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Preservice Teachers Defining "Self-As-Teacher": The Elementary Science Teaching Rationale

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This study reviews allied literature and specific teacher educator behaviors that promote preservice teachers' development of a personalized, research-based elementary science teaching rationale (STR). Declaring absolutes is not the goal of the rationale. Rather, the goal is to initiate, among preservice teachers, the lifelong professional disposition of thoughtful teaching based upon cycles of reflection on one's experiences, the literature, and research on effective science teaching. The authors have found that the STR, as a key assignment in their methods courses, encourages these desirable "habits of mind."

Introduction

Ethical practice and foundational knowledge provide the glue that holds members of a profession together. The path to that foundational knowledge and the reflective habits that accompany its mastery and understanding begins at the preservice level for teachers (Abell & Eichinger, 1998; Schön, 1983). To realize these goals, preservice teachers must immerse themselves in the practice and art of teaching through discussion, study, reflection, and experience. The preservice experiences prompt the first cycles of "fine tuning" of the individual's knowledge base of teaching. The introduction of this cyclic pattern of improvement is the precursor to the highly desirable "disposition" (Interstate New Teacher Assessment and Support Consortium, 1992) of a commitment to lifelong learning and reflective teaching. This process begins when the preservice teachers first purposefully examine their future place—philosophically, practically, and intellectually—within the next generation of teachers.

The authors have found that the creation of a personal science teaching rationale (STR) by the preservice teacher is an effective catalyst to establish this nexus of foundational knowledge, experience, and educational philosophy. The STR is more than an interesting collection of statements on a preservice teacher's ideas about teaching. It is a plan of how those ideas will translate into action in their own classrooms. The STR is the final performance for the preservice teachers in the authors' methods classes, requiring the preservice teachers to create a cogent and detailed discussion of their teaching. This discussion must take into account pivotal elements of their experience; their methods studies; and their personal beliefs, ideas, and values about knowledge and learning. Each preservice teacher must then meld these elements with teaching and learning theory into one

carefully written essay (usually 12-18 pages in length) that reflects a personalized portrait of effective elementary science teaching. In terms of the broader priorities of elementary science teacher preparation, the STR addresses the well-documented need to strengthen the relationship between research, beliefs, and actual practice. It requires each preservice teacher to explore ". . . the complexity and diversity of [their] beliefs and practice . . . acknowledging that the relationship between the two is interactive and multifaceted" (Calderhead, 1993, p. 17).

This paper complements the study by Varrella and Veronesi (2003) that provided valid and reliable quantitative evidence on the value of the STR within a study population of 74 preservice teachers. The following discussion examines the critical role of the STR in developing the preservice teachers' concept of "self as teacher." This discussion will focus on relevant literature and desirable teacher educator behaviors.

Literature Relevant to the Development of the STR

A teacher's values and beliefs about knowing and knowledge directly affect his or her teaching, evaluative, and judgmental actions (Rokeach, 1970; Schwandt, 1997). These beliefs are formed during the preservice experience. They are influenced by the individual's coursework and particularly by the student teaching or internship experience. In this formative preservice period, the individual's understanding of the complexities of teaching begins as a loosely amalgamated set of beliefs about teaching, knowledge, and knowing. Even so, these beliefs about knowledge and knowing can be considered the preservice teacher's epistemology (Hammer & Elby, 2002; Schwandt, 1997). This is an uneven construct at this point for preservice teachers, and when questioned, they are inclined to describe their beliefs about knowing and teaching in generalities often prefaced by, "I believe that . . . ." Such statements reflect a lack of supporting evidence from practical experience and grounding in science education literature. The responsibility to introduce and support the disciplined study of these topics, interlocking the research base and experience, falls to the elementary science methods instructor.

The Limitations of a Technical Orientation

An effective science methods course will orient on desirable elements such as cooperative learning, open-ended inquiry, performance assessment, the importance of preconceptions, the use of higher-order questions, and hands-on activities (Fosnot, 1996; NRC, 1996; Osborne & Wittrock, 1983; Penick, Crow, & Bonnstetter, 1996; Yager, 1995). Mastering these techniques and methodological elements become the order of the day for the preservice teachers. These strategies are recognized as having an immediate effect on the preservice teachers' success in teaching and, therefore, are highly valued when compared to that "theoretical stuff" that comes along with the study of best practices in most science methods classes.

Unfortunately, even when preservice teachers study best practices in terms of their grounding in research on teaching and learning, they remain inclined to search for an imagined series of algorithms and objective teaching skills. If, tragically, the science methods instructor encourages this search for the silver bullet of elementary science teaching through a narrow, methodological lens of study and related performance assessments, there is room only for a "technical" view of self-as-teacher. Such circumstances limit the preservice teachers' growth

and development, encouraging a facile view of effective elementary science teaching. Such a confining and technically oriented beliefs system constrains the choices that a teacher at any level of experience may make in a given teaching day. Their teaching palette is devoid of the Technicolor knowledge base that comes from the disciplined examination of literature, practice, and method. With a myopic set of beliefs about teaching, the preservice teacher, and later the teacher, will struggle with the cycles of personal reflection and refinement that inform the constant strategic adjustments that are essential for the maintenance of a high-quality learning environment for their pupils (Maor & Taylor, 1995).

Technique and Art—Building a Sound Epistemology

Brickhouse (1990) arrived at a conclusion similar to that of Maor and Taylor (1995) in her research on practicing teachers' understanding of science and their classroom instruction. She describes how teachers' beliefs influence their daily pedagogical choices and, thus, the manner in which their students learn science. Therefore, stretching the preservice teachers' minds beyond a limited technical orientation helps them to develop an evenhanded and necessarily complex view of self-as-teacher, encircling the nature of knowing, methodological and content knowledge, and "context" specific pedagogies (Burry-Stock, 1995; Shulman, 1986). As the preservice teacher's knowledge of and beliefs about teaching and learning expand, so does their ability to make the daily and fluid adaptations requisite for highly effective teaching. Varrella (2003) provides an extension of this premise to the experienced science teacher. He documented a strong relationship between expert practice and a rich beliefs system, finding that the most competent teachers are highly responsive to contextual cues within their classroom which are critical to their students' learning and are equally adept at mediating external forces, such as standards and schedules, in an effective and consistent manner.

Clearly, once "centered," the science teacher becomes a more effective decisionmaker and skillful instructor. The question becomes how to move novices in the desired direction quickly. Hofer and Pintrich (2002) notes that regardless of the path or number of stages, the developmental trajectory of the individual's epistemological development moves from an objectivist and formula defined view of knowing and knowledge toward a more contextual and constructivist perspective. This profound deepening of one's epistemology is critical for an individual to define "self as teacher" and be capable of acting on that definition. The development of the personal STR, particularly in a program with continuity and emphasis on knowledge, knowing, and reflection-in-action, stimulates the preservice teacher's progression into the realm that encompasses both the technique and art of teaching. This broader and deeper understanding of teaching and learning at an early stage in their career—using Berliner's (1986, 1988) "stage theory" terminology as a referent—helps the novice teacher rise quickly to the level of competence and even proficiency in teaching. The development of these abilities is especially swift if the science methods coursework overlaps with "active" teaching experiences such as those found in advanced field experiences and through an extended Professional Development School (PDS) internship experience.

The STR encourages students to first direct their energy into the necessary metacognitive activities that enable them to examine their beliefs and attitudes about elementary science teaching in terms of evidence. In the writing of their STR, the preservice teachers must clearly articulate their beliefs about teaching and understanding of the learning process in the elementary science classroom.

Schwandt (1997) describes this as ". . . [an] epistemology with a lower-case 'e'—reflection of various kinds about what it means to know" (p. 40). The STR functions as a centering and focusing device for the development of the preservice teachers' epistemology, which will eventually guide their curricular choices, preferred methods, and learning goals for their elementary pupils when they become "the teacher."

Historical Considerations

One of the earliest discussions of the STR is found in Penick and Lunetta's (1980) work describing the STR, or "research-based rationale," as key part of the Iowa "UPSTEP" model of teacher preparation. Penick (1986) also contends that beginning teachers who develop a research-based rationale for teaching science are better prepared to self-evaluate. Self-evaluation is a key element of reflection in action (Schön, 1988) and is representative of the more recently described dispositions elucidated in the INTASC Standards (Interstate New Teacher Assessment and Support Consortium, 1992).

The inclusion of a research-based STR continues to gain favor among science teacher educators; this is evident in the growing body of related publications and refereed presentations completed in the last ten years (Clough, 1992; Monhardt & Veronesi, 1998; Penick, 2003; Tillotson, 1998; Veronesi, 1998). Along with the papers and publications noted above, the rationale has been the subject of a series of panel and roundtable discussions conducted at the International Conference for the Association of the Education of Teachers in Science (organized by R. Harris, January 1999, 2000, 2001, 2002, 2003). Samples of rationales are even available on the websites of teacher educators (e.g., Professor R. Bonnstetter's site at http://scied.unl.edu/pages/preser/sec/ratpapers/rationalelink.html).

The dispositions introduced and encouraged in the preservice setting, and embodied in the construction of a personal STR, are essential to the more experienced science teacher as well, especially related to reform and enhancement activities. Penick (1986) and Varrella (1997) assert that teachers who have a goal-centered, research-based rationale for teaching science are inclined to remain responsive to the cultural and contextual elements of contemporary science education reform. Such teachers continuously examine their teaching strategies and beliefs, making accommodations and even assimilations as warranted, based upon their pupils' needs. The common evolutionary and occasional revolutionary transformations (Kuhn, 1996) in thinking and explicit practice are a hallmark of the adaptable and reflective practitioner, who has a well-defined but dynamic epistemology. These adaptive behaviors spring from a more relativistic and subjective standpoint, akin to that described by Hofer and Pintrich (2002), as noted above.

Developing an Effective Rationale

Research (Varrella & Veronesi, 2003) supports the authors' premise that the rationale can be a highly effective element of the science methods course, impacting the quality of thinking on and practice of teaching among preservice teachers. The above discussion of the STR in terms of research, a richer epistemology, and historical discussions and applications, underscores the value of the STR; however, the specific instructor characteristics and dispositions that contribute to the successful application of the STR in the preservice elementary setting are not evident from data within that study or the discussion above.

Looking into the Methods Classroom

The STR is the culminating assignment in the authors' science methods courses. The preservice teachers are required to examine their epistemology in light of the broad milieu of teacher tasks, ranging from effective curriculum design to assessment and evaluation. The authors often find that composing the STR is the preservice teachers' first experience at weaving all aspects of teaching into one "garment," which they intend to wear. Within their paper, each preservice teacher describes not only his or her own actions, but also those of their future students. Preservice teachers often note that, "The rationale is the first time I really felt a sense of how I will teach."

To help the preservice teachers formulate a sensible STR, the authors encourage their preservice teachers to write their STR from a goal-based standpoint. The authors often liken the writing of the rationale to a court case, encouraging their preservice teachers to defend their key points with relevant practical and literature-based evidence. This strategy helps the preservice teachers build upon their personal philosophy papers written in their introductory or general methods courses. The preservice teachers construct their STR around four critical elements: (1) learning goals for their students, (2) goals for themselves as teachers, (3) personal experiences (as students on the "receiving end" of the teaching and through program-based field experiences or internships), and (4) study of the theoretical basis for content and pedagogical choices.

To introduce the preservice teachers to the patterns of thinking requisite to writing a high-quality STR, they are encouraged to refer to and reference the literature and their teaching experiences during general class discussions as well as within peer-group discourse on class assigned readings and peer analysis of work. They are also encouraged to apply their STR-oriented ideas to their curriculum design assignments and microteaching activities. In the same spirit, the authors consistently offer a verbal rationale for assignments, expectations, and course-based inquiry, placing their teaching choices and methods on the examination table each week. Setting this tone in the classroom allows the authors to model the utility of an explicit rationale for teaching, and aligns with Kagan's (1992b) recommendation that teachers work toward establishing a self-image of efficacy based on performance and reflection. (See Appendices A and B for a synopsis of teaching and learning activities and a sample rubric.)

Student end-of-term teacher evaluations in the authors' classes consistently document the affect of the above strategies in relation to the merit and worth of their STR experience. Preservice teachers from both sites acknowledge the specific contributions of their methods instructors in terms of insight, organization of classroom experiences, handouts, and course texts. These elementary preservice teachers also note that the researchers' enthusiasm for science, related to disciplined inquiry and integration of "some fun" into science teaching, contributed to their positive attitude about science teaching and learning. A positive attitude about science learning and teaching helps open the door for habitually science-shy elementary preservice teachers, creating a willingness to work toward the formulation of a rich personal STR and more inspired elementary science teaching.

Facilitating Teacher Educator Strategies and Dispositions

Through further discourse among colleagues and analysis of the STR found in the literature (Monhardt & Veronesi, 1998; Penick, 1999; Tillotson, 1998; Varrella & Veronesi, 2003; Veronesi & Varrella, 1999), a common series of teacher educator dispositions, strategies, and beliefs emerges. At first glance, this set of elements simply appears to be the realization of the National Science Education Standards (NRC, 1996); however, when taken in total and in light of the relationship to the STR as a pivotal methods course assignment, these elements represent not only desired behaviors, but also elements in a thoughtful, organized, and purposeful elementary teacher preparation program. These essentials facilitate the preservice teachers' growth as science teachers and their ability to construct an STR (i.e., the written and intellectual construction of an STR). These professors have the following expectations:

- They expect their students to teach to goals, not random outcomes.
- They emphasize hands-on and inquiry-based activities during demonstrations, inquiries, curriculum development activities, and microteaching.
- They keep their students actively involved in every methods class session (i.e., students note that time never drags in the science methods class).
- They offer their rationale (i.e., the teacher educator's) for the events and activities they conducted in the science methods class.
- They emphasize children's cognition and the power of the children's lived experiences towards understanding and conceptual change.
- They expect all class members (preservice teachers and teacher educators) to enmesh themselves in continuous cycles of reflection that guide subsequent, informed actions.
- They share a commitment to individualized support of each preservice teacher's growing abilities as a future teacher of elementary science.
- They demand that their preservice teachers develop the disposition of thoughtful and careful curricular and instructional choices based upon practical and theoretical considerations.
- They expect their preservice teachers to consistently imagine and describe themselves, as well as their students, in an active learning setting.
- They emphasize and use the STS (i.e., science in the context of human experience) and issue-based teaching paradigm as a part of their philosophical premise and as an organizer and referent for teaching and curriculum design.
- They remain committed to the integration of science with other subject matter areas.
- They use varied instructional practices that emphasize the application of theory and method in all day-to-day events in the classroom.
- They refer consistently to the literature and to the practical K-6 setting, thus modeling the value of research and practice as they are related to the justification of teacher choices.

Conclusion

The value of the STR has been documented in a variety of contexts (Clough, 1992; Penick, 1986; Penick & Lunetta, 1980; Tillotson, 1998; Varrella & Veronesi, 2003; Veronesi, 1998). This discussion builds on these works, examining relevant history, contemporary literature, and facilitating teacher educator behaviors that

assist preservice teachers in developing a research-based STR. Unlike examinations of the development of epistemologies from the psychological perspective such as those by Hofer and Pintrich (2002) or Kuhn and Weinstock (2002), this discussion has followed the more applied, practical perspective akin to the ideals described by Kagan (1992a, 1992b), Kagan and Tippins (1992), and Schön (1983). The authors require their preservice teachers to develop a clearly stated epistemology based upon practice, theory, and reflection. Each preservice teacher must focus on effective teaching through the synthesis of a personal definition, including a real-life context such as self-as-teacher in the classroom, using a series of "reasoned arguments" (Kuhn & Weinstock, 2002).

The development of a series of reasoned arguments through the STR assists the preservice teacher to move toward purposeful teaching. Finding the ultimate answer is not the goal of writing the rationale. The goal is to initiate a lifelong professional disposition of thoughtful reflection on effective teaching, drawing on the best of research and personal experiences. This key assignment in the authors' preservice programs encourages their preservice teachers to become thoughtfully enmeshed in the deep debate on theoretical, philosophical, and pedagogical matters (Matthews, 1998) that directly influences their maturing epistemology and corresponding teaching practices. One student described the value of the STR as a contributor to self-recognition as a teacher: "[The STR] helped me pull ideas about my teaching together in my own head for the first time." Such introspection prepares the neophyte to become involved in the debate on and actions within the broader school improvement agenda, similar to experienced teachers like those described by Fetters, Czernick, Fish, and Shawberry (2002) and Varrella (2003).

An additional benefit that the authors have gleaned from their preservice teachers' rationale experience is that while facilitating their students' continuous examination of self-as-teacher, the authors remain engaged in their own cycle of renewal, thus further cementing the partnership in learning that all teachers should share with their students and their colleagues as lifelong learners.

(Rubrics for STRs, recent examples of elementary and secondary STRs by preservice teachers, and comments on and examples of how the STR can be used as documentation for NCATE will be provided by the authors on request.)

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References

Abell, S. K., & Eichinger, D. C. (1998). Examining the epistemological and ontological underpinnings in science education: An introduction. *Journal of Research in Science Teaching*, *35*(2), 107-109.

Berliner, D. C. (1986). In pursuit of the expert pedagogue. *Educational Researcher*, *15*, 5-13.

Berliner, D. C. (1988, February). *The development of expertise in pedagogy*. Paper presented at the Charles W. Hunt Memorial Lecture presented at the Annual Meeting of the American Association of Colleges for Teacher Education, New Orleans.

Brickhouse, N. W. (1990). Teachers' beliefs about the nature of science and their relationship to classroom practice. *Journal of Teacher Education*, *41*(3), 53-62.

Burry-Stock, J. A. (1995). *Expert Science Teacher Evaluation Model (ESTEEM): Theory, development, and research* (1st ed.). Kalamazoo, MI: Center for Research on Educational Accountability and Teacher Evaluation (CREATE).

Calderhead, J. (1993). The contribution of research on teachers' thinking to the professional development of teachers. In C. Day, J. Calderhead, & P. Denicolo (Eds.), *Research on teacher thinking: Understanding professional development* (pp. 11-18). London: The Falmer Press.

Clough, M. P. (1992). Research is required reading. *The Science Teacher*, *59*(7), 37-39.

Fetters, M. K., Czerniak, C. M., Fish, L., & Shawberry, J. (2002). Confronting, challenging, and changing teachers' beliefs: Implication from a local systemic change professional development program. *Journal of Research in Science Teaching*, *12*, 101-130.

Fosnot, C. T. (1996). Constructivism: Theory, perspectives, and practice. In C. T. Fosnot (Ed.), *Constructivism: Theory, perspectives, and practice* (pp. 205-216). New York: Teachers College Press.

Hammer, D., & Elby, A. (2002). On the form of a personal epistemology. In B. K. Hofer & P. R. Pintrich (Eds.), *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 169-190). Mahwah, NJ: Lawrence Erlbaum Associates.

Hofer, B. K., & Pintrich, P. R. (Eds.). (2002). *Personal epistemology: The psychology of beliefs about knowledge and knowing*. Mahwah, NJ: Lawrence Erlbaum Associates.

Interstate New Teacher Assessment and Support Consortium (INTASC). (1992). *Model standards for beginning teacher licensing and development: A resource for state dialog*. Available online: <www.ccsso.org/intascst.html#draft>. Retrieved April 5, 2003.

Kagan, D. M. (1992a). Implications of research on teacher belief. *Educational Researcher*, *27*, 65-90.

Kagan, D. M. (1992b). Professional growth among preservice and beginning teachers. *Review of Educational Research*, *62*, 129-169.

Kagan, D. M., & Tippins, D. J. (1992). How teachers' classroom cases express their pedagogical beliefs. *Journal of Teacher Education*, *42*, 281-291.

Kuhn, D., & Weinstock, M. (2002). What is epistemological thinking and why does it matter. In B. Hofer & P. Pintrich (Eds.), *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 121-144). Mahwah, NJ: Lawrence Erlbaum Associates.

Kuhn, T. S. (1996). *The structure of scientific revolutions* (3rd ed.). Chicago: University of Chicago Press.

Maor, D., & Taylor, P. C. (1995). Teacher epistemology and scientific inquiry in computerized classroom environments. *Journal of Research in Science Teaching*, *32*, 839-854.

Matthews, M. R. (1998). In defense of modest goals when teaching about the nature of science. *Journal of Research in Science Teaching*, *35*(2), 161-174.

Monhardt, R., & Veronesi, P. D. (1998, March). *Elementary teachers' first attempts at STS: Is this the place to start?* Paper presented at the National Science, Technology, and Society Conference, Chicago.

National Research Council (NRC). (1996). *National science education standards*. Washington, DC: National Academy Press.

Osborne, R. J., & Wittrock, M. C. (1983). Learning science: A generative process. *Science Education*, *67*, 489-504.

Penick, J. E. (1986). Science education research: Why don't we believe it? *Curriculum Review*, 65-67.
Penick, J. E. (1999, March). *The rationale paper: Structured reflection for teachers*. Paper presented at the International Meeting of the Association for the Education of Science Teachers, Austin, TX.
Penick, J. E. (2003, August/September). Teaching with purpose. *NSTA Reports*, *14*, 46.
Penick, J. E., Crow, L. W., & Bonnstetter, R. J. (1996). Questions are the answer. *The Science Teacher*, *63*(1), 26-29.
Penick, J. E., & Lunetta, V. N. (1980). Iowa-UPSTEP: A dynamic model in science teacher education now. *Teacher Educator*, *16*, 14-18.
Rokeach, M. (1970). *Beliefs, attitudes, and values*. San Francisco: Jossey-Bass.
Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. New York: Basic Books.
Schön, D. A. (1988). Coaching reflective teaching. In P. P. Grimmett & G. L. Erickson (Eds.), *Reflection in teacher education* (pp. 19-30). New York: Teachers College, Columbia University.
Schwandt, T. A. (1997). *Qualitative inquiry: A dictionary of terms*. Thousand Oaks, CA: Sage.
Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, *15*(2), 4-14.
Tillotson, J. W. (1998, January). *A cycle of excellence in science teacher development*. Paper presented at the Annual Association for the Education of Teachers in Science (AETS) Conference, Minneapolis.
Varrella, G. F. (1997, March). *Voices of reform: The proficient/expert teacher*. Paper presented at the National Association for Research in Science Teaching Annual Meeting, Oakbrook, IL.
Varrella, G. F. (2003). All star performers: Science teachers at the top of their game. In J. Weld (Ed.), *The game of science education* (pp. 22-47). Boston: Allyn & Bacon.
Varrella, G. F., & Veronesi, P. D. (2003). *The elementary science teaching rationale: Development of a self-report instrument*. Manuscript submitted for publication.
Veronesi, P. D. (1998, January). *"Our-best" rationale for teaching elementary science: A first year report*. Paper presented at the Annual Association for the Education of Teachers in Science (AETS) Conference, Minneapolis.
Veronesi, P. D., & Varrella, G. F. (1999, March). *Building a sound rationale for teaching among preservice candidates*. Paper presented at the Annual Conference of the National Association for Research in Science Teaching, Boston.
Yager, R. E. (1995). Constructivism and the learning of science. In S. M. Glynn & R. Duit (Eds.), *Learning science in the schools: Research reforming practice* (pp. 35-58). Mahwah, NJ: Lawrence Erlbaum Associates.

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Appendix A

Synopsis of Teaching & Learning Methods
Gary Varrella and Peter Veronesi's Elementary Science Methods Courses

Our elementary science methods courses are oriented toward best practices. We strive to create a balance between practical teaching considerations, curriculum development skills, theory/literature applied to practice, and, of course, the development of a sound and theory/literature-based rationale. Our priorities include attention to the nature and power of children's preconceptions about the natural world, conceptual change (i.e., moving from naïve/phenomenological interpretations of the natural world to those that align with our best understandings of the time), inquiry, creativity, generative learning, and questioning techniques. The courses are guided by a philosophy of experiencing the phenomena before considering the explanation (an application of generative learning theory). Major events in our methods courses are constructed around the following elements:

- *Field experiences*—These range from traditional observation-based experiences to the intense experience of the PDS (Professional Development School) intern.
- *Study of the literature*—This spans practical readings from *Science and Children*, to use of popular texts such as Janice Koch's *Science Stories* (2002), and selections from seminal works such as Roger Osborne and Peter Freyberg's *Learning in Science* (1985) and Mary Budd Rowe's article, "Wait Times: Slowing Down May Be a Way of Speeding Up" (1986).
- *Curriculum development using the learning cycle model*—This includes lesson and unit development and an emphasis on inquiry and assessment.
- *"Microteaching" (i.e., model teaching in the methods classroom)*—This is done collaboratively in teams, emphasizing the learning cycle and inquiry.
- *Methodological skill development*—This provides opportunities to (1) "practice" these techniques through microteaching, and (2) write and reflect on their application through curriculum and rationale development.
- *Video self-analysis of two science lessons taught during the PDS internship*—This is a highly successful new assignment for the first author referenced to goal setting, reflection, INTASC standards, and the "Science Classroom Observation Rubric" (Burry-Stock, 1995).
- *Reflection and development of an articulated epistemology* (see Appendix B)

The placement of the course in the program varies. Peter's science methods course is integrated into a six credit course, co-taught with a math and social studies educator and offered prior to student teaching. It includes a modified field experience of 45 hours of directed co-teaching and general teaching assistance, part of which is geared exclusively toward science inquiry. Gary's PDS-based course spans a preliminary late spring field experience and the fall portion of the yearlong elementary PDS internship. (The entire program is 17 months in length at George Mason University.) A 15-hour field experience for science is conducted in late spring; and in the successive fall term, during the PDS internship, science is a part of each intern's experience. During that time, the video analysis is completed. In both instances, there is only one elementary science methods course included in the elementary teacher preparation sequence.

References

Burry-Stock, J. A. (1995). *Expert Science Teaching Evaluation Model (ESTEEM) instruments* (1st ed.). Kalamazoo, MI: Center for Research on Education Accountability and Teacher Evaluation (CREATE).

Koch, J. (2002). *Science stories: A science methods book for elementary school teachers* (2nd ed.). New York: Houghton Mifflin Company.

Osborne, R., & Freyberg, P. (1985). *Learning in science: The implications of children's science*. London: Heinemann.

Rowe, M. B. (1986). Wait times: Slowing down may be a way of speeding up. *Journal of Teacher Education, 31*(1), 43-50.

Appendix B

EDCI 553 Rationale Rubric, Dr. Varrella
The Science Teaching Rationale
Background Information and Rubric (for PDS interns)

Your rationale is a personal statement about you as a teacher. It is an illustration, painted through your discussion, that must include *you* and your *students*. What will you do in and outside of your classroom as a teacher? If I visit you in three years in your classroom, what will I see your students doing, hear them saying, see them studying? What will you be doing, saying, etc.? Your discussion should be rich in examples from the literature and from your own experience that demonstrate you have solid reasons, both practical and theoretical, for teaching as you do. Build your rationale around how your classroom will operate and what guides and informs your curricular and pedagogical choices! Evidence of melding the thinking and writings of more than one author in your rationale are important *(collectively and conveniently called "theory," in the rubric).* Things you should consider including in your rationale are as follows:

- How you will use standards and curriculum to reflect your epistemology (i.e., your philosophy on teaching and learning)
- Questioning & wait time I and II
- Equity and democracy
- "Authentic" and STS approaches (i.e., relevancy and "connectivity")
- Problem solving and inquiry
- Types and applications of assessment and evaluation
- The role of textbooks, safety, learning cycle, and lecture (it too has a place, but how, when, for what reason?) related to the above

There will be multiple rationale papers available for review in the methods classroom. **Note:** You may wish to cite our texts in different contexts, using different chapters. This is appropriate, since our texts are rich in theory, models, and practical examples; however, to earn a high mark on your rationale, you must use other readings in the class, and if it suits your rationale development, materials from other classes and other sources as well. You will have already completed the reading necessary to write this paper (if you have kept up in class) before it is due. You must build on the ideas, readings, discussions, and reflections we have had in class and your own experiences in your field observations and in your current internship to construct your own coherent and rich science teaching rationale.

Write this paper with the conviction that it is an accurate description of you as the teacher. Think of it as something you would be proud to leave at a school after an interview!

Last of all, use subheadings and be attentive to paragraph construction, transition from discussion point to discussion point, and *do not forget to write a conclusion*. Remember, the rubric is the guideline for grading. ***Be sure you understand it and review it once or twice while writing your rationale.***

On the back, you will find a set of guidelines that will be used to grade your papers.

EDCI 553 Rationale Rubric **Dr. Varrella**

Name _____ Total Score _____

Point Scale (200 points)	**Synthesis (70% - 140 pts)**	**Construction (20% - 40 pts)**	**Citations (10% - 20 pts)**
Outstanding (A) **(≥ 94%)**	The discussion connects theory and practice with cogent and well-supported arguments/ discussion. The picture of the interactions between students and teachers is clear, rich, and carefully explained and supported through research and examples from personal teaching experiences (may include microteaching, field observations, and internship). Discussion thoroughly links learning theory, practice, inquiry, curriculum design, assessment, sensitivity to gender/culture issues, etc.	Writing is clear, it is obvious that the work was carefully edited, and there is a flow/coherence to the discussion.	12 citations from different sources, including at least 7 from the 553 class. (Do not cite 5 chapters each from two different books; give credit equally to a rich variety of appropriate sources.)
Very Well Done (A-) **(≥ 90%)**	The discussion connects theory and practice with cogent and well-supported arguments/ discussion. A picture of the interactions between students and teachers is apparent and is supported by the selected literature. Discussion thoroughly links learning theory, practice, inquiry, curriculum design, assessment, sensitivity to gender/culture issues, etc.	Writing is clear, it is obvious that the work was edited, and there is a flow to the discussion.	10 citations
Well Done (B to B+) **(≥ 80%)**	There is ample evidence that the author has considered and included theory, practice, and experience in building his or her rationale of teaching. Theory is used as a foundation for practice; however, key elements are missing (e.g., no mention of standards, assessment, gender/ culture, etc.)	You got the point across well— without any literary barbarisms.	8 citations
Needs improvement (less than a C □ □)	I hope you will not find yourself needing to worry about this or lesser grades.		

gfv (last revised 11/6/03)