientific inquiry? What evidence do you see?**

Yea. Well they are asking questions – you know. They are hypothesizing. They are asking questions. Will the colorful background – could the population change back the way it was. If we change the colorful background, the population will stay the way it is – they are saying – you know and then – they are saying the number of newspaper moths will stop growing and the red moths will stop getting smaller. So they are hypothesizing there. Then another one – Latisha says since there are so many newspaper ones now I think that their population will stay the way it is. So I mean they really – they have differing opinions – you know and they are forming different hypotheses. And then you know – others will come up with a question.

Why?

- h. If you had observed this lesson, and were a mentor to this teacher, what advice or guidance would you give this teacher regarding the planning or teaching of this lesson to this group of students?**

I don't know what she led off with – you know – I don't know how she set up the activity. I think perhaps I would have given them a little bit more guidance as far as a – she says she gave them a laboratory guide sheet. Is this the only thing that was on the laboratory guide sheet – if the background were changed from a colorful – is that the only question? If she gave them laboratory guide sheet, then perhaps she should have gone over it with them first. In a group and cleared up any misunderstandings or misconceptions they have prior to doing the inquiry.

IX. Description of a Successful Lesson

1. Please describe for me the setting, subject matter, and context (school/ community) of this class.

Subject matter was water sampling – we were checking for nutrients in the water in an environmental class – we happen to have a canal out back of the school. We were on a block schedule – so approximately 90 to 100 minutes – can't remember exactly how many minutes. It was in the morning couple of weeks ago.

2. How many students were in the class and what grade levels were represented?

35 students 10th thru 12th

3. What were the student learning goals for this lesson?

The goals – we have a water problem down here – as I'm sure everybody in the world does with the everglades restoration – and I wanted to bring home to them the fact that the nutrients in the water what they do – what caused what happened. My objective was to show them what the nutrients can do and this canal – it's out – it's behind a subdivision. There are alligators in the canal – there is very little fish that we could notice in there. When I saw fish I mean minnows or anything like that. Cause it appears that people are probably pumping their washers into the canal. And I wanted to just give them a little brief example cause all of these canal systems are tied into the everglades. And I wanted them to test for nutrients just to – you know the phosphorites, nitrates– things like in the water. Anyway all of these canal systems are tied in to the everglades that goes to Lake Augotschoe'chobie. And I thought that this is what we are going to do. I also had gone out to Augotschoe'chobie and I got water samples form the north side of the lake and the south of the lake. And brought them

back for them to sample those. I checked – I did the DO obviously out at the lake cause you can't – you have to do that right away. But we checked for dissolved oxygen content and in the canals I had the water sampling – the kinds were doing that and they – They really got into it. They were in groups of 3 to 4 and they were using chemicals. Some of them probably for the first time because they don't take chemistry. They take environmental science for their third science credit. They were excited – they were having fun. And you know they just really got into the class. And since then anytime anyone mentions any nutrients they know exactly what we are taking about. Nutrientization.

4. Why were these goals important for these students?

Because this affects them in everyday life. I mean this is our water supply. I wanted to bring it home to them. Also the fact that these students are not – have never really been environmentalists so to speak – they don't really care about the environment – it's there and it's always going to be there as far as they are concerned. But now they are seeing that the possibility of the fact that maybe it won't be.

5. How did these goals fit into your overall goals for the year?

Well, part of our sunshine state standards is to make them aware of their environment and particularly in the Florida – in the everglades. That's one of our curriculum that we are required to teach down here. So it fit in very well.

6. How did (if at all) the characteristics of this class influence your planning or instructional strategies for this particular lesson? For example, were there any ethnic, cultural, or linguistic diversity circumstances you considered?

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Yes it did. Because I have a kid that's in a wheelchair. And I did talk to the students prior to this and say how about helping me out here. And what they did with Billy was just basically picked the wheelchair up with him in it and off we went. I also have some ESL students – you know – they don't speak English that well. And I mix them in. I try to make my groups as heterogeneous as possible. But for this I definitely mixed them up and it was kind of neat to see them interacting.

7. Did the range of abilities of the students (e.g., exceptional needs, cognitive, social/behavioral, attentional, sensory, and or physical challenges) and/or the personality of the class affect your planning? If so, how?

Well yea, because some of the kids don't speak English as well. So that's why I put them into the heterogeneous groups. They are from all over the place – so I mean I don't have to deal with it that much. The kids are really – I'm amazed – I mean I'm constantly being surprised at their willingness to help each other. You know they will tease them sometimes but that's ok because the way they do it is not in a harmful way – and they really begin to feel like part of the crowd. And I've noticed too, that since doing this that the crowd has really bonded – the class has really bonded a lot more – you know. And there is a lot more interaction between them. And the Hispanic, Brazilian, Thai, everything else I've got in that class are more willing to get up and do a presentation or attempt a presentation in class. They are not worried about being laughed at. You know they can clap for themselves.

8. In the teaching of this lesson, did spontaneity play a role in the success of this class? If so, how?

Yea, to some extent. I had already prepared them and I even had a speaker come in from the water district – and we have videos and everything else.

9. What about this particular example of teaching and learning is most significant to you?

10. What specific evidence helped you determine that you were successful at achieving the identified learning goals with your students?

Because they were discussing it among themselves. They have asked me if we can do it again. And I've kind of – carried out in front of their nose – that we might even go out to the lake and do this. And they are after me to do that. I've taken them out before – it's a lot of fun.

Standard to Assess	Evidence to Support Standard T1	Score
I. Preparing the Way for Productive Student Learning		
n) Understanding Students	Fairly detailed descriptions of student demographics and school context. Seems to relate to students and their issues. Sensitive to lack of chemistry.	4
o) Knowledge of Science	Would use demos to enhance KT lesson. Would like rubric to improve lesson. Discusses water analysis, small groups, heterogeneous grouping.	3.75
p) Instructional Resources	Large class size. Makes use of canal behind school and local lake for water analysis. Chemical kits.	3.5
II. Advancing Student Learning		
q) Science Inquiry	Does not suggest that students actually perform moth experiment. Rather, teacher should clear up misunderstandings before activity.	2.5
r) Conceptual Understanding	Sets appropriate and meaningful goals and instructional strategies to get them to understand.	3.0
s) Contexts of Science	Mentions the real historical case of the moths as relevant to the work. Links class work to state frameworks and students lives.	3.75
III. Establishing a Favorable Context for Student Learning		
t) Engagement	Sees value in motivating students with artifacts. Highly values student participation from all. Fosters a strong classroom supportive community.	3.5
u) Equitable Participation	Recognizes Alejandra's situation and makes a recommendation that a peer do more to include her. Works with ESL, physically disabled, and low performing students. Accommodates all.	3.5
v) Learning Environment	Would like more structure to moth activity. Supportive and sensitive to differences.	3.25

IV. Supporting Teaching and Student Learning		
w) Family and Community Outreach	N/a	1
x) Assessment	Good assessment of student understanding with KT in question 1. Relies primarily on informal assessments. No mention of Data collection.	3.5
y) Reflection	Thorough reflection with good insights—class bonding, presentations, interactions.	3.5
Collegiality and Leadership	Does not offer any positive feedback to teachers, but does make recommendations.	3.0

TRAINING ENTRY #2

Introduction Questions:

17) How long have you been teaching?

This is my 8th year

18) What subjects and grade levels do you teach?

I teach science – I teach chemistry and physical science – I have most 10th graders but I get the whole range of high schoolers.

19) How would you describe the school in which you teach?

We have about 1500 students in the school--And it's about I don't know – 40% Arabic.

20) How would you generally describe your students?

How would I describe my students –uhm...just average teenagers I guess

21) What is your average class size?

24

I. Teaching and Learning: See Artifact #1, #2, & #3

- 19) Based upon this student's two responses, how would you describe the student's growth in understanding about the kinetic theory of matter?**

How would I describe the growthI think he had or she – I guess he – I would say sounds like he learned a lot. He's got a lot more of the vocabulary in there and seems to understand the concept a lot better in the 2 week. Ok – I think he understands the stuff much better in Artifact #3 than he did in #2. It sounds like he really got the point a lot better.

- 20) What evidence can you identify from the responses that supports your conclusion?**

Just – let's see.. he talks about the compressibility and what happens in a crash here. He says the solid has a definite shape and let's see – talks about liquids and the bonds a little bit and how fast the molecules are moving – So it sounds like he's got a better idea overall.

- 21) What does the work tell you about any challenges or misunderstandings this student is experiencing?**

Misunderstanding – ok ...uhm...let's see.....Uh....you know I don't see any misunderstandings in it. Seems like a good job. I didn't see any – any problems.

- 22) Describe the feedback or further instruction (if any) that the teacher should provide the student based upon Artifacts 1, 2, & 3?**

Well – let me see – Ask the question again – how would I make it better is that?

Okfeedback.....OkWell I think it looks pretty good – I mean he seems like he understood the kinetic theory pretty well. The teacher should just leave it the way it is – I would say.

- 23) Do you think the car advertisement is an effective instructional resource in establishing a connection between the student's background, experiences, and/or interests and the content material? Why or Why not?**

I think so – yea I really liked the idea of using the car. At first I didn't like it – but when you say does it capture his interest – it definitely got his interest here and I think that might be one of the big points you know. Get them interested in it. So I think it really does.

- 24) Based upon the artifacts provided, what advice might you give this teacher to improve this lesson in the future?**

Oh .. advice to improve... You know it's hard to say from one Artifact how if everybody got the idea but that's what would make me interested – to see how everyone else reacted. This might be like his best student and he really got the – I mean if everyone got it as well as this guy did – I'd say keep this lesson the way it is. If some folks didn't get it – maybe – you know a few more examples.

II. Teaching and Scientific Inquiry

- i. How do you think the teacher should respond to this group of students in order to support scientific inquiry?**

How to respond to this group of students....to support scientific....Uhm – well Yanping says the red can't get much smaller – but maybe the teacher might say – well is there a number lesson one – you know – and they will say well yea – of course zero – so she might – the teacher might ask – what do we call it when there's no – no more of that species left. And maybe they might understand extinction a little bit that way too.

- j. Recall that one of the teachers' goals was to support student scientific inquiry. Do you think your idea supports student scientific inquiry? Would there be another one that might do more toward that goal?**

How does my suggestion support student scientific inquiry? Uhm...it might help them ask how some species disappear or get extinct and how some actually thrive in a changing environment.

- k. **Another one of the teacher's goals was to help students understand how the environment interacts with a species' population through natural selection. Do you think your idea helps achieve that goal? Would there be another response that might do more toward that goal?**

I think so. Uhm....well if the population gets so low that they're naturally selected out; I think that they need to understand the environment – the change in the environment makes a big difference. Uhm....or at the end here Yanping says something about the red can't get much smaller and there's only one moth – one red moth at the end. So the teacher might say well what if we had another round – what might happen – you know – even if we changed the backgrounds – there's only one red moth left. They see that red moth then that's the end of him.

- l. **Suppose this teacher also said she had a goal of ensuring fairness, equity and access for all students. What steps should the teacher take to fulfill this objective?**

She wants to get equity and access for all students....Uhm..well it seems like the one student there is just taking notes and not really – not really participating. So I might suggest a smaller groups. Uhm...I think that would force more of them to get involved.

- m. **From their discussion, what aspects of the interaction between the environment and species' characteristics do the students appear to understand and what misconceptions still remain?**

Ok – what do they understand? Well Evan talks about how the red ones get eaten most cause they are the brightest – so uhm. . I think he understands that – oh yea,

cause the newspaper ones get eaten least cause they blend in the most. So he understood that – maybe he didn't understand what – how – let's see...(red ones still get eaten the most cause they're the brightest – they blend in) .. I don't think – I think he understood that the newspaper moths blended in and the red ones were bright so they didn't blend in – so I don't think he understands unless he actually sees it – how the new environment is going to affect it. I don't think that he understands that the red ones might not stick out as much and the newspaper colored ones are going to actually maybe not blend in as much as they did before. Uhm....Latisha and Yanping say 'well there are so few red ones now that they might disappear and they are not sure that you know the population can make a comeback. And I think that's something that was a good idea to – cause I think if the red ones get so low that they might not be able to come back. One little predator comes along and gets that last one – just by chance maybe and they are gone. So I think – I think they understand that the population change can actually be – you know – a loss of an entire group.

- n. Do you see any evidence that any of these students are learning to engage in scientific inquiry? What evidence do you see?**

Uhm.....I see Latisha here she said uhm....the red ones would be harder to see – and she says ok how is the population change? There is so few red ones now I don't see how they can grow in number. So again, she is concerned about – you know the red moths completely going away and how can the population change. So I think she is asking a good question.

- o. If you had observed this lesson, and were a mentor to this teacher, what advice or guidance would you give this teacher regarding the planning or teaching of this lesson to this group of students?**

Uhm....I think the one thing I'd suggest would be a smaller group. I think 4 might be – 4 might be too big --I think it said they had groups of 4 or 5. I might like to see groups of 2 or 3. To keep everybody more involved in that. And uhm.....maybe I don't know – do it – do it once and have them figure out what's going on. And try again and maybe throw in not only the actual comic stuff the next time – you know the comic newspaper – maybe throw in a oh I don't know – some super moth or genetically enhanced moth or something like that – one weird one like that.

Uhm...like I don't know say they have a moth that's cut out of – you know the comics and it would blend in nicely with the comics and then they have one cut out of I don't know – bright yellow construction paper and he doesn't blend in with almost anything. So maybe – you know – they would – I don't know if it probably an extension of the lesson – but you know how things change and mutate – this might actually help understand – help the students understand a little more about how the environment reacts with the population.

Now suppose that this conversation – this situation that we have here – suppose it takes place with very little time left in class. In light of your last suggestion regarding trying the experiment with a different color, what would you recommend the teacher do in that situation?

Oh I think that's a good activity. I'd have them try again on the next day or a couple of days later. Actually sleep on it over night – they might think about it a little more too.

X. Description of a Successful Lesson

- 1. Please describe for me the setting, subject matter, and context (school/ community) of this class.**

I had one real short thing in a physical science class recently – we were talking about how things of different mass can actually fall at the same speed and the students didn't get that right away – so the textbook had a picture and we actually did it in class. We took two identical sheets of paper and said ok – they are the same sheet of paper right? – Same – everything is the same on it – yep ok – they are the same. And we crumpled one up in a small ball and we dropped them both at the same time and the flat sheet of paper, of course, fell more slowly than the crumpled up one because it had more area in it. And I said well why did the crumpled up one fall faster? And some of them said because it was more dense. And I said well that's probably true – it's a little more dense – I said there's more to it than that. And I said what actually floated down? And they said oh well the air – you know the float sheet down.

I said good, good – I said – I asked them – you know – how would this work on the moon? And they said well since there's no air on the moon and there is no gravity it would just float there. And I said wait a minute, there's no gravity on the moon. So I got a little video and I showed them the Apollo 13 astronauts dropping the hammer and feather on the moon. And they said – oh well ok – So they kind of got that since there's no air – but there is gravity – that they fall at the same time.

And we talked a little bit about Galileo's experiment and then out of the blue this one kid ---he says Mr. Brown I got an experiment to show you here – so he took the same crumpled up sheet of paper and took the same flat sheet of paper – only this time he

put the flat sheet of paper – held it by the ends and it just like cut thru the air – it had no air resistance at all. It was only like 3 feet off the ground – and it hit the floor first. I said wow that was pretty good. And he really took it a step further than I ever had before. He turned the paper sideways and – you know – the thin part of the paper – went straight down – it just dropped right to the ground before the other sheet of paper – you know the crumpled up one. So he actually – you know – I think he actually learned something and he understood the concept.

2. How many students were in the class and what grade levels were represented?

There was about 22 students in this class and mostly 9th and 10th graders – I think they are all 9th and 10th graders---the class period--55 minutes---It was actually about 3 weeks ago

3. What were the student learning goals for this lesson?

Well I wanted them to understand that things fall at different rates on earth because of air resistance not because of how gravity affects them.

4. Why were these goals important for these students?

Why is it important for these students?uhm – let me think I think it's just a good general science concept that helps them understand the world around them.

5. How did these goals fit into your overall goals for the year?

I would say it was – I think it fit well – I think it was a good learning experience that we had.

6. How did (if at all) the characteristics of this class influence your planning or instructional strategies for this particular lesson? For example, were there any ethnic, cultural, or linguistic diversity circumstances you considered?

Uhm...I do think about that – fortunately our school has a bi-lingual program for the Arabic students – so a lot of them are bi-lingual in my class so – I give them a little extra time in class – just like one has to interpret a word or two for another student. So that's the only diversity problem that I sometimes see.

- 7. Did the range of abilities of the students (e.g., exceptional needs, cognitive, social/behavioral, attentional, sensory, and or physical challenges) and/or the personality of the class affect your planning? If so, how?**

Their personality of the class affects my planning. They are a pretty wild group so I tend not to have too many crazy activities for them. At least not in-doors. At least not in-doors. If we are going to do something really active – I take them outside.

- 8. In the teaching of this lesson, did spontaneity play a role in the success of this class? If so, how?**

Yea actually it did. That one student got up – here Mr. Brown let me show you this – and he took the 2 sheets of paper – so that was really good. I gave him extra credit for that – cause it was such a leap forward for him especially. Wow Mr. Brown learned something from one of us – that's great.

- 9. What about this particular example of teaching and learning is most significant to you?**

- 10. What specific evidence helped you determine that you were successful at achieving the identified learning goals with your students?**

Well I did have a final test for them that asked some very specific questions about things dropping like that and most of them seemed to get – there were a few that just still hung onto their perceived notion that – you know – when I crumpled up the one it had more mass than the other sheet of paper – so I guess they missed it – but I'd say out of the 22 students – I'd say 18 of them really got it. Uhm...just some

conversations we had discussions – especially after the Apollo 13 video – I’m sorry Apollo 17 video.

11. What would you do differently if you had the opportunity to pursue this lesson in the future? Why?

What would I do different.....Probably after the test that I gave I would probably if I had time – plenty of time – I would take the 4 students who still didn’t get it and try – I don’t know – drum it into them – re-teach them – do something – ask them why they didn’t get it and the other folks did. They are still clinging to their misconceptions from the past.

Standard to Assess	Evidence to Support Standard T2	Score
I. Preparing the Way for Productive Student Learning		
Understanding Students	Weak description of students “average teenagers”. Refers to specific students as evidence. Recognizes bilingual issues and takes minimum steps to address.	2.75
Knowledge of Science	Did not identify any misconceptions in student work. Mentions extinction, but is vague on the relationship of molecules, bonds, forces.	2,5
Instructional Resources	Inventing a ‘supermoth’. Use of video of Apollo 17. Crumpled up paper.	3.25
II. Advancing Student Learning		
Science Inquiry	Makes not explicit recommendation that students carry on with moth experiment.	2
Conceptual Understanding	Describes students’ growth as ‘good’. No connection to framework.	2
Contexts of Science	No contexts provided or specific reasons for importance.	1
III. Establishing a Favorable Context for Student Learning		
Engagement	Prefers to ask students direct content questions rather than self-discovery or guided inquiry.	2.25
Equitable Participation	Suggestions about Alejandra (not mentioned by name), may be ineffective. No other suggestions offered.	2.25
Learning Environment	One gets the sense that it is a very controlled environment “wild bunch”. Teacher centered. Inside/outside activities/	2.5

IV. Supporting Teaching and Student Learning		
Family and Community Outreach	N/a	1
Assessment	Fairly accurate description of student understanding. Uses formal and informal assessments. Data collection 17/22 got it.	3.75
Reflection	Cannot provide ideas regarding possible improvements to Artifact 1. Reflection is one dimensional—ie smaller groups.	2
Collegiality and Leadership	Very little support offered to virtual colleagues.	2

TRAINING ENTRY #3

Introduction Questions:

1) How long have you been teaching?

7 or 8 or 9 years – I haven't really stopped to count to give you an exact number

I have counted recently do you want me to give you an exact number?

22) What subjects and grade levels do you teach?

Currently I teach physics 10th and physics 12

23) How would you describe the school in which you teach?

Inter-city exam school. It's 7th through 12 – the kids in the 6th grade in the City of Boston take an exam and basically if they pass the exam then they are allowed to come to school here. It's the oldest girls school in the country but it's not a girls school anymore.

24) How would you generally describe your students?

Behind every student is a prepared parent that cares very much about them

25) What is your average class size?

26

I. Teaching and Learning: See Artifact #1, #2, & #3

- 25) Based upon this student's two responses, how would you describe the student's growth in understanding about the kinetic theory of matter?**

It looks good. It looks like the student progressed measurably.

- 26) What evidence can you identify from the responses that supports your conclusion?**

Because in the 2nd response he is using terminology that the teacher would have obviously wanted him to use. He is using it correctly. I'm assuming that this student is a boy. It looks good.

- 27) What does the work tell you about any challenges or misunderstandings this student is experiencing?**

Ok – misunderstandings – let me go over this again. It's difficult to assess what misunderstandings the kid has because there using this analogy so it's hard to know whether the kid because they are relating it to the advertisement itself understands the chemical concepts or misunderstands the chemical concepts or whether the kid is just relating it to the advertisement. So I mean it's hard to assess just from this but it looks like the student has done what the teacher has asked.

- 28) Describe the feedback or further instruction (if any) that the teacher should provide the student based upon Artifacts 1, 2, & 3?**

Like I said it looks good to me. I would think that the teacher would have the same constraints of curriculum so that this wouldn't be very much time for them to go too much further into this. So the teacher would probably have to go on and probably compared to the rest of the class this is probably one of the better papers.

- 29) Do you think the car advertisement is an effective instructional resource in establishing a connection between the student's background, experiences, and/or interests and the content material? Why or Why not?**

Not really. Because it is such a stretch and then – well yes and no I don't really know what the teacher did in between. The thing is it could have been or it could have been not really and that's why I say that the kid the way it's written it could be that the kid understands it and is making the relationship and is using English pros and analogies to do this or it might be that the kid just has misconceptions that aren't visible because I don't know – it all depends on what happened in between. And also it all depends on the rest of the class cause if this was – you could have this be – this could be one kid in isolation and the rest of the class is far behind. So it's too little to go on but it looks like the rest of the class is going like this then it looks like it was effective.

- 30) Based upon the artifacts provided, what advice might you give this teacher to improve this lesson in the future?**

I don't have sufficient – looking at the student work it's very hard to say what the teacher did. I mean I can see how the student progressed and I can see the handout that was given to the student right – I don't know what was really said and what the manner of instructions are – so it's very hard for me to tell – like I said it looks fine.

II. Teaching and Scientific Inquiry

- 1) How do you think the teacher should respond to this group of students in order to support scientific inquiry?**

Well the obvious question is let's try it.

- 2) Recall that one of the teachers' goals was to support student scientific inquiry. Do you think your idea supports student scientific inquiry? Would there be another one that might do more toward that goal?**

Scientific inquiry -Well of course, because the kids have put up questions and they have put up hypothesis and they want to test their questions. The teacher could have taken a moment and I mean if the teacher didn't have time to go over and do this experiment – the teacher could have told them how each of them kind of hit on different aspects of gene theory independently of each other. Gene theory and population changes and could have basically congratulated each of them for their thought processes used – but that would stop everything right there. That's why if you actually want to do this on an inquiry basis method I would think that you would go right ahead if you had time left in the class.

- 3) Another one of the teacher's goals was to help students understand how the environment interacts with a species' population through natural selection. Do you think your idea helps achieve that goal? Would there be another response that might do more toward that goal?**

If the students change the environment and go and do another trial then yes.

- 4) Suppose this teacher also said she had a goal of ensuring fairness, equity and access for all students. What steps should the teacher take to fulfill this objective?**

Well she needs to get Alejandra involved somehow and that would mean – probably the best way to do it would be to ask Alejandra what she thinks and what would she do – like I said cause the obvious next question and the obvious next answer is to try it. And in that case then you can make Alejandra give her some sort of responsibility and she could be the person who sets up the experiment for the others so that she has a special role – so that she is made to feel like she is more of an equal rather than just an observer.

5) From their discussion, what aspects of the interaction between the environment and species' characteristics do the students appear to understand and what misconceptions still remain?

Well the misconceptions would have been Evan's first thing saying that because they were bright – but then again that might not have been a misconception because they still might be brighter than their environment – cause we are not real sure what color red they are using. Ok – then the next one – ok then Yanping's next comment she kinda told Evan why she thinks that that might be a mistake so that's ok. Latisha doesn't see how the red population can grow. That's a small misconception there and that would be cleared up if they did another trial. If they do another trial do you think that they should start with the same number they started with in the 1st one or should they continue from where they are now? They can do it both ways. And the thing is if they do it both ways and continue from where they are right now Latisha's question of whether or not the numbers can grow would be answered. And also if you were doing multiple groups across the class Yanping's observations that the red ones might disappear completely could come to happen which is just an example of genetic drift – Which would just help prove genetic drift which I'm sure is going to be next in the curriculum or somewhere in the curriculum.

6) Do you see any evidence that any of these students are learning to engage in scientific inquiry? What evidence do you see?

Yea – it seems like all four of them are. I don't understand what you mean?

Well because they are all hypnotizing about what's going to happen next. The only thing that they haven't done is – is propose to do it and to set up a test of their hypotheses.

- 4) If you had observed this lesson, and were a mentor to this teacher, what advice or guidance would you give this teacher regarding the planning or teaching of this lesson to this group of students?**

Well that would all depend on what the teacher did know .

You know that's a hard question because I see what the students did and I don't know what the teacher's reaction is. I'd pat him on the back and say keep it up. I totally believe in group work – the more you can get the kids talking to each other the better off.

XI. Description of a Successful Lesson

- 1. Please describe for me the setting, subject matter, and context (school/ community) of this class.**

Ok – the day before yesterday, it was 10th grade physics – a new curriculum we are trying to – it's a new curriculum so everything is new – I don't know what the background – especially the mathematical background of the kids are and one of the states' frameworks that I was trying to address was to conceptually understand Newton's Law of universal gravitation which is Force equals the gravitational constant times the mass of the first body times the mass of the second body divided by the distance between the squares. Anyway that's a big equation – it's probably one of the biggest equations that these kids have seen up until now. And the day before I realized that the mathematics itself was what was bogging things down. And the fact that the kids didn't know how to deal with very very large numbers or very very small numbers. And with this particular formula you are dealing with both extremely small and extremely large.

With this particular formula you are dealing with both the extremely small cause the gravitational universe/constant is in the magnitude of 10s and negative 11 and you are

also dealing with the very large – because you are dealing with the masses like the mass of Jupiter which would be 10 to the 27^{th} . And then you are dealing with multiplying and dividing numbers that are just huge and mind boggling as far as the kids are concerned and how to put them into their calculators. Plus you have the added problem of algebra and the idea of them multiplying several variables across the top of a fraction and dividing several variables across the bottom.

Ok – so that's the setting. And so I decided to devote a whole class period on just trying to - I worked with them to set up the problem and then to have them actually input the problems into their calculators – and for them to wanted to learn – basically to learn a new button on their calculator which is the – it shows up as either the second function ee button or a button all to itself which is ee or a button that says ext . Different calculator makers make them differently. That was one thing.

Another one was the algebraic manipulation – and then another thing was to be able to divide several variables across the denominator. It was actually very good because the thing is that once I got them going – once I got a few successful people – I turned the kids to help teach each other. And the thing is when I say it was successful I know by looking at the momentum of the class because instead of – they started squealing with happiness cause they could actually get the numbers, which is a rare thing. And you know that they are excited because they have this calculator with many many buttons and they don't know what half of them are at this point in their life. And one they are learning something new about their calculators. And two they are being able to be successful in math which a lot of the kids in the 10^{th} grade – I mean they come into my

class saying that they are not going to do well because they hate math and they have decided that they can't do math. So it was very successful actually.

2. How many students were in the class and what grade levels were represented?

32

3. What were the student learning goals for this lesson?

4. Why were these goals important for these students?

5. How did these goals fit into your overall goals for the year?

6. How did (if at all) the characteristics of this class influence your planning or instructional strategies for this particular lesson? For example, were there any ethnic, cultural, or linguistic diversity circumstances you considered?

Well my class is basically a representation of the United Nations. As far as was that an important factor in this particular lesson – no. But the size of the class certainly effected what I could do. And that's the whole reason why I employed the kids themselves to teach each other. The whole idea – my instructions to them was – I'd walk around and if the kid got the right answer – I'd tell him to wipe out his computer – his calculator screen – and to help one of his friends through but not do it for the friend. Basically to walk them through it without doing it for them. So basically by employing the expertise of the kids that finished faster was the real thing that would enable me to deal with such a large class.

7. Did the range of abilities of the students (e.g., exceptional needs, cognitive, social/behavioral, attentional, sensory, and or physical challenges) and/or the personality of the class affect your planning? If so, how?

Oh yea, like I said. I know that there are kids that came into my class who whether it's because of a cognitive reason or whether it's because of a personal block or whether it's because of a past teacher or respected adult who said that they don't like math – A lot of these kids come in and they feel that it's ok to become an adult and not know

anything about math and, therefore, they won't do any math or they will try not to participate whenever possible. So I knew that I coming up face me – but in order to circumvent that – that's why I employed their friends. The kid sitting next to them – so that instead of me telling them what the right way to do things were I had their friends helping them. And that enabled the whole class to come up to the same level.

8. In the teaching of this lesson, did spontaneity play a role in the success of this class? If so, how?

Oh they always do – let me see – that class – oh yea, at the end of the class I was talking about the relationship of the different variables to each other and I was talking about how different masses and some kid, I forget how he asked the question, asked about extreme cases of mass – you know what's the heaviest thing and so there was a short discussion on what a black hole is and what if the sun became a black hole would the gravitational pull against the earth still be the same? different? Or greater? And it was actually very good. Whenever a kid asks a question I try and answer it. The one thing that I think is really awful to do is to say oh we'll get to that in two weeks because by then the question is already cold and nobody cares and sometimes the kid will be angry at you for putting him off.

9. What about this particular example of teaching and learning is most significant to you?

10. What specific evidence helped you determine that you were successful at achieving the identified learning goals with your students?

11. What would you do differently if you had the opportunity to pursue this lesson in the future? Why?

I would have done it a day earlier. Well what I mean by that is I tried the day before –like I said this is a new curriculum – this is the first time we've been teaching

physics in the 10th grade – So I didn't anticipate these problems with mathematics. So when I came to this big equation I didn't expect that they wouldn't know how to put in a super large number into their calculator. And so, I would have addressed this earlier rather than you know – the day before wasn't as productive as it could have been.

XII. Examining a Whole class discussion in Science (Tape did not work)

16) How do you describe your 'ideal' classroom discussion about science?

There is a whole bunch of ways to get the kids back into each other – there is so many to describe – I mean I don't know where you want me to begin. My favorite – well to – one thing I like competitions and I like discussions where you give kids topics and then you put them in groups and give them questions but first you have them discuss the different topics and then you pose the questions and allow people from the group to choose who is going to answer the questions first. And then you give them a question and make sure that everybody in each group is able to answer – that one is fun. You get through a lot of material and it seems to be really good.

2) What type of topics do you usually work with in a discussion?

Well either review of introductory. I think discussions are usually best either right as a test review type of thing because I'm working to try and go over materials and possibly I've covered incompletely. Or as an introductory type of thing when you bring in some manipulatives or chance for objects, demonstrations and so forth. Actually there is a web site that I use to get a lot of those demos from called the 'smile' website. I like going there for a unit cause I teach high school and the smile site has a lot of things designed for elementary, but the other – but the elementary

lesson plan actually make very good demos – I’ve made demos for high school. And you can use those demos to either pose a question or to explain a point or a concept that you are going to be getting into. And I think it’s a really nice hook for an introductory type.

3) And how do you see as your role in the whole class discussion about science?

Well it depends on if it’s discussion or review of mainly the facilitator and score keeper. If it’s focused upon demos or introductory type of one then I’m kinda the facilitator.

What my role is in the first one is to try and get them to ask questions. I don’t like to pop up with the answers too fast – I mean like I like them to raise their hand and give me various hypotheses of why something is doing what it’s doing. And I’ll sometimes write those hypotheses down and let them debate and argue with one another why one is better or why one isn’t better. And then in the very end I’ll try and get them to reach some sort of consensus and even if it’s an incorrect consensus I’ll still be like ok with that because then I’ll start introducing things of either why the consensus is correct or incorrect. Or, why they didn’t put it into their evaluation. And if they were incorrect then I tell them a few more things to think about that will eventually reach the correct reasons. And I think it’s better if they reach the reasons on their own cause then it’s more like they did it rather than I was standing up there and telling them the way things are.

XIII. Accomplishments Outside of Class: The Impact on Student Learning

Professional Activity/Accomplishment	Yes	No	Rating
qq) Attending educational conferences/workshops	x		5
rr) Professional development activities at school	x		1
ss) Reading educational literature	x		2
tt) Reading scientific literature	x		4
uu) Writing educational articles (professional)		x	
vv) Writing scientific articles	x		1
ww) Serving on an advisory committee at the school or district level	x		2
xx) Serving as a Union representative		x	
yy) Developing science curriculum for your class, school, or district	x		4
zz) Mentoring a new/student teacher	x		4
aaa) Leading a professional development workshop for your colleagues	x		3
bbb) Taking a science course at a local university	x		3
ccc) Collaborating with colleagues on an interdisciplinary project	x		2
ddd) Pursuing National Board certification	x		5
o) Taking an educational course at a local university	x		3

2. Is there any other activity missing from this list that you think is important to improving student learning?

Yea – the summer workshops – the different ones that are offered by the different institutes, organizations, government agencies where people from across the country get to get together to work and to learn about science – those are really good – those are really really good

Community Resource/Accomplishment	Yes	No	Rating
a) Participating in parent-teacher conferences	X		3
b) Attending open house night	X		3
c) Telephone calls to parents/guardians	X		2
d) Emails communication with parents/guardians	X		2
e) Assisting in scientific research with a local college	X		1
f) Classroom observations from parents	X		4
g) Contacting outside experts by telephone or email	X		3
h) Recruiting guest speakers from the community	X		4
i) Supervising after school activities	X		3
j) Coaching sports		x	
k) Working with the Parent-Teacher Association		x	
l) Establishing a partnership with a local teachers' college	X		3
m) Contributing time to local religious or charity groups		x	
n) Serving as an academic advisor to students	X		4
o) Serving on the local Board of Education		x	

Is there any other activity missing from this list that you think is important to improving student learning?

Some of the internships which I shove some of the kids off to – some of the summer programs – I'm not involved with them directly but there is Boston University has some Saturday programs which I can give some extra credit to the kids for going to see – these are some instruments and stuff that we don't have available at our school – And then there is also some of the summer programs that I can recommend some of the kids to go to – there is one for inter-city kids interested in medicine and one for the kids interested in Engineering and a couple of others that come my way that get passed on to the kids. And I think for the individual kid those are very useful.

**Based upon the above lists, which one activity do you think is most important to helping a teacher become more effective at improving student learning?
Please explain your reasons for making this choice.**

Either the National Boards or the summer workshops. As for the National Boards, well – I think it would have been much less if I had gone through the – my district I guess

they want National Board certified teachers so they have a program to kind of help you through it. And I guess to help you write, help you take lessons and all that kind of stuff – so I didn't have time for that. That would have been an extra 2 hour commitment every week and I just didn't have the time for it. I think if I would have done that it would have been much less of a meaningful experience. I think the whole crux of everything that the National Board certification process is is that a self reflected analysis of how you are interacting with your curriculum and with your students and really you are the only person that can really judge that. I did sit on three of their meetings and at least at the workshop that I attended it was all about how do we get through and how do we pass and how do we write what the readers want you to write and they were saying that they were going to give us deadlines that we had to have our video done by and they were going to do this – it was just too contrived and I think it missed the mark of what I think the heart of what the National Boards started out to be. And the whole thing event – that type of process would have neglected the whole intersection. Introspective aspect of teaching which I think is the most important aspect. Because just like if you can get a kid to think about a subject that you are teaching – if you can get a kid to internalize it – then he'll have it forever. It's the same thing I think with adults. It's just harder for adults to be introspective and I think because I did it alone and I mean I went to my peers to have them I mean people that I respected in my school to have them read what I had written – you know just to get their feedback – but even that wasn't a very healthy process. So yes it is easily one of the best professional developments I've ever gone through. And actually even at the

end of this month they tell me that I didn't pass and that I have to re-do something I'm not going to – it won't bother me and I won't feel like I wasted any time.

Standard to Assess	Evidence to Support Standard T3	Score
I. Preparing the Way for Productive Student Learning		
z) Understanding Students	Not enough info to make any assessment. Uses Ss sense of a competitive spirit to foster healthy classroom discussions. Little detail regarding students or their particulars.	2.5
aa) Knowledge of Science and Pedagogy.	Discusses Newton's law of Gravitation, genetic drift, and natural selection. Mentions group work, student centered learning, motivation, and peer teaching.	4
bb) Instructional Resources	Used calculators to develop new skills. Makes use of web sites as teacher resources.	3
II. Advancing Student Learning		
cc) Science Inquiry	Would have Ss continue with moth experiment, but one gets the sense that inquiry not common in his class.	2.5
dd) Conceptual Understanding	Reviewed math skills to prepare the way for physics concepts. Places natural selection into a broader context—genetic drift-theory.	3.5
ee) Contexts of Science	Makes connection between physics and math, and genetic drift and natural selection, but the big picture is missing.	2.75
III. Establishing a Favorable Context for Student Learning		
ff) Engagement	Described how all students were involved in exercise and how peer teaching took place. Likes demos to stimulate interest.	3
gg) Equitable Participation	Emphasizes the need to involve Alejandra in a meaningful manner.	3.5
hh) Learning Environment	Addressed students fears and insecurities involving mathematics and supported their individual efforts. Prefers students raise hands to talk.	3.25

IV. Supporting Teaching and Student Learning		
ii) Family and Community Outreach	Generally does not place a high value on parent involvement. Likes classroom visits by parents. Enjoys guiding students on academic issues one on one. Values guest speakers.	2.25
jj) Assessment	Assessment described are primarily informal—student emotional responses, reactions, comments.	2.0
kk) Reflection	Reflection is good, but prefers a vague analysis over a more detailed possibility. Strong values of self-reflection as a meaningful TPD.	3.5
ll) Collegiality and Leadership	Provides positive feedback. Finds content related TPD valuable and has mentored and led science workshops. Summer workshops. Not much mention of colleagues.	4.0

TRAINING ENTRY A

Introduction Questions:

26) How long have you been teaching?

8 years

27) What subjects and grade levels do you teach?

I teach biology – this is the first year I’m teaching biology. For the past 5 years I haven’t taught it. The first time as 10th graders. And I also teach Chem 1, which is mostly 11th graders but there are some 110th graders in there also. And I teach Chem 2, which is 11th and 12th graders.

28) How would you describe the school in which you teach?

It’s very large and over crowded – 4200 kids – it’s basically an upper middle class population – but it’s mixed – it draws from partly a rental community and a high end housing community

29) How would you generally describe your students?

They are pretty good – I mean I find there are no behavioral problems or anything like that – my general problem is laziness – you know – not responsible enough – don’t turn in work on time – you know we have the test today kind of attitude, sometimes. And some are great students. You know, you tend to remember the ones that wind up not doing it but most of them are pretty good students

30) What is your average class size?

My chemistry class this year are actually small – they are like 33 kids and my biology class has 35 kids in it, 36 I take that back. They both have 36 in there.

I. Teaching and Learning: See Artifact #1, #2, & #3

5) Based upon this student's two responses, how would you describe the student's growth in understanding about the kinetic theory of matter?

I definitely, definitely say it's advanced. In Artifact #1 I was surprised or rather Artifact #2, the pre-assessment, surprised at some of the information that was in there for a regular Chemistry student. I thought it was – I don't want to say advanced information – but seems higher level than a general Chemistry student. But when you go to Artifact #3, even so, there is definitely an advanced understanding, describes inter molecular bonds, the differences, compressibility between liquids and solids and made some connections there. Definitely advanced learning there.

6) What evidence can you identify from the responses that supports your conclusion?

From the pre – I thought that it was advanced that they made it look like a drop of water. To me that was a big connection for general chemistry kids and that a drop of water is made of fluid molecules and has no sharp edges. Just the fact that the wording to me was advanced for a regular general chemistry kind of student. You know and there was a lot of imaginary in there, which I would not necessarily see from my students, which is what I'm comparing it to. In Artifact #3, it shows knowledge that in the liquid the molecules move faster than solid but not as fast as a gas as comparing all three states of matter. They are always in constant motion, which even though a lot of students think in solids, there is no motion – the attraction between the liquid is greater than in the gas – I assume they are referring to the molecular attraction there – it's telling that it's an inter-molecular force – it's between molecules not within so that's higher learning right there. The next

statement is also saying that the bonds, it's implying that the bonds are stronger than solids than in liquids and that is why liquids can take their shape. It talks about aerodynamics there which gets beyond really chemistry, but that was ok too. That was good. And the next sentence made no sense to me. I don't know if it was a typo or what but it actually made no sense. "In the event of an accident, even though the car moved so fast"; That was some error. It gave property of liquid that it's fluid. It can flow. Did saying that the bonds are strong but they are still moving – I mean it's repetitive a little bit but we are getting the point across there, trying to get the point across to that liquid. Then it goes onto solids, you know it also made the relationship that even though the car looks like a fluid, it's going to that you want it to feel solid and greater bonds and solids, it's also repetitive again but it's trying to get the point across.

7) What does the work tell you about any challenges or misunderstandings this student is experiencing?

It's not quite as structured an answer that I'd want, but it pretty much gets the point across that the bonding is definite in the solid and liquid. And the bonding, because it's stronger in a solid, it's not going to move as much as a liquid can. It gives connectivity particles moving more quickly in the liquid than a solid. I think it kinda gets the point across. It's a little repetitive and not as clear as I would want to see it stated, but you could dig out the information in there.

8) Describe the feedback or further instruction (if any) that the teacher should provide the student based upon Artifacts 1, 2, & 3?

I would probably just go through the 3 states of matter again and just make sure that they were clear on compressibility, on the intra-molecular property, even the inter-molecular

properties there. I don't know, I told you on that stuff I'm not quick on that. I have to look at it and think about it. I would probably go over that again just to reinforce it. And just to make sure and pull out the answers from the kids. You know to make sure that they had the information and it was correct. It looks like it's pretty much there through for a general chemistry class.

9) Do you think the car advertisement is an effective instructional resource in establishing a connection between the student's background, experiences, and/or interests and the content material? Why or Why not?

I don't think I would have chosen that advertisement there but it would because I think the high school students they are all into cars, they are getting their license, etc. so it's kinda a hook to get them interested in looking at it and it's something that they can relate to and they would think about it and feel you know they would have some connection to it rather than using some other situation that had no relevance to them.

10) Based upon the artifacts provided, what advice might you give this teacher to improve this lesson in the future?

Well I think I would definitely use a different Artifact #1 – something that would be a little more catchy. I don't even know if I'd use an advertisement. I'd just use a car I think Or maybe some you know the top part of it is fine although the bottom part is a little disjointed too. But something that's even more I mean a sable is a real is not an eye catcher for a 16, 17 year old students. I'd use something a little flashier car wise there. Something that they could really kinda more so think and imagine to. I don't think it's something that as stimulating as if I put a Ferrari on there or something like that.

II. Teaching and Scientific Inquiry

a. How do you think the teacher should respond to this group of students in order to support scientific inquiry?

I would probably tell them to perform the experiment and do it on a newspaper background and see what happens to the moth population cause they are discussing it – they are obviously not coming to a conclusion and I would have them do it to see what the change would be.

b. Recall that one of the teachers' goals was to support student scientific inquiry. Do you think your idea supports student scientific inquiry? Would there be another one that might do more toward that goal?

Yes, because then they are going back and they are going to actually see what's going to happen by conducting an inquiry. They are going to see if they are right, they are wrong. They are going to gather more data. They are going to interact and get a conclusion to it.

c. Another one of the teacher's goals was to help students understand how the environment interacts with a species' population through natural selection. Do you think your idea helps achieve that goal? Would there be another response that might do more toward that goal?

I think that you could logically maybe go back to the other one and see how, what stuck out and if they would put something on the colored background – see which ones would apparently stick out more that would predation that would occur to it and maybe if they could visualize without actually going through it they may see that the population may change over time. So that one of them might decrease, it may not change so much since they said that they only had one red moth but it may decrease another population where it could go toward extinction even. Well I do think if you change the background you, that's relating to changing the environment. So if you show an environmental change

and then show what happens to the peppered moth as a result of it – it is showing/achieving that goal.

d. Suppose this teacher also said she had a goal of ensuring fairness, equity and access for all students. What steps should the teacher take to fulfill this objective?

She may have changed around the jobs that people did to make sure that everybody got a fair share at either being a predator or recorder or putting the moth in or something like that. She may also make one like a team leader and you know ask questions after each predation and make sure that everybody speaks to each other there. You know that they have to fully communicate with each other. I've used things with cards, where you put different numbered cards and they kinda just switch so that everybody gets a job or gets to do everything. Not just one person watching and some person does everything.

e. From their discussion, what aspects of the interaction between the environment and species' characteristics do the students appear to understand and what misconceptions still remain?

I think that from the initial experiment that they see that if something blends into the background it won't be noticed and therefore it won't be taken up by a predator and it will carry on. And in the second part, I think that they are not as clear because one gives a background that totally blends in and the other one is not a total blend so they are not quite as sure as what's going to happen as far as predation goes. Because in the first one they had a newspaper, it was on a newspaper and one of the moths was a newspaper so it was a direct blend there. Whereas in the other one the cartoon, each one might stand out somewhat, it's not going to be as much of a blend so it's more difficult to predict exactly what's going to happen.

f. Do you see any evidence that any of these students are learning to engage in scientific inquiry? What evidence do you see?

Yea, well they are questioning each other and they are seems like they are kind of digesting what they are saying. They didn't come up with the specific answer here but at least there was discussion going on. It wasn't like they all agreed with one person, and that was the end of it. They all had an opinion except for the person that didn't talk and they were communicating with each other.

g. If you had observed this lesson, and were a mentor to this teacher, what advice or guidance would you give this teacher regarding the planning or teaching of this lesson to this group of students?

I think I would have had the lab set up both ways, as I had mentioned before. To do it one way with the newspaper background and then switch the background. Let them discuss it and then let them actually carry it on the other way so it would be more of a complete – they would really get – the first time could be by chance but the second time if they saw that it because it blends into the background that may hit the point home more clearly. I don't think it was bad the way it was but it maybe more give them more information, more data collection, more experience, more discussion and kinda get the interaction of students going and come up to a stronger conclusion.

XIV. Description of a Successful Lesson

- 1. Please describe for me the setting, subject matter, and context (school/ community) of this class.**

It was a biology class in school. It was a laboratory that we / that the kids did on the cell - the parts of the cell

- 2. How many students were in the class and what grade levels were represented?**

36 students – 10th graders

3. What were the student learning goals for this lesson?

To work collaboratively – to be responsible and to learn the parts of the cell – different organelles and their function

4. Why were these goals important for these students?

Well we are just beginning a biology and the cell is the basic unit of structure and function in all living things. So by understanding the parts of the organelles that make it up and their function, it helps to understand the whole organism as a whole and how specialization has helped things advance over time

5. How did these goals fit into your overall goals for the year?

It's just part of the building process to learn – you need to learn the basics in order for us to expand and learn more difficult material as the year goes on. Everything really goes back to cell parts and to function – structure and function and it ties in all over everything – structure and function size, how everything lends itself to all fitting together whether you look at the molecular level or the microscopic level it all goes back to that.

6. How did (if at all) the characteristics of this class influence your planning or instructional strategies for this particular lesson? For example, were there any ethnic, cultural, or linguistic diversity circumstances you considered?

No – Almost all my kids are English speakers. They may have different ethnic backgrounds but I have them split up into lab groups that mixes it. And by having to work together and each student having a responsibility they collaboratively all had to interact with each other, communicate with each other. And besides building science skills they were building inter-personal skills too.

- 7. Did the range of abilities of the students (e.g., exceptional needs, cognitive, social/behavioral, intentional, sensory, and or physical challenges) and/or the personality of the class affect your planning? If so, how?**

Not really. I do have one student that is gifted and also learning disabled and I have him working in a group with another gifted student and two other just intelligent students and they help him because he has disgraphia ((??spelling) and dyslexia and a whole bunch of other stuff. So manipulatively it was good for him to have to work within a group. But generally, the kids are more or less homogenous.

- 8. In the teaching of this lesson, did spontaneity play a role in the success of this class? If so, how?**

There was a little bit of improvising. I mean some one student forgot to bring something in and somebody was absent in another group and they at the last minute teamed up together two groups and were able to borrow some stuff and get it together – so there was a little bit of spontaneity as far as that goes. But most of it was well planned before.

- 9. What about this particular example of teaching and learning is most significant to you?**

It's the excitement – it created a lot of excitement. I didn't think it was going to - not that I didn't think it was going to be so great cause this is my first year teaching biology for the past 5 years and none of the other teachers do this and I had done this previously with students. And it really created a whole air of excitement. It had to be done in one class session which was an hour. They had to work together and by the end of it they really had a great time. It was a good experience. It wound up being a good learning experience for them too.

- 10. What specific evidence helped you determine that you were successful at achieving the identified learning goals with your students?**

Everyone was able to complete their project by the end of the hour. They all brought in their materials. They all worked collaboratively to finish it up and I went group to group and quizzed them on every organelle they had to show me the structure and tell me the function. And it was kinda like a queen “o” – but the timed thing – so it was kinda like a quickie you know where they were competing with each other. And then there was a whole class where they went around and examined everybody else’s project and voted for one best in the class. It was kinda within their group – they were competing and then – not competing – they were working collaboratively but then it became kinda like a class kind of competition a little bit.

11. What would you do differently if you had the opportunity to pursue this lesson in the future? Why?

To tell you the truth, I really liked the way it turned out. I was surprised that it did. I didn’t know that it was going to be as good a learning experience as it wound up being. And the kids were really excited about it, which was really important too – instead of just you know – another kind of lab with an attitude. They were very excited about doing it and bringing it in and getting it together. So it wound up being a really good lesson.

XV. Examining a Whole class discussion in Science

17) How do you describe the learning environment created by the teacher?

I think that it was a good atmosphere. I think being outdoors right in the situation was good. The kids felt comfortable and it was in a pleasant environment to carry on an ecological discussion.

18) What evidence (if any) can you site from the tape that indicates that this teacher is fair and equitable with learners?

He seemed to be fair. When two students started to talk at the same time, he you know, said you go first and the next one will go afterwards. And I remember at the end he also – there were two new students that had some information – it kind of stopped at that point – but he was getting in new students and kind of getting them into the group there and it seemed like it was you know he had it – it was under control. And people had a chance. He wasn't going to stop anybody from talking. Having them have the opportunity to make their observations, or whatever.

19) How would you describe the level of student engagement in the class?

It seemed to be pretty good. I wouldn't say that everybody said something on the piece that I saw but they were - they had something to say. I mean being that there were I think they weren't English speakers as their primary language – they seemed to get it across in the beginning – I couldn't understand the video that well but I think there was a pretty good engagement for the short segment that I saw.

20) Do you think that the teacher has been effective in facilitating and supporting meaningful scientific discussion where students explore and have the opportunity to understand important scientific ideas? What does this teacher do or not do that supports your answer?

Yes, I mean he in the beginning he re-capped something. He mentioned I think I would have – there could have been a little more discussion of you know how would you go about to find this. What kind of experimental thing could you do and maybe make a little bit more of a connection – they made somewhat of a connection that the rain may have changed the flow and therefore there were less cabbages and then maybe less bugs. What kind of experiments could have been done to determine if the

cabbage actually gave the bug the kind of place to hide so the predators didn't see them or what kind of things they could have done or looked for. I mean there were some connections made but I think a few more could have been made in there.

21) How would you describe the quality of student-to-student interactions with regards to scientific, analytical and/or critical thought?

I didn't see that much student to student. I saw two students that I remember that kind of had a point back and forth with each other. There wasn't that much student to student interaction. It seemed more like student teacher to me a little bit but they were using information that they learned about ecology to discuss why they thought things might have happened – whether it be climatic and it did connect the abiotic and biotic factors the climate, the rain had some effect on the things in the ecosystem.

22) Based upon the discussion presented in this clip, how would you describe the level of student understanding regarding pertinent scientific ideas?

There was a lot of observational skills there. I didn't see as much analytical deducing and getting into how through the food chain or through the ecosystem analysis of what was going on. There was a lot of observations, but I didn't see as much analysis of the information.

23) If this teacher were a colleague of yours and approached you for some input into this lesson, what advice, guidance, or insights would you offer that might improve the teaching and learning in this class?

I think that as lab groups – well I assumed that they worked in groups – that they as they had their different questioning maybe it could have gone on to set up some scientific project to test the question or the hypothesis or whatever they came up with. And to go a little bit further, maybe different groups could check different

things so that at the end once they collaborated with their results at the end, they would come up with a more concrete solution rather than a concrete reason as to what happened instead of just like guessing as to what happened. This would give them more information as to why it did happen. It could have been gone further and you know tired up the information better. That was a little clip.

8) What criteria or values in teaching for teaching and learning are using when you are make your recommendations?"

I'm just – I like to see students come to some kind of conclusion – not to be left hanging. You know there was a lot of information, observations, but there was no concrete answer to it. And lots of science doesn't have concrete answers but I think the resources were available to come up with a more concrete decision and I think that students will walk away first of all learning how to inquire, to come up with something and to test it and not everything works out in life. And that good information, like positive results, as well as negative results are good information and it would teach them further how to go on and use scientific inquiry to solve a problem.

XVI. Accomplishments Outside of Class: The Impact on Student Learning

Professional Activity/Accomplishment	Yes	No	Rating
eee) Attending educational conferences/workshops		x	
fff) Professional development activities at school	x		2
ggg) Reading educational literature	x		3
hhh) Reading scientific literature	x		5
iii) Writing educational articles (professional)		x	
jjj) Writing scientific articles	x		3
kkk) Serving on an advisory committee at the school or district level	x		5
lll) Serving as a Union representative		x	
mmm) Developing science curriculum for your class, school, or district	x		5
nnn) Mentoring a new/student teacher	x		5
Leading a professional development workshop for your colleagues	x		5
ooo) Taking a science course at a local university	x		5
ppp) Collaborating with colleagues on an interdisciplinary project	x		4
qqq) Pursuing National Board certification	x		4
o) Taking an educational course at a local university	x		3

2. Is there any other activity missing from this list that you think is important to improving student learning?

It's not necessarily advisory committees but in-school type committees. The advisory committee that I took for letter g – was more of a parent type advisory committee – like school parent community advisory committee – but I've been on other advisory committees within the school that are just like teachers and administrators that have been helpful. As far as disciplinary attendance – you know school rules and regulations that directly impact students.

Community Resource/Accomplishment	Yes	No	Rating
a) Participating in parent-teacher conferences	x		5
b) Attending open house night	x		5
c) Telephone calls to parents/guardians	x		5
d) Emails communication with parents/guardians	x		5
e) Assisting in scientific research with a local college		x	
f) Classroom observations from parents		x	
g) Contacting outside experts by telephone or email	x		4
h) Recruiting guest speakers from the community	x		5
i) Supervising after school activities		x	
j) Coaching sports		x	
k) Working with the Parent-Teacher Association		x	
l) Establishing a partnership with a local teachers' college		x	
m) Contributing time to local religious or charity groups	x		2
n) Serving as an academic advisor to students	x		5
o) Serving on the local Board of Education		x	

8. Is there any other activity missing from this list that you think is important to improving student learning?

Well I have a web site and I also have grades on line and that doesn't exactly fit into totally here. I have more of an interactive access for the parents. I have a web site that has the assignment on it all the time – that has links on it to their grades so they can get into their grades all the time – and a link to e-mail – so it's more of a communication situation that does exist. So that the parents have more direct viewing of student grades and I upload them constantly.

9. Based upon the above lists, which one activity do you think is most important to helping a teacher become more effective at improving student learning? Please explain your reasons for making this choice.

They are so inter-related – I'm going to have to say for myself – obviously, student learning – really reading scientific literature. The more knowledge that I feel that I have and the more connections that I could make to their learning in the classroom I can make things more interesting, more relevant, more engaging for them and that to me is where most of their learning is. If I can connect with them and engage them because I am knowledgeable and have a lot of information to share with them and create a lot of relevance for them, I think that is, that stays in will academically do well for me. And

that's how I really do conduct my classroom and the rest of it is just collateral helpfulness. But that to me is the most important thing.

Standard to Assess	Evidence to Support Standard	TA Return to MSU	Score
I. Preparing the Way for Productive Student Learning			
a) Knowledge of Students			
b) Knowledge of Science and Pedagogy			
c) Instructional Resources			
II. Advancing Student Learning			
d) Science Inquiry			
e) Goals and Conceptual Understanding			
f) Contexts of Science			
III. Establishing a Favorable Context for Student Learning			
g) Engagement			
h) Equitable Participation			
i) Learning Environment			
IV. Supporting Teaching and Student Learning			
j) Family and Community Outreach			
k) Assessment			
l) Reflection			
m) Collegiality and Leadership			

TRAINING ENTRY #B

Introduction Questions:

31) How long have you been teaching?

In this country, now, I have been teaching for 6 years. Before that I taught in my home country, in Giana, ((??sp) South America and also I taught for 7 years in the Bahamas

32) What subjects and grade levels do you teach?

I've been teaching science all the time. Biology, my license area is in Physics and Biology and I've also taught Chemistry. I've taught at the high school level– 9 through 12

33) How would you describe the school in which you teach?

The school I'm teaching now is technical and vocational high school – it's in the Bronx, New York City

34) How would you generally describe your students?

I would say they are about just a little below average – though there are a few that are doing very well and I would say average – you have many that are average – a few that are below average – but generally speaking they are just below average

35) What is your average class size?

34

I. Teaching and Learning: See Artifact #1, #2, & #3

11) Based upon this student's two responses, how would you describe the student's growth in understanding about the kinetic theory of matter?

Ok, I would say that the student shows much improvement and is able to put their thoughts in a better way. Is able to expand on their ideas and shows complete understanding and knowledge of intermolecular forces, inter kinetic theory of matter and the attraction between the particles in comparison within liquids, solids and gases. And is able to make conclusions based on that knowledge gained and also is able to compare the fluidity of the liquid in particular with that of the mercury the mercury sable. However, I think that I wonder if the student has seen the liquid mercury itself, what we know of as quick silver because that moves very smoothly across any surface – especially a smooth surface. Also, probably the student didn't quite research the meaning of fluid – the solidity which is really includes both liquids and gases. But I think generally it's a good analysis and the student is able to make the comparisons, highlight the comparisons and also make conclusions which is good.

12) What evidence can you identify from the responses that supports your conclusion?

Yea, well the student is able to first of all, the student give in the first Artifact #2, the student uses personally experiences of what is a solid, a liquid and was able to relate the fluidity of the car to troubled water, which is actually something that the students actually seen – something concrete. That the student is using that experience to explain what is meant by the fluidity and the statement imagine something that looks so fluid yet seems to solid. So the student, this student shows that ability to be able to assess the situation from observations and from previous experiences and to be able to

come up with a conclusion in Artifact #2. In Artifact #3 the student goes even further and it shows that some degree of learning has taken place upon the kinetic theory of matter in that he is able to make comparisons with solids, liquids and gases.

13) What does the work tell you about any challenges or misunderstandings this student is experiencing?

Ok. One of the misunderstandings, I think, is the idea that fluids include both liquids and gases.

14) Describe the feedback or further instruction (if any) that the teacher should provide the student based upon Artifacts 1, 2, & 3?

Ok. Let's look at Artifact 1 again. I think the car looks great, and is attractive. It looks very good, I guess that attracts the attention of the kids and it's big and then the statement is very bold. I think for Artifact 1 I don't see much that you can add to it what it has there except the print down at the bottom is a little small.

15) Do you think the car advertisement is an effective instructional resource in establishing a connection between the student's background, experiences, and/or interests and the content material? Why or Why not?

Ok. Yes, I think so. I think that the fine print maybe is a little too fine; some of the words are difficult to make out and the words above '100,000'. The picture there, I'm wondering if it's a fish. You know just to the right of 100,000, to me it's looking like the head of a fish. And the name which is shown a little to the right of the back of the car, 'Mercury Sable LS automobile magazine – all star and design of the year'. I think it is. However, the print is a little small for some of the students. I don't know if they will be able to read those fine prints.

16) Based upon the artifacts provided, what advice might you give this teacher to improve this lesson in the future?

For the picture, I don't see much you can do except something to show that the car is moving – maybe some lines at the back or something like that. For the Artifact 2, I don't think there is much you can do there because that should be like your pretest. For Artifact 3, I guess the teacher might have to probably the teacher has taught the things but the kid did not quite get it, that a fluid includes both liquids and gases. And also, can add some activity that shows liquid mercury moving across the surface. And that might enhance and give more support to the name Mercury of the car. I think the student is able to do a very good analysis here and arriving at a suitable conclusion. Generally, I think this is it's good work by the student.

II. Teaching and Scientific Inquiry

a. How do you think the teacher should respond to this group of students in order to support scientific inquiry?

I think when I at page 4, that if the background of his activity were changed to a colorful type of paper, such as the Sunday cartoon section of pages from a comic book, how might the population of moths do when they examine change? I think that Evan when he started out, Evan and Yanping they were doing very well in their statements – when Evan said I don't think it will have any effect. The red ones will still get eaten the most because they are the brightest. That was good. And then Yanping said ok maybe in our experiment that zero moths population gets bigger because they are harder to see. That is also very good. And if the background changes, lots of colors, the red ones might stick out more and get eaten. However, when we get to Latisha, I think Latisha kinda mislead everybody here when she said ok how will the population change, there are so few red

ones now. I think she didn't understand that you are going to start the experiment from fresh all over again – with the numbers that you started the first experiment with, 33, 34, 33. She was of the opinion that you were starting the experiment after the 20th round, 33, 1 and 53. Yea, and from there on they got kinda bogged down and didn't see that the experiment was supposed to be repeated completely from the beginning. And I think the teacher would have to spend a little time there to correct that misconception.

b. Recall that one of the teachers' goals was to support student scientific inquiry. Do you think your idea supports student scientific inquiry? Would there be another one that might do more toward that goal?

I think it does support scientific inquiry because the students are learning through experimentation here and able to arrive at conclusion. Evan and Yanping were doing very good with their conclusions but then, as I said, they were kinda mislead by Latisha; and then they forgot the original statement and took off with Latisha's statement that the red ones were so few in numbers, just one left and that kinda through the conversation off the track. So maybe he'll have to point out to them that the experiment is starting again with 33, 34, 33; with the colorful background, because it's a new experiment. Yes, it's not an experiment of with starting with the new numbers but the red one is on the end – especially.

What if you were to continue the experiment with the low numbers and just change the background with the low numbers, with the numbers after 20 rounds? What if the student suggested that?

Ok. The white moth would definitely be at a disadvantage as they would be caught easily because on a colorful background they will stick out. The moths will be black and white and they might also decrease in number because they will kinda be show up more on a the colorful background. I would hope that they would ask those two types of

questions first and we would be able to go into that kinda of information, of course. I/we would expect that they would ask if the newspaper moths will take the color per the colorful newspaper. Or if they will remain as black and white. If they remain as black and white then the numbers will decrease because they will be conspicuous there on that colorful background and, therefore, their numbers will decrease. And the white moths as well the numbers will decrease. The red moths, since you'll be adding red moths, and I guess the colorful background will have some red, then more will survive because you keep adding one each round.

- c. **Another one of the teacher's goals was to help students understand how the environment interacts with a species' population through natural selection. Do you think your idea helps achieve that goal? Would there be another response that might do more toward that goal?**

I think so, that the students will see that the environment has a lot to do with natural selection.

- d. **Suppose this teacher also said she had a goal of ensuring fairness, equity and access for all students. What steps should the teacher take to fulfill this objective?**

Probably, everyone there was able to participate in the activity but probably in the case of when they were repeating it to the colorful background she could change around some of the roles – have a different moderator. You know everyone has a chance to participate in each different activity.

- e. **From their discussion, what aspects of the interaction between the environment and species' characteristics do the students appear to understand and what misconceptions still remain?**

Ok, the students seem to get the idea that of camouflage. That because the newspaper moths had a similar color to the newspaper background they were able to survive and increase in numbers. This story brings me to one that I taught in one of my classes, the

peppered moth also where you had these birds eating up the moths. Originally, before the Industrial Revolution the trees had a light colored bark and these moths would rest on them, when they are planning on feeding or looking for food. And these predator birds would be able to catch the dark colored ones because they had less ability to hide in the background of the tree trunk. And later on after the increase in isolation, all that pollution caused the change in the color of the tree trunks for the bark of the tree took on a darker color. And as a result of that the light colored moth became more conspicuous now on that dark background and easily caught by the birds. However, they were a few of those dark colored moths around at the time when the tree trunks were light colored and as the time passed their population increased in a similar way as to the newspaper moths in your experiment here. Because the background was more suitable for them to hide. As the pollution changed the colors of the bark of the trees. And so more and more of them were able to survive and this you know, I think they got the idea of natural selection from this activity in the same way as the moths with the genes for dark color were able to survive.

f. Do you see any evidence that any of these students are learning to engage in scientific inquiry? What evidence do you see?

Not very clearly but they were able to say that if they could blend into the same color of the background, there is a greater chance of them surviving. They got that idea. I think the teacher can now expand on that and bring out the idea of natural selection and go on even to bring up the idea of evolution, as changes take place over a series of generations.

6) Do you see any evidence of misconceptions in the conversations?

Apart from the ones that I highlighted earlier, where Latisha did not quite understand that you are going to start the experiment back from the beginning, I think that's one misconception that the teacher has to clear up. Yes –They have carried out the activity.

They have analyzed the data. Ok. They are able to come up with some kind of conclusion at least Evan and Yanping were able to come up with satisfactory conclusions there.

- g. If you had observed this lesson, and were a mentor to this teacher, what advice or guidance would you give this teacher regarding the planning or teaching of this lesson to this group of students?**

I would probably have the teacher extend the lesson another period, the next day and have them do the activity with a colorful background.

XVII. Description of a Successful Lesson

- 1. Please describe for me the setting, subject matter, and context (school/ community) of this class.**

A 10th grade class and we are looking at a topic of water pollution in a living environment of a biology class. It comes under the topic of the effects of human activities on environment on the ecology section.

- 2. How many students were in the class and what grade levels were represented?**

32 students – 10th graders

- 3. What were the student learning goals for this lesson?**

Ok, the students should have been able to compare water from different sources and identify some of the pollutants in the different samples of water.

- 4. Why were these goals important for these students?**

This is important in order for them to get the idea to understand that the water from these different sources can have different foreign substances inside which we call pollutants and it can affect the living things in the water

5. How did these goals fit into your overall goals for the year?

Well these are goals that will, the overall goal for the year would be to get the students prepared for the regents examination that we have in New York and to get them to understand the effects of human activities on the environment and how some of these effects can be harmful.

6) What about this particular example of teaching and learning is most significant to you?

Why is this the example you thought of?"

Yes, well students would be able to see the relationship between human activities, pollution of surroundings, and the effects of living things on the surroundings that utilize these resources. Ok, so that they will be able to make recommendations on how ok the students after going through the activities and getting to understand the concepts, they would now be able to make recommendations on how we can prevent pollution of our resources, such as the water resources.

7) What evidence do you have that you were successful to within a certain extent?

I think so to some extent. They were able to identify some of the pollution, pollutants in the different samples of water and give some explanation of how they got into the water, what are the sources of these pollutions, agents. And in addition they were able to participate in a discussion in a later lesson where they analyzed the data they collected from experiments that were done to identify some of these pollutants and then make recommendations on how we can reduce the amount of pollution.

8. How did (if at all) the characteristics of this class influence your planning or instructional strategies for this particular lesson? For example, were there any ethnic, cultural, or linguistic diversity circumstances you considered?

There was diversity, the type of students cause this was an inclusion class. An inclusion class is one that has a mixture of students from the special ed department and working with students in the general education departments of the school that gather in the same classroom. Because of this, I did- I realized that it was important to have more hands on activities for the students so that they can see the things in a concrete way and so they will be able to make a better assessment and come up with conclusions that are more satisfactory.

9. So in the teaching of this lesson did spontaneity play a role in the success of this class – if so how?”

Yea, yes there were occasions where there were students who were kinda more reserved and the activities helped them to raise their level of participation and even participate in the discussion. They were able to do a better job then if it had not been a hands on.

9. What would you do differently if you had the opportunity to pursue this lesson in the future?

I would definitely use more time for the activity because I could have used more time for the analyzing of the different samples in particular. We analyzed, let me just give you an idea, we analyzed river water, that's water from the Bronx River and then we had pond water, we had rain water, and the river water, pond water, and water from a lake in Vancouver Park. And so we would have spent more time on it – on the activities part. It brought out quite a lot of stuff and you know there is much more you can do and that would enhance things that were done in other topics early in the year.

XVIII. Examining a Whole class discussion in Science (Artifact #4)

24) How do you describe the learning environment created by the teacher?

Ok. I think in the circumstances it's good but they seem to be outdoor and they seem to be in the area where they did their investigation.

25) What evidence (if any) can you site from the tape that indicates that this teacher is fair and equitable with learners?

I think the teacher was fair in that the teacher was able to get quite a few of the students involved in the discussion. However, if it were possible I would have tried to get a kind of semi-circle arrangement for the students. And that way I would have been able to get more of them involved because there were a few to the back, the end closest to me, that I think he should have called on them – one or two of them and to try and get them involved. Also, it would have been nice, if it was possible, to zoom in on the speakers while they were having the discussion.

26) How would you describe the level of student engagement in the class?

I think the level was good. The students, they showed scientific reasoning and thinking, they were able to communicate their ideas clearly to the group and they defended their statements so they showed ownership over the discussion. Generally, I think they came to a better understanding regarding the status of the legal system, though it was not clear who was leading what. Like they couldn't say for sure what were some of the relationships in the food chain. Especially in regards to the ripple bug.

27) Do you think that the teacher has been effective in facilitating and supporting meaningful scientific discussion where students explore and have the opportunity to understand important scientific ideas? What does this teacher do or not do that supports your answer?

Yes, I think so. The teacher had the students carry out these investigations, I guess they worked in small groups or in teams and they were able to, as well as individually, collected data and a biotic and they were also focusing on the question – Is this a healthy ecosystem? So I think that they were. The teacher actually, the way that they were behind on organized the activities – it shows that he was engaging the students in this kind of activity.

28) How would you describe the quality of student-to-student interactions with regards to scientific, analytical and/or critical thought?

Well, they did some analysis of one another's comments and what they said in the discussion and kind of – there were some challenge at times to what the students explained and so the student had to go a little deeper and explain further – which I think is commendable.

29) Based upon the discussion presented in this clip, how would you describe the level of student understanding regarding pertinent scientific ideas?

I think that the students were able to learn from the engagement in these activities and they were able to see relationships between organisms. Though I think the teacher will have to do a little bit more to show their more in-depth relationships in the food chain. The roles of the different individuals.

30) If this teacher were a colleague of yours and approached you for some input into this lesson, what advice, guidance, or insights would you offer that might improve the teaching and learning in this class?

I think I did not see much evidence of the teacher commending the students for their ideas. I think that that could have helped to kind of boost them up a little more and make them more likely to participate.

31) And what criteria for teaching and learning are you using when you are making these recommendations or when you look at this tape?

I would guess I would try to sometimes rather than just allow the ones who are volunteering to speak – sometimes it's a good idea to call on those who are a little more reserved to get them involved. Because some of them have ideas or misconceptions and they will go away with those rather than sharing them. And if they are misconceptions, if they do not speak out, no one will ever know. And so, it would be a good idea to call on some of those students. The quiet ones and have everyone hear their point of view, their ideas. Then you get an idea also as to what it is that they are getting from the activity or the lesson. So then you can make adjustments based upon what you observe.

XIX. Accomplishments Outside of Class: The Impact on Student Learning

Professional Activity/Accomplishment	Yes	No	Rating
Attending educational conferences/workshops	x		5
Professional development activities at school	x		4
Reading educational literature	x		4
Reading scientific literature	x		5
Writing educational articles (professional)	x		3
Writing scientific articles	x		4
Serving on an advisory committee at the school or district level	x		4
Serving as a Union representative		x	
Developing science curriculum for your class, school, or district	x		5
Mentoring a new/student teacher	x		4
Leading a professional development workshop for your colleagues	x		4
Taking a science course at a local university	x		4
Collaborating with colleagues on an interdisciplinary project	x		5
Pursuing National Board certification	x		5
o) Taking an educational course at a local university	x		4

2. Is there any other activity missing from this list that you think is important to improving student learning?

I would say collaborating with teachers in your subject area. Collaborating and planning curriculum and even lesson plans.

Community Resource/Accomplishment	Yes	No	Rating
a) Participating in parent-teacher conferences	x		4
b) Attending open house night	x		4
c) Telephone calls to parents/guardians	x		4
d) Emails communication with parents/guardians		x	
e) Assisting in scientific research with a local college		x	
f) Classroom observations from parents		x	
g) Contacting outside experts by telephone or email	x		4
h) Recruiting guest speakers from the community	x		5
i) Supervising after school activities	x		3
j) Coaching sports	x		3
k) Working with the Parent-Teacher Association		x	
l) Establishing a partnership with a local teachers' college		x	
m) Contributing time to local religious or charity groups	x		3
n) Serving as an academic advisor to students	x		4
o) Serving on the local Board of Education		x	

10. Is there any other activity missing from this list that you think is important to improving student learning?

I think this covers most everything here

**11. Based upon the above lists, which one activity do you think is most important to helping a teacher become more effective at improving student learning?
Please explain your reasons for making this choice.**

I think that the one factor that might be most useful to encourage student learning would be greater parental involvement. I think if this teaching-learning thing is a partnership and the partnership includes the teacher, the student and the parents. And each of those areas must be addressed. The parents' support and encouragement to their students, to their kids, that's very important. Usually the students who are successful, it's because they have great support from their parents. And I think that that would play a great part, especially in New York City.

Standard to Assess	Evidence to Support Standard TB Return to MSU	Score
I. Preparing the Way for Productive Student Learning		
Knowledge of Students		
Knowledge of Science and Pedagogy		
Instructional Resources		
II. Advancing Student Learning		
Science Inquiry		
Goals and Conceptual Understanding		
Contexts of Science		
III. Establishing a Favorable Context for Student Learning		
Engagement		
Equitable Participation		
Learning Environment		
IV. Supporting Teaching and Student Learning		
Family and Community Outreach		
Assessment		
Reflection		
Collegiality and Leadership		

Appendix G: Coding and Calculation of Status for Group 2A-Pre

Received Materials Organize Materials Read Instructions Read Standards Overall Planning Discussions Permission Slips Fill Out Forms Video Tape Workshops										Entry 1 Idea Over Time				Entry 2 Scientific Inquiry				Entry 3 Discussion				Entry 4 Professional				TOTAL STATUS
2	2	2	2	2	2	2	2	2	2	Plan	Collect	Analyze	Write	Plan	Collect	Analyze	Write	Plan	Collect	Analyze	Write	Plan	Collect	Analyze	Write	
										5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	80
2	2	2	2		2		2		2																	14
2																							4			6
2	2	2			2	2	2			5	5			5	5			5	5			5	5			50
2	2	2	2				2			5	5											5	5	5	5	38
2	2	2	2																							6
2										5	5			5	5							5	5			32
2	2	2		2		2	2	2																		12
2	2	2	2	2	2	2	2	2														5	5			26
2	2	2	2			2	2	2												5		5	5	5		34
2		2	2																							6
2			2	2		2	2							5	5							5	5			30
2					2	2	2												5	5		5	5			26
2		2		2		2														5	5	5	5			23
2	2	2				2	2	2		5				5	5			5				5	5	5	5	52
2	2			2						5												5				16
2										5												5				12
2							2															5	5	5	5	24
2	2			2																						6
2				2																		5	5			14
2						2	2															5	5			16

EXAMPLE #1 301757851 Coded as a 14% Status

T: Beginning

Interviewer: – Which means?

T: Beginning means – I've filled out all the paperwork, paid all the fees and got the box

Interviewer: Great – ok. Anything else?

T: And well I've read the material a few times, gone to a seminar.

EXAMPLE #2 317870367 Coded as a 52% Status

T: I'm just finished and am ready to seal the entry envelope 4 with my documented accomplishments. You know, just put it away – I've rewritten it so many times. On entry 2 I think I'm more than ½ way – I have my introduction and my data analysis and I'm getting the conclusion this week. Hopefully on tape. I'm most of the way through – maybe I'm ½ way through writing and I will re-write a lot. So I would say close to 50% finished with entry 2. I'm just getting started on the writing on entry 1 – but I have a head full of it. It's jelling and I have my units chosen and my – the pieces of work that I will use for the Idea I'm teaching. That one is in process in my head and I expect it to be the most challenging in the writing for me. And the discussion I've just picked a couple of things I think I may use and I haven't even started on that yet except to begin thinking about which topics I think would make good discussion topics and which class. And I haven't given one thought to the assessment center tasks yet.

Status Coding Explanation

In order to get the most accurate assessment of a teacher's status with regards to the National Board certification process, a detailed qualitative analysis was performed.

This analysis involved coding each participants response to the question: "Could you please describe your current status with the certification process?" They were asked this question after the introductory questions and before Scenario 1.

The responses provided evidence as to what the teacher had done, completed, worked on, thought about, written, video taped, and studied. A coding scheme was devised that allocated a certain percentage of the entire portfolio process. For example, receiving materials counted as 2 % of the total amount of work required to complete the portfolio. The percentages were based upon the researcher's experience and familiarity

with the certification process and a few basic assumptions. Examples 1 & 2 above demonstrate the type of evidence and the resulting coded status.

The first basic assumption is that all four entries are of equal difficulty and require equal amounts of time. This of course is not necessarily true, but it does allow for teachers doing different types of work to be compared. The assumption of equality between entries is not unwarranted. The process is identical for every Entry. Each Entry requires a candidate to plan their activities and response, collect evidence, analyze that evidence, and then write about their experience. For this analysis, completing all four entries accounts for 80% of the portfolio construction. The remaining 20% includes paperwork, permission slips, preliminary reading, and preparation. The resulting status measure for each candidate is on average within 5% of the candidates own estimation.

Appendix H : Transcript Processing Explanations and Examples

Instructions for Processing Transcripts

- 1) Delete “INTERVIEW PROTOCOLS VERSION 4 OCTOBER 16, 2002”
- 2) Bring “**Introduction Questions:**” to top of page
- 3) Make sure that the Tables for question V have been added to the end of the document.
- 4) All Questions in **BOLD**
- 5) All Answers in regular type (not bold)
- 6) All questions single spaced
- 7) All Answers double spaced (except in introductory questions where answers are single spaced).
- 8) Only one double space between last line of answer and first line of next question
- 9) Remove all of Dave’s comments and questions and then bring together the answers of the participant into a understandable means.
- 10) Delete Question number 6 and its answer.
- 11) Bring “**I. Teaching and Learning: See Artifact #1, #2, & #3**” to the top of page 2
- 12) Delete everything in question I. between and including “**Overview: --- Questions:**”
- 13) Delete non-content based conversations between Dave and subject. For example, exchanges dealing with clarification of questions, confirmation of answers, repeating of answers, restating of questions, cordial comments from Dave, facilitating questions from Dave, etc. Note: If comments from Dave are removed, then any content related answer remaining from the subject, must be made understandable. For example, if Dave asks “You mean the teacher?” and the subject responds “Yes, them”, then it would be changed to read, “Yes, I mean the teacher”.
- 14) Delete everything in question II. between and including “**Overview: --- Questions:**”
- 15) Delete non-content based conversations or extraneous prompts between Dave and subject. For example, exchanges dealing with clarification of questions, confirmation of answers, repeating of answers, restating of questions, cordial comments from Dave, facilitating questions from Dave, etc. Note: If comments from Dave are removed, then any content related answer remaining from the subject, must be made understandable. For example, if Dave asks “You mean the teacher?” and the subject responds “Yes, them”, then it would be changed to read, “Yes, I mean the teacher”.
- 16) For Question IV, delete everything between and including “The videotape (**Artifact #4**)” and “**Questions:**”
- 17) For Question V, take candidate ratings and put them into the appropriate table. Do not include comments to ratings. For “no” answers, leave corresponding rating blank. Once tables are complete, delete all the conversations around table items. Place question two on “additional item” below first table.
- 18) Question 3 on NBC rating, must be cut and copied onto separate document.

- 19) Questions 4 & 5 must be cut and paste below second table.
- 20) Delete "conclusion of interview.
- 21) Check spacing and widen margins. Start each question at top of next page where practical. Make it look clean and uniform.
- 22) Characteristics to characteristics
- 23) Delete "(Receiving Awards, Honors, or Special recognition)." From V table 1.
- 24) First line indent set at 0
- 25) Left tab and Hanging indent set at .25"
- 26) Right tab set at 6.5"

The following are 6 examples of the above rules and procedures at work. The original version is presented first exactly how the transcriptionist types out what she heard. The original is immediately followed by the processed version.

EXAMPLE #1

Original Version:

- 32) Based upon the discussion presented in this clip, how would you describe the level of student understanding regarding pertinent scientific ideas?

I really – don't understand your questions. Ask me your question again.

Dave – Ok. Based upon the discussion that you saw in the clip, how would you describe the level of student understanding regarding the process of scientific inquiry in content related to environmental sciences? Another way to think about it is – did the kids appear to know what they were talking about and were they thinking in a scientific manner?

OK – That was pretty hard to assess for me because I think that the project that they were working on wasn't narrowed down really very well. I mean it's hard – in environmental science – probably to do this. And so that the level did not seem really high to me. The students were grappling with so many different factors that they – it didn't look like they were able to get a handle on what was truly going on. And while that may be a real part of scientific inquiry – it would have been nice to see a little narrower question or narrower set of questions for their research so that they could have at least felt like they had some kind of answers. It seemed like it was very diffuse and they didn't have any answers. Some kids were looking at parameters. I mean – some kids really did appear to be using scientific reasoning. Scientific thought yes, but they were dissatisfied because they couldn't come up with any really meaningful conclusions.

Final Version:

- 33) Based upon the discussion presented in this clip, how would you describe the level of student understanding regarding pertinent scientific ideas?**

That was pretty hard to assess for me because I think that the project that they were working on wasn't narrowed down really very well. I mean it's hard – in environmental science – probably to do this. And so that the level did not seem really high to me. The students were grappling with so many different factors that they – it didn't look like they were able to get a handle on what was truly going on. And while that may be a real part of scientific inquiry – it would have been nice to see a little narrower question or narrower set of questions for their research so that they could have at least felt like they had some kind of answers. It seemed like it was very diffuse and they didn't have any answers. Some kids were looking at parameters. I mean – some kids really did appear to be using scientific reasoning. Scientific thought yes, but they were dissatisfied because they couldn't come up with any really meaningful conclusions.

EXAMPLE #2

Original Version:

1. What about this particular example of teaching and learning is most significant to you?

Dave – What happened in this class that was memorable for you? Can you tell me what happened?

Yea. Looked at – the students set up their little fermentation chambers and their fermentation locks and they had a couple different carbohydrates **monosack rods, dissect rods and polysack rods**. And a student in each group would have a different one. And the students saw that they measured the rate of fermentation by the number of carbdioides bubbles produced per minute in the fermentation lock. And they gathered data and then shared the data and graphed and saw that the monosack rods and dissect rods are the highest rate of fermentation. And the polysack rods have the lowest rate. And we could move that into a discussion of why and was able to assess students understanding of differences between the simpler surgars in polysack rods and kind of move into a discussion of why there is differences in rates of fermentation exist and relay that to the differences they know between the molecular structures of these different molecules.

Final Version:

2. What about this particular example of teaching and learning is most significant to you?

Yea. Looked at – the students set up their little fermentation chambers and their fermentation locks and they had a couple different carbohydrates monosaccharide, disaccharides, and polysaccharides. And a student in each group would have a different one. And the students saw that they measured the rate of fermentation by the number of carbon dioxide bubbles produced per minute in the fermentation lock. And they gathered data and then shared the data and graphed and saw that the monosaccharide and dissect rods are the highest rate of fermentation. And the polysaccharides have the lowest rate. And we could move that into a discussion of why and was able to assess students understanding of differences between the simpler sugars in polysaccharides and kind of move into a discussion of why there is differences in rates of fermentation exist and relay

that to the differences they know between the molecular structures of these different molecules.

EXAMPLE #3

Original Version:

- 31) Based upon this student's two responses, how would you describe the student's growth in understanding about the kinetic theory of matter?

Well ... they have certain statements that shows that they have learned about kinetic theory – like that the molecules in a liquid move faster than that in a solid but not of gas. The fact that they are in constant motion – attraction – intermolecular forces. However, I don't know whether the teacher was trying to give them an analogy to use the car advertisement as an analogy for kinetic theory or uhm...to be able to actually explain the car in terms of kinetic theory. And since this is an advertisement, I would assume that it's kind of like an analogy – like what is it they are trying to impress upon the buyer.

Dave – Yes

Does that – is that what you mean?

Dave – Well the instructions that were provided to students say to interpret the ad from a molecular point of view.

It's sort of an interesting question because the ad certainly isn't supposed to mean anything molecular. People are going to be buying a car will not be looking at it in terms of – of molecules I don't think – or even thinking about it in terms of kinetic theory.

Dave – I think that the aim is to interpret the headline on the ad.

Ok – that makes more sense. Ok – so your questions is how well did the students learn it?

Dave – How would you describe the growth and understanding about the kinetic theory of matter for the student?

I would say that the student definitely has demonstrated some growth and understanding.

Dave – Demonstrated what?

Growth and understanding

Final Version:

32) Based upon this student's two responses, how would you describe the student's growth in understanding about the kinetic theory of matter?

Well ... they have certain statements that shows that they have learned about kinetic theory – like that the molecules in a liquid move faster than that in a solid but not of gas. The fact that they are in constant motion – attraction – intermolecular forces. However, I don't know whether the teacher was trying to give them an analogy to use the car advertisement as an analogy for kinetic theory or uhm...to be able to actually explain the car in terms of kinetic theory. And since this is an advertisement, I would assume that it's kind of like an analogy – like what is it they are trying to impress upon the buyer. It's sort of an interesting question because the ad certainly isn't supposed to mean anything molecular. People are going to be buying a car will not be looking at it in terms of – of molecules I don't think – or even thinking about it in terms of kinetic theory. I would say that the student definitely has demonstrated some growth and understanding.

EXAMPLE #4

Original Version:

34) Do you think that the teacher has been effective in facilitating and supporting meaningful scientific discussion where students explore and have the opportunity to understand important scientific ideas? What does this teacher do or not do that supports your answer?

Scientific ideas?

Yea – for example the fact that there – changes in the organisms or fewer or more of one type of organism. They didn't just look for one reason. They talked about all the different reasons and how maybe what they saw didn't explain it – because they were there just briefly. And I thought that was good.

Dave – And how did the teacher help support that?

Well – he affirmed it. He sort of was like yea. I thought just sort of re-agreeing with the students.

Dave – I'm sorry I couldn't hear

Agreeing or affirming with the students that made those comments

Final Version:

35) Do you think that the teacher has been effective in facilitating and supporting meaningful scientific discussion where students explore and have the opportunity to understand important scientific ideas? What does this teacher do or not do that supports your answer?

Yea – for example the fact that there – changes in the organisms or fewer or more of one type of organism. They didn't just look for one reason. They talked about all the different reasons and how maybe what they saw didn't explain it – because they were there just briefly. And I thought that was good. Well – he affirmed it. He sort of was like yea. I thought just sort of re-agreeing with the students--agreeing or affirming with the students that made those comments.

EXAMPLE #5

Original Version:

33) Describe the feedback or further instruction (if any) that the teacher should provide the student based upon Artifacts 1, 2, & 3?

Uhm....see – I would really like to go back & reread everything again to fully answer that question. I'm it's also – I hit upon this somewhat – uhm.....I'm not really sure. Some of the liquids by having strong bonds but relatively high molecular movement – move over surfaces like a snake in constant motion. To me – I – personally I would not – I would not use that and I really wouldn't want a student to sort of equate the two together.

Dave – uhm....

Uhm....I would have go through and really look at it in more detail and think about it

Dave – ok

But I feel that the student has – wait a minute this isn't – no the other one is --

.....what level was this – 10th grade ok – Uhm....yea, I've have to read it – I don't really know what the teacher would do to beyond this point.

Dave – ok

Because I've never gotten into – I've never taught chemistry

Dave – that's fine

Final Version:

34) Describe the feedback or further instruction (if any) that the teacher should provide the student based upon Artifacts 1, 2, & 3?

see – I would really like to go back & reread everything again to fully answer that question. I'm it's also – I hit upon this somewhat –.....I'm not really sure. Some of the liquids by having strong bonds but relatively high molecular movement – move over surfaces like a snake in constant motion. To me – I – personally I would not – I would not use that and I really wouldn't want a student to sort of equate the two together.I would have go through and really look at it in more detail and think about it--But I feel that the student has – wait a minute this isn't – no the other one is --.....what level was this – 10th grade ok –....yea, I've have to read it – I don't really know what the teacher would do to beyond this point. Because I've never gotten into – I've never taught chemistry.

EXAMPLE #6

Original Version:

Suppose this teacher also said she had a goal of ensuring fairness, equity and access for all students. What steps should the teacher take to fulfill this objective?

I think the first thing would be to ask questions of Alejandra. Uhm but personally they would be – they wouldn't be the most challenging on the spot questions. But they would be more questions to make sure that she feels comfortable with the group and comfortable speaking with the group. And I guess it really depends too, she's from Ecuador, and it depends on if she is uncomfortable speaking English. I would also probably try and take that into account. If she doesn't speak English at all of very very little uhm – you know – taking notes would be kind of a challenge. I'm assuming that she speaks a little bit. Uhm – that would be definitely one of my first steps. Uhm – I guess it depends on the classroom environment and why she has Evan working with 3 gals and that kind of stuff – it's tough to say

Dave – Has Evan working what?

With 3 gals – girls.

Dave – Oh I'm sorry – Is that something that would be – you'd want to know why – is that what you said?

Uhm – it wouldn't well I I'm interested in it if if one of her professional goals is working on equity in the classroom. Uhm – you know – it depends on the ratio of guys to girls in the classroom and that kind of stuff; but.

Dave – Anything else?

Nope that's it.

Final Version:

Suppose this teacher also said she had a goal of ensuring fairness, equity and access for all students. What steps should the teacher take to fulfill this objective?

I think the first thing would be to ask questions of Alejandra. but personally they would be – they wouldn't be the most challenging on the spot questions. But they would be more questions to make sure that she feels comfortable with the group and comfortable speaking with the group. And I guess it really depends too, she's from Ecuador, and it depends on if she is uncomfortable speaking English. I would also probably try and take that into account. If she doesn't speak English at all of very very little – you know – taking notes would be kind of a challenge. I'm assuming that she speaks a little bit. – that would be definitely one of my first steps. – I guess it depends on the classroom environment and why she has Evan working with 3 gals and that kind of stuff – it's tough to say. – it wouldn't well I I'm interested in it if if one of her professional goals is working on equity in the classroom. – you know – it depends on the ratio of guys to girls in the classroom and that kind of stuff.

Appendix I: Important Communications with Candidates

1. Letter from the National Board to Prospective Participants

October 4, 2002

Dear National Board Candidate,

The National Board often encourages research on issues regarding the National Board Certification process, its impact on teachers and student learning. As a National Board Candidate, many researchers want to contact you and get your insight to the process.

We here at the National Board always strive to protect candidate's privacy when requests are made for information. That is why we are sending this letter to you. Please be advised that your participation in any research study will have no impact on your scoring or performance rating for achieving National Board Certification.

The current researcher requesting your participation is Mr. David Lustick. He is a National Board Certified Teacher and research specialist at Michigan State University. He is doing an independent study of teachers pursuing National Board Certification. The study proposes to investigate the experiences of science teachers participating in the National Board for Professional Teaching Standards certification process. Participants will be interviewed by telephone this fall. Data will be collected through an interview with each selected participant. The recorded interviews will then be analyzed to identify teacher perceptions, ideas, and practices in relation to the certification assessment and the standards of accomplished teaching in science. The interview will take about an hour. You will be compensated for your time with a \$25 gift certificate to Amazon on line stores.

If you are interested in learning more about participating in this study, contact David Lustick using the attached self-address stamped postcard. For your convenience, you may also choose to call him at (517) 432-3043 or email him at: lustick1@msu.edu.

Sincerely,

Ann Harman, Ph.D.
Director of Research

2. Postcard Included with the Letter from National Board

YES! I am pursuing National Board Certification for 2004 and am interested in learning more about receiving a **\$25 gift certificate to Amazon.com** and participating in a prestigious study on the **NBPTS certification process.**

First Name_____ **Last Name**_____

Address_____

City_____ **State**_____ **Zip**_____

Telephone_____ **Email**_____

I will contact you upon receipt. Thanks! David Lustick

3. Letter sent to Candidate who expressed an interest in participating

January 23, 2003

«first_name» «last_name»
«street_address»
«City», «State» «Zip»

Dear «first_name» «last_name»,

Thank you for demonstrating an interest in my study on National Board certification. I am a National Board certified secondary science teacher and a research specialist at Michigan State University. You have been chosen as a potential participant in an independent study of teachers pursuing National Board certification. I invite you to consider this professional and worthwhile offer. You will be compensated for your time with a \$25 gift certificate to Amazon on line stores. The research being conducted is independent of the NBPTS and your participation in this study will have no bearing on the National Board's assessment of your certification efforts.

This study proposes to investigate the experiences and approaches to teaching and learning of secondary science teachers participating in the NBPTS certification process. Participants will be interviewed once or twice by telephone with the first interview this winter and the second later in 2003. The recorded interviews with each participant will then be analyzed to identify teacher perceptions, ideas, and practices in relation to the certification assessment and the standards of accomplished teaching in science. Each interview will take about an hour.

Your privacy will be protected to the maximum extent allowable by law. The subjects shall not be identifiable in any report of research findings; on request and within these restrictions results may be made available to subjects. If you have any questions about this study, please do not hesitate to contact me. If you have questions or concerns regarding your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact (anonymously, if you wish) Ashir Kumar, M.D., Chair of the University Committee on Research Involving Human Subjects (UCRIHS) by phone: (517) 355-2180, fax: (517) 432-4503, e-mail: ucrihs@msu.edu, or regular mail: 202 Olds Hall, East Lansing, MI 48824.me at (517) 432-3043.

If you would like to participate, simply fill out the statement of consent form and return it to me in the self-addressed stamped envelope. I invite you to seriously consider this worthwhile opportunity and I look forward to your response.

Sincerely,

David Lustick

4. Statement of Consent and Introductory Survey Questions

Statement of Consent

Please read the following statement of consent. If you agree to participate, please sign, answer the 4 general questions, and return this page in the self-addressed stamped envelope at your earliest convenience. If you would like an electronic version of the letter and agreement, I can provide one upon request.

After reading the accompanying letter, you freely consent to participate in this study of the National Board of Professional Teaching Standards (NBPTS) certification process. Your participation is voluntary and you may choose not to participate at all, may refuse to participate in certain procedures or answer certain questions or may discontinue the experiment at any time without penalty or loss of benefits to which you are otherwise entitled. You indicate your voluntary agreement to participate by completing and returning this form in the enclosed self-address stamped envelope.

Name (Please Print Clearly) _____

Signature _____ **Date** _____

Telephone Number _____ **Email** _____

Which Standard Time are you on? ET, CT, MT, or PT Year of NB certification? _____

Please answer the following questions (circle all that apply):

1. How did you first hear about National Board certification?

- a) colleague
- b) media
- c) union
- d) school administration
- e) other (please specify): _____

2. What incentives did your district, state, or school offer to encourage teachers to pursue National Board Certification?

- a) salary, step, or rank increase
- b) yearly bonus for life of certificate
- c) one-time bonus upon achieving certification
- d) none
- e) other (please specify): _____

3. In your efforts to complete the certification requirements, which of the following resource(s) do you anticipate using or have used?

- a) school or district support group
- b) email group
- c) web
- d) none
- e) other (please specify): _____

4. Which statement best describes your work on the portfolio entries to date?

- a) I have received my materials, but have yet to begin work constructing my portfolio entries.
- b) I have completed 25% or less of my portfolio.
- c) I have completed about 50% of my portfolio.
- d) I have completed about 75% or more of my portfolio.
- e) other (please specify): _____

5. Letter of Instruction sent with video tape, artifacts, and handout for interview

November 26, 2002

«first_name» «last_name»
«street_address»
«City», «State» «Zip»

Dear «first_name»,

Thank you for agreeing to participate in a study on science teachers pursuing National Board certification. I know how valuable your time is and appreciate your willingness to be interviewed. Enclosed are the materials you will need for our upcoming conversation. If I have not yet reached you by phone to arrange an appointment, I will do so shortly.

The enclosed materials include:

- 1) A 9-page handout that includes Artifacts 1, 2, & 3 as well as 5 questions we will discuss. If you wish, you *may* look over the questions before the interview, but it is not required.
- 2) A videotape labeled Artifact #4. Please do **not** view prior to our conversation.
- 3) A self-addressed stamped envelope for returning the 9-page handout and the videotape after the interview.

A few things to remember:

- 1) It is important to understand that there is no 'right' answer to any question.
- 2) When you are interviewed, you should have access to a VCR and TV to watch the 6-minute segment during the interview. You do not have to physically hold the phone when you watch the tape. It is perfectly acceptable to put the receiver down and go to another room to view the tape and then return.
- 3) You will need to have a pen or pencil to jot down some notes and answer a few questions on the handout.
- 4) The interview should take about an hour. Since I will be recording the conversation, the place you choose to talk should be quiet with a minimum of background noise.

Once again let me assure you that you will not be identifiable in any report of the research findings. Your privacy will be protected to the maximum extent allowable by law. If you have any questions about the enclosed materials, the procedures described, or the study itself, please do not hesitate to contact me or ask for clarification during the interview.

I look forward to talking with you soon.

Sincerely,

David Lustick

6. Email message sent to candidates in Groups 2 and 3.

Dear «first_name»,

Thank you for contacting me regarding the study on National Board certification. Your willingness to learn more and potentially participate in the study is greatly appreciated. I will be sending out a formal letter of invitation and a Consent Form for this study with a SASE through snail mail tomorrow. However, in the meantime, could you please look over your contact information and confirm/correct/or complete it? I want to make sure that I have it accurate.

Name: «first_name» «last_name»

Address: «street_address»

City: «City»

State: «State»

Zip: «Zip»

Telephone: «Phone»

Finally, Which statement best describes your work on the portfolio entries to date?

- a)___I have registered, but have not begun constructing my portfolio entries.
- b)___I have completed 25% or less of my portfolio.
- c)___I have completed about 50% of my portfolio.
- d)___I have completed about 75% or more of my portfolio.
- e)___other (please specify):_____

Thank you for your time and I look forward to your response. If you have any questions or concerns, please do not hesitate to contact me.

Sincerely,

David Lustick

NBCT

Michigan State University Specialist/Researcher

7. Letter of Apology Sent to Candidates that would have been Group 2A

January 16, 2003

«first_name» «last_name»

«street_address»

«City», «State» «Zip»

Dear «first_name» «last_name»,

Thank you for agreeing to participate in a study on science teachers pursuing National Board certification. I first want to apologize for the lateness of this letter. I became aware of your responses only today. It seems that they were misplaced into an unused mailbox and were only discovered today by a secretary. No one is more disappointed by this development than me. Though I try to follow up on every possible contingency when tracking and monitoring these responses, sometimes mistakes are made.

Unfortunately, the phase of the study for which you were willing to participate is complete. Once again, I am sorry for any inconvenience or disappointment this error may cause you. I hope this experience will not sour your desire to participate in educational research in the future. Your willingness to contribute to the knowledge about our profession is greatly appreciated.

I wish you well and the best of luck in all of your endeavors,

Sincerely,

David Lustick

8. Letter of Update to every candidate who participated in each of the 3 groups.

July 10, 2004

I hope this update finds you doing well and enjoying the summer weather. I have been very busy examining the data from our study on National Board certification. I am writing now to bring you up to date on where things stand. I intend to finish primary writing by the end of the month. After a review and editing phase, the final report will be delivered in September. At this time, I will contact you again with instructions for accessing the document.

Your contributions to this study are greatly appreciated. I consider myself honored and humbled to have had the opportunity to talk with you about teaching, learning, science, and National Board certification. The outcomes of my interviews demonstrate some very interesting and (I hope) meaningful insights into the certification process and science education.

Someday, I hope we can meet at a conference or collaborate on another research project. If there is ever a time when I might be able to help you with something, please do not hesitate to ask.

Regards,
David Lustick
Michigan State University

9. Email reminder to Candidates about receiving their Gift Certificate

This is an email 'heads up' reminder that your \$25 gift certificate to Amazon.com will arrive soon. Please be on the look out for an email message from Amazon.com that will contain the on line gift certificate. Be careful not to delete it. If you have a filter for your email program that blocks messages from Amazon, you may want to adjust them until the certificate arrives. If you would like it sent to a different email address, please let me know the address by this weekend.

I hope your teaching this year is going well. It won't be too long before you find out about NBPTS. Unofficial word from the Board is that decisions will be posted by the first week in December.

The study is going well. I will contact you again next year with the results.

Thanks for your participation in the project.
Fondly,
David Lustick

Appendix J: UCRIHS APPROVAL RENEWAL

APPLICATION FOR *RENEWED* APPROVAL OF A PROJECT INVOLVING HUMAN SUBJECTS

University Committee on Research Involving Human Subjects (UCRIHS)

Ashir Kumar, MD, Chair
202 Olds Hall, Michigan State University
East Lansing, MI 48824-1046
PHONE (517) 355-2180 FAX (517) 432-4503
E-Mail - UCRIHS@msu.edu
WEB SITE - <http://www.humanresearch.msu.edu/>

Office Hours: M-F (8:00 A.M.--5:00 P.M.)

Please write in your IRB # IRB#01-728

DIRECTIONS: 1. Please complete all questions on this form and 2) Attach a copy of your **CURRENT CONSENT FORM**. 3. Responsible Investigator must sign this page.

****NOTE:** This Renewal form with its respective enclosures (e.g. current consent forms, revised instruments, etc.) may now be submitted electronically as an email attachment. This email must be sent from the MSU pilot account of the Responsible Principle Investigator (i.e., 1st

REQUIRED

1. Responsible Project Investigator:

(MSU Faculty or staff supervisor)

Name: Prof. Mary Kennedy

Social Security #: 377-42-1918

Z-PID

Department: Teacher Education

College: College of Education

Academic Rank:

Mailing 116F Erickson Hall

Address: MSU, East Lansing, MI

Phone (517) 432-5549

Fax: (517) 432-4092

Email: mkennedy@msu.edu

The provided information is complete and accurate; furthermore, I accept continued responsibility for conducting the proposed research in accordance with the protections of human subjects as specified by UCRIHS, including the supervision of faculty and student co-investigators.

SIGN HERE: _____

Date:

Note: Without signature, application can not be processed

IF APPLICABLE

2. Secondary Investigator:

(**Students Must Provide Student ID#)**

Name: David Lustick

Student ID#: or SS# 119-40-3040

Z40392696

Department: Teacher Education

College: College of Education

Academic Rank:

Mailing 116U Erickson Hall

Address: MSU, East Lansing, MI

Phone: (517) 432-3043

Fax: (517) 3536393

Email: Lustick1@msu.edu

Additional Investigator Information

3. Name: _____

Student ID#: or SS# _____

4. Name: _____

Student ID#: or SS# _____

5. Name: _____

Student ID#: or SS# _____

[] Check box if there is any change in Co-Investigators

**6. Title of
Project:**

☐ Check box if there
is a title change.

**National Board Certification as Professional Development:
What are Teachers Learning?**

Investigator of record).

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