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ABSTRACT

This paper reports on the perceptions of preservice teacher candidates (students) regarding their personal content- and context-specific pedagogies toward a strategy that promotes the development of these important teaching abilities; the elementary science teaching rationale. Perceptions about a science teaching rationale were surveyed at the end of two different science teaching methods courses and before student teaching. The science teaching rationale described in this paper requires students to meld research-based methods with practice. The science teaching rationale provides a window on the perceptions of how the individual students will teach, what they as the teacher will be doing, what their students will be doing, and the theoretical basis for their content-based, pedagogical, and epistemological choices. This study provides the first detailed evidence for the value of the science teaching rationale based on the results of a questionnaire from two comprehensive teacher preparation programs. A mixed quantitative and qualitative design was employed studying students' views in a post-hoc case study (n=74) and includes a study population from universities in two different states. A 29-item Likert scale was used as well as open-ended response questions. The validity and reliability of the instrumentation are reported on as well. (Contains 25 references.) (Author/ASK)

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Building a Sound Rationale for Teaching Among Preservice Teacher Candidates

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of

The National Association for Research in Science Teaching

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Abstract

This paper reports on the perceptions of preservice teacher candidates (students) regarding their personal content and context specific pedagogies toward a strategy that promotes the development of these important teaching abilities; the elementary science teaching rationale. Perceptions about a science teaching rationale were surveyed at the end of two different science teaching methods courses and before student teaching. The science teaching rationale described in this paper requires students to meld research-based methods with practice. The science teaching rationale provides a window on the perceptions of how the individual students will teach, what they as the teacher will be doing, what their students will doing, and the theoretical basis for their content-based, pedagogical, and epistemological choices. This study provides the first detailed evidence for the value of the science teaching rationale based on the results of a questionnaire from two comprehensive teacher preparation programs. A mixed quantitative and qualitative design was employed studying studentsí views in a post-hoc case study (n = 74) and includes a study population from universities in two different states. A 29-item Likert scale was used as well as open-ended response questions. The validity and reliability of the instrumentation are reported on as well.

Building a Sound Rationale for Teaching Among Preservice Teacher Candidates

Overview

The preparation of successful and effective science teachers necessitates more than just providing a strong background in science content and a series of methods or strategies for delivery of the content to students in schools (Tillotson, 1998, Yager, 1995). To *teach* a subject to their future science students in ways that promote understanding, our students must develop a

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series of content and context specific pedagogies (Burry-Stock, 1995; Shulman, 1986). The development of this type of true expertise in teaching is time consuming and requires a deep and broad understanding of the art and practice of teaching that is informed by both theory and practice (Penick, 1986; Varrella, 1997). Additional strategies for the preparation of teachers that address these goals is always welcome, but should be examined carefully.

Literature indicates that Penick (1988) originated the discussion of the development of a science teaching rationale as a necessary prerequisite for a beginning science teacher so that thoughtful consideration and reflection of research-based teaching strategies could emerge. The concept of the rationale was furthered by Clough (1992) and again by Veronesi (1998). Penick argued that beginning teachers who develop a research-based rationale for teaching science are better prepared to self-evaluate. This ability is closely related to, and augments, the habits of a reflective practitioner. In short, teachers have the opportunity to compare the model of teaching science they outlined in their rationale to the teacher they have become at any point in time. Penick also asserted that teachers who have a goal-centered research-based rationale for teaching science will more likely stay in tune with science education reform and examine how their beliefs about teaching should be modified to reflect this new knowledge.

Science educators have long suggested many different research-based methodologies or ideas for teaching science. Methods such as cooperative learning (Ellis and Whalen, 1992) or the use of questions (Penick et. al., 1996) are thought to be more efficient for increased learning in science than direct instruction. Whether implicitly or explicitly stated, these teaching approaches are grounded in research on teaching and learning. The strategy used to modify the thinking of students in this study is a document called the science teaching rationale. The rationale is a required research-based paper that each student writes, rewrites, and orally defends. The science rationale is a term-long assignment in the science methods courses referenced in this paper that meld contemporary research with an actual vision of future practice. The rationale is to provide a window into how the individual student will eventually teach, what they as the teacher will be doing, and what their students will doing as a result of their actions. The rationale provides the goals for teaching and the theoretical basis for content, pedagogical, and epistemological choices. The essence of the process and the event of writing the rationale is an attempt to provide students with, as Kagan (1992) explains, an image of self as the teacher so they do not flounder when they go into their student teaching experiences and beyond.

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Purpose of this Research

The inclusion of a research-based science teaching rationale has gained favor among science teacher educators with time and continued success (Tillotson, 1998; Veronesi, 1998). However, these studies serve as a beginning only and a further study that documents student perceptions about this potentially pivotal preservice activity via a more disciplined approach was, and continues to be needed.

This research also advances notions put forth by Pajares (1992) who argued for a research focus on studentsí beliefs toward constructs in teaching and learning. Pajares notes that current definitions for research in beliefs can be defined from a great number of conceptual frameworks that include: attitudes, values, judgements, axioms, opinions, ideology, perceptions, conceptions, conceptual systems, preconceptions, dispositions, implicit theories, explicit theories, personal theories, internal mental processes, action strategies, rules of practice, practical principals, perspectives, repertories of understanding, and social strategies. For the purposes of this research, perceptions of preservice students toward their science teaching rationale is that which is most congruent. Other workers who have focused on teacher beliefs discuss the role between the nature of teacher beliefs and the impacts these beliefs have on instructional practices in the classroom (Brookhart & Freeman, 1992; Goodman, 1988; Mundby, 1982; Weinstein, 1988; Wilson, 1990). In addition, if Pintrichís (1990) suggestion that beliefs are going to become the most important aspect of teacher education, then research in this area becomes imperative.

To encourage our students to become thoughtful and reflective teachers who can act on their reflections (Abell & Eichinger, 1998; Schön, 1988) we must provide opportunities to experience the value of discussion, synthesis, and reflection within their preparation programs. The science teaching rationale is an effective approach to establish a purpose and nexus for the study, discussion, and application of theory-based readings, and the practical links to better teaching among preservice students. This experience within the preservice setting addresses the well-documented need to strengthen the relationship between research, beliefs, and actual practice; helping our students "recognize the complexity and diversity of both . . . acknowledging that the relationship between the two is interactive and multifaceted" (Calderhead, 1993 p. 17).

Experiences and evidence shared in this paper show that the development of a personal, research-based/practice-based rationale is one of the more challenging and rewarding opportunities that our preservice teachers experienced in their preparations to become "The best teacher I can be." The challenge stems from the epistemological questions with which our students must begin to grapple in our preservice classrooms and the fundamental challenge of writing a research-based paper (often the studentsí first). Finding the ultimate answer is not the goal, rather the goal is to begin a life-long professional habit of thoughtful reflection on effective teaching that draws on the best that research and strongly held personal experience can provide. This pivot point in our preservice programs encourages our students to become thoughtfully enmeshed in the, deep debate and disagreement on these (e.g., theoretical, philosophical, experiential, multicultural, religious, feminist, and environmental) matters (Matthews, 1998).

What is "Best" Teaching?

Penick and Yager (1993) discuss exemplary practices or teacher characteristics of the best in teaching. They claim teachers make a difference by:

- Providing a stimulating and accepting environment.
- Having high expectations of themselves and their students.
- Challenging students beyond ordinary school tasks.
- Being models of active inquiry.
- Not viewing classroom walls as a boundary.
- Using societal issues as a focus.
- Being extremely flexible in their time, schedule, curriculum expectation, and view of themselves.
- Providing systematically for feelings, reflections, and assessments.
- Requiring considerable student self-assessment.
- Expecting students to question facts, teachers, authority, and knowledge.
- Stressing scientific literacy.
- Wanting students to apply knowledge
- Seeking science excellence.

Some individual teachers would logically be stronger at one trait over another and these strengths would vary over time. Calderhead (1987) discusses the problem of ambiguity that exists in the teaching profession. Teachers, for instance, are faced with thousands of decisions each day that require them to use a knowledge base. Having a knowledge base stemming from the research literature that melds into practice informs and facilitates these necessary day-to-day decisions about teaching.

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Elementary science methods courses are one place for students to acquire skills and attitudes that relate to the list of exemplary characteristics (Penick & Yager, 1993). In an attempt to increase the level of self-efficacy toward teaching science, students from both programs in this study were required to write their own elementary science teaching rationale during their methods course.

History

Site 1

The intent of the rationale paper used in an elementary science methods course at site 1 was to help beginning elementary preservice students strengthen their confidence and self efficacy toward science instruction. This pilot study begins discourse on a longitudinal research project in science teacher education to develop an effective strategy to support new elementary teachersí science instruction. The developmental process of reflecting on, and writing a science teaching rationale is a strategy that addresses the concern of lower confidence and sense of self-efficacy.

Forty preservice students were enrolled in a two-semester methods course (first semester general methods, second semester science methods) during the fall semester of 1998. Candidates were assigned to write and orally defend a Research-Based Elementary Science Teaching Rationale (*R-BEST* Rationale, Veronesi, 1998) for teaching science in their future classrooms. Candidates were given the first two months of the semester to write an initial paper for mid-term, get instructor feedback, rewrite and resubmit, then finally orally defend their rationales during a finals week exit interview. The focus of their papers included specifying the research-based methods they would employ in the teaching of science based on their goals for their studentsí learning. They were then to weave their goals about science learning into a personal vision of their future classrooms.

Each teaching action they envisioned as an alternative was to be based on their goals for students and then linked to relevant research literature. For example, if one of their goals for their studentsí science learning was to have students communicate their evidence to other group members, they might cite cooperative learning as a research-based means of realizing their goal. Whenever the teacher candidates referred to a teacher action, they were to

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show evidence of its learning effectiveness in the literature.

Various teaching and learning strategies and constructs for science teaching were modeled for students in their methods course. Each model (e.g. learning cycle, inquiry, open-ended questioning, wait-time) was research-based and the teacher candidates were free to choose those strategies that best fit their goals for their students. Some topics that received a great deal of perusal included constructivism, inquiry, questioning, Science, Technology, and Society (STS), cooperative learning, and alternative and performance assessment.

The final evaluation of their understanding of teaching elementary science was demonstrated through a fifteen-minute oral defense of their rationale during finals week of the second of the two-semester methods sequence. Students were assessed on their completeness of thought and how well they had incorporated research-based methods into their explanations. As with any assessment, the quality of explanation ranged from very strong and articulate with substance to very week, inarticulate with little knowledge of any research-based literature. The candidates completed the survey used in this research on the last day of class, began student teaching during the spring, 1999 semester, and will be certified teachers in May 1999. The search for jobs will begin in earnest for most after May 1999.

Site 2

The instructors at both sites share intent, constructivist epistemologies, and overall goals for students related to the outcome of the rationale, however, course timelines differed. At site 2, all students were on a quarter system. There was only one science methods course for elementary students, which was ten weeks long. The rationale paper was the last project, due on finals day (during week eleven) at site two.

Thirty-four preservice students, 20 winter quarter 1998 and 14 spring quarter, 1999, comprised the study population at site 2. These students were undergraduates, most of whom were in their junior year of college, having already been admitted to the teacher preparation program. Due to the compressed timeline (one term ñ compared to two terms), a "primer" assignment was used to help students focus on expectations and have a preliminary experience in the writing style (research-based) necessary to write a successful rationale. Students wrote a brief research-based paper on a specific subject (e.g., rubrics, Science-Technology-Society, standards, and assessing preconceptions). The assignment was nicknamed "SOKE" (Synthesis of Key

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Elements) and tended to be 400-800 words in length and included at least three or four citations from the literature. The expectation was a clear and concise discussion built on current research-based literature with cogent linkages between theory and practice. Students drew from their personal experiences as students and/or pre-student teaching field experiences for the latter element (practice, i.e., day-to-day teaching and learning) and were required to draw from course readings for the former element (theory).

The SOKE is the primer for writing the rationale paper. This briefer paper provided an opportunity for the instructor to assess studentsí abilities to write and to provide written comments to each student. The SOKE tended to be very labor intensive for both students and instructor. In the case of the former, many of the students had limited experiences writing a paper melding theory into practice and tended to struggle with this first assignment. The time-intensive detailed responses to their papers by the instructor had the desired effect of setting high, but fair expectations. Final evaluation and grading of the SOKE and the rationales was facilitated by rubrics provided to the students in the course syllabus.

The students drew on a variety of pedagogical strategies in writing their rationale paper. The most common references within the rationales were to questioning and wait-time; STS (an emphasis within the class); learning cycle, pre-, formative, and summative performance assessments; democracy in education (an emphasis of the College of Education as a whole), and issues of gender equity. Students drew heavily from course readings to write their rationales. They also tended to draw from germane readings in other courses, particularly in the areas of democracy in education and developmental aspects of younger children, for those elementary majors with a special emphasis in early childhood.

Unlike site one, exit interviews were not conducted. Students were required to bring an outline to class to share with their colleagues in discussion groups, offering suggestions, references, and constructive criticisms within the discussion. Many of the students also sought out the instructor for advice through office appointments and/or e-mail. Some students brought in full-draft rationales for comments when the instructor would provide brief, formative recommendations. The final evaluation was a lengthy, but careful grading of the assignment by the instructor. Students tended to retrieve their rationales quickly to edit and keep as evidence of their teaching philosophy. For those using them in a practical sense, students eventually included their rationales in their portfolios.

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Design and Procedure

This study continues and adds to the initial exploration of the rationale paper reported on by Veronesi (1998). Veronesiís (1998) original questionnaire was composed of eleven questions. To continue this research into the rationale paper, a mixed quantitative and qualitative design was employed (quantitative dominant). This study concentrated specifically on elementary preservice studentsí perceptions and opinions on the value of their rationales as part of their preparations to become elementary teachers.

The sample (n = 74) for this study was drawn from elementary science teacher preparation courses taught at two different universities, one in Appalachia and the other in New England. The sample represents nearly 100% of the enrollments in these classes (response to the questionnaire was voluntary 74 respondents a possible 79). Data were collected at the end of the term after the students had completed all course work and when they could reflect more accurately on their final perceptions of the merits of the rationale paper within their program of study.

The Self-Reflection Survey for the Elementary Science Teaching Rationale (SRS-ESTR) questionnaire used in this study was a nominal (Likert) scale with four categories including: SA= strongly agree; A= Agree; D= Disagree; and SD= Strongly disagree. Twenty-nine items were included in the questionnaire. Two additional open-ended response items were included, exploring factors that assisted the students in writing their personal rationale and general comments.

Statistical measures of internal validity and reliability (e.g., item-to-total correlation and Cronbachís alpha and the results of preliminary factor analysis) are included. Given the data were gathered from two different institutions (n = 40 and n = 34), post-hoc comparisons are also shared. These results provide insight into the relationships between preservice teaching approaches and student views and performance from two separate, but statistically similar (regarding response patterns) settings.

Questionnaire (Instrument) Development

The 11 item instrument reported on by Veronesi (1998) is the predecessor of this 29 item Self-Reflection Survey for the Elementary Science Teaching Rationale (SRS-ESTR). The current SRS-ESTR discussed here included 18 positively worded questions, for example:

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3. I *truly* believe what I wrote in my ESTR and will try to implement these ideas in my classroom.

SA A D SD

20. Preparing the ESTR helped me focus on things that will make me a better teacher.

SA A D SD

Negative wording was used for 11 other questions found in the SRS-ESTR. Examples include:

4. What I wrote in my ESTR was done only to get a good grade.

SA A D SD

9. My ESTR does not really represent the realities of the elementary classroom.

SA A D SD

A colleague at site 2, with expertise in psychometrics, responded to and provided formative responses to the authors before finalization of the instrument (SRS-ESTR) reported on in this study. Data were collected from the students after completion of their rationales. Students signed a release granting the researchers permission to use their responses, provided the individuals remained anonymous.

Preliminary Data Analysis and Related Discussion

All data were converted to a common scale for convenience of analysis. Specifically, the responses to the positive questions were ranked on a range of 1 - SD (strongly disagree), to 4 ñ SA (strongly agree). To use a common positive scale, the reverse scoring range was used on the negatively worded questions. That is, 4 ñ SD (strongly disagree), to 1 ñ SA (strongly agree). Therefore a student who was positive about the "rationale experience" would strongly agree (ranked numerically as a 4) with the positive questions and strongly disagree (also ranked numerically as a 4) with negatively worded questions. The net result is a set of means that reflect the studentsí views on the value of their personal ESTR with "4" indicating a strongly positive view and "1" indicating a strongly negative view for all 29 original questions.

A series of means were calculated for site 1 and site 2 separately and are summarized in Table 1. All data were analyzed using SPSS for the microcomputer (Noruöis/SPSS Inc., 1997). On visual inspection alone it is notable that although the timeframes were very different ó 1 quarter compared to 2 semesters ó the patterns of responses are remarkably consistent. However, before collapsing the data into one set to explore fundamental psychometric properties of reliability and validity of the instrument, the two subsets were compared using a one-way ANOVA. The one-way ANOVA was used to identify potential population differences between the two means on each response variable, given the samples were independent and included different subjects (Peers, 1996). Table 1 also summarizes the results of the one-way ANOVA including the F -statistic and the probability (p -value).

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Insert Table 1 about here

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Item 10 of the SRS-ESTR had been previously eliminated by the researchers as a question that had generated confusion on the part of the students (from their written comments and responses). On inspection, the response patterns for the two subsets of students held to the same pattern, but means and standard deviations were different enough on items 2, 5, 11, 26, and 29 to generate a significant difference at the $p < 0.05$ level. These items were eliminated leaving 23 items for the N = 74.

The authors attribute the significant difference in the response patterns to items 2, 5, and 11 to difference in teaching style and expectations of preservice teachers between site 1 and site 2. Specifically for item 2, there were site-based differences in the types of intermediate activities leading up to the writing of the final rationale; for item 5 there was no interview at site 2 and so the question was hypothetical at best for site 2 students. For item 11, only a portion of the students at site 2 were actively developing portfolios. The response patterns for question 26 had a broader range than any other item (note the higher standard

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deviations for sites 1 and 2) indicating confusion and/or ambivalence regarding the importance of further field experience (item 26). Question 29 (relates to "what [their] students would be doing as reflected by their rationales") poses a more interesting contrast. The students at site 2 ($n = 34$) were more concerned about what they would be doing, when compared to the students at site 1 ($n = 40$). A concern about procedural and management issues is most common among novices (Berliner, 1986, 1988). Since most of the students at site 2 were undergraduates and, in general, were less experienced and younger than the population at site 1, this significant discrepancy is not surprising.

The full data set ($N = 74$) can be found in Table 2. Recalling the reversal of the numeric ranking of the negative questions. It can be surmised that students were very positive about their ESTR. The means are all well above three. The range indicates that in all instances there were some students who less positive (i.e., note the range of responses -- 2 = disagree to 4 strongly agree) on specific questions, but in general were very positive. In addition, the standard deviations are relatively small, indicating a close dispersion around the means, which are positive (i.e., agree to strongly agree).

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Insert Table 2 about here

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Dimensions of Reliability and Construct Validity of the SRS-ESTR

To establish a level of reliability, item-to-total correlations were examined (Table 3) and a Conbachís alpha reliability coefficient, an indicator of internal consistency, was calculated. The value of *alpha* = .92 is large, indicating that the instrument is highly reliable. With the exception of item 24 ($r = .15$), item-to-total correlations were acceptable (range of $r = .44 - .70$) with the majority of the items, 19 of 23, showing a moderate to high correlation ($r \geq .5$).

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Insert Table 3 about here

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Although not included in the tables, a preliminary factor analysis was also completed. Using a simple three-factor structure, approximately 53% of the variance was accounted for using a varimax rotation. When a five-factor solution was used the amount of variance accounted for increased to 64%. These are sound indications for validity of the instrument as well. When considered together, the face validity of the items, the high Cronbachís alpha of .92, the consistency of the item-to-total correlations, and the amount of variance accounted for in the preliminary factory analysis indicate construct validity.

Qualitative Analysis

The students from both populations were generally quite positive in their perceptions or beliefs toward the final drafts of their rationales. Each candidate was given the opportunity to comment on any item and specifically encouraged to comment at the end of the questionnaire. The candidates at site 1 discussed three main areas of value in their rationales. First, candidates felt that they were confident about what they had written and therefore were excited about using their rationales during a job interview: "I know [it] will be a strong reference in my future job interviewing." Second, candidates were appreciative that the process of writing their rationales forced them to "dig" into the state and national science standards in a practical way. Third, students felt that they had a much clearer vision of their future science teaching practices because of the reflective thought they used in writing their rationales. Many students independently stated that they were going to use the ideas they expressed in their rationales in a practical way:

"I think the rationale paper is the clearest and most helpful single assignment I have had in this program!"

Candidates at site 2 responded in similar ways. For example, these students similarly focused on how the rationale made them think about teaching elementary science. A few candidates at site 2 also felt their "beliefs about teaching elementary science were finally realized."

Candidates at both sites also discussed the sources for the information they used in their rationales. Not surprisingly, the methods course itself was frequently referenced. Decisions of the instructor in terms of curriculum and guidance did have an impact on their perceptions and written rationale. It is also interesting to note that communicating with their peers ranked high for the development of their teaching rationales.

Following is a list of sources that are ranked highest to lowest from each site. The frequency of responses dictated the order of these reference sources:

Primary Importance - Site 1:

1. The instructor (much individual feedback given)
2. Library research-specific journals named
3. Peers
4. Internet

Secondary Importance - Site 1:

5. Experiences from previous jobs
6. State and National science standards
7. Cooperating practicum teacher
8. Instructors from other classes
9. "Remembering what my experiences were like in elementary science"

Primary Importance - Site 2:

1. Field experiences
2. Handouts in class
3. Class texts
4. The instructor

Secondary Importance - Site 2:

5. Instructors from other classes
6. Peers
7. Library
8. Science Standards

These data are interpreted to mean that both instructors had a primary impact on these methods students. The instructor at Site 1 indicated that, "ERIC and the national/state standards were places to find out about research-based teaching strategies that would address their goals". What is not as clearly indicated by this data are the specific instructor characteristics that may have been contributory to the prominence within the relative ranking of the preservice studentsí perceptions. It is the belief of the instructors that modeling desired teaching habits (e.g., wait time and varied assessments of studentsí work) surely played an important role as well since modeling was a clear, shared goal of both instructors. Other habits included: instructor enthusiasm, modeling of research-based pedagogy, engaging activities, constant support of studentsí ability and attitude toward science and teaching, and anonymous midterm critique of a first draft. (These comments were consistently evident in end-of-term student evaluations of the site 1 and site 2 instructors as well.) Candidates from Site 2 noted especially the specific contributions of the instructor in terms of insight and classroom experiences. The role of the instructor also had an impact on the final rationale at Site 2 when the handouts and the course texts are considered to be instructor-chosen (part of course requirements).

It is clear by the student comments at both sites that they had an overall positive view about their final teaching rationales. They noted that they were proud of their work, would be willing to share it with their cooperating teachers during student teaching, and planned to use their rationale as further evidence of their understanding of teaching and learning when interviewing for jobs. Students noted that the rationale "helped [them] pull ideas together in [their] own head" and that "it makes you think about how you want to teach."

Discussion and Implications

This study extends earlier work (Veronesi, 1998) on the rationale paper as an effective strategy to help extend the depth and breadth of preservice students personal, research/practically-based rationale for teaching elementary science. The studentsí rationales were based on two elements: 1) their personal study of pedagogy; and 2) the nature of knowledge building in the learning environment (epistemology) as they interpreted it at the end of their methods courses. This study also previews strategies used to build a research-based rationale as an essential element of preservice science teachersí preparation and quantitative evidence of the studentsí views on their elementary science teaching rationales collected through a questionnaire.

This study establishes baseline data that can be further explored through classroom-based observation and additional self-reflection as these same respondents are followed into their first few years of teaching. Pajares (1992)

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argued extensively for research into teacher beliefs because, he asserts, they ultimately influence what a teacher does in the classroom. He discussed the need to address beliefs in a context that is defined in terms of connections to subconstructs and other affective structures.

Individuals from sites 1 and 2 had positive perceptions about teaching elementary science after their rationales were written. They perceived that the process of writing and defending (site 1 only) the rationale paper focused their attention on how to teach science to children using research-based strategies and toward better teaching practices in general. The students communicated this positive perception through their responses to the 29 questions in the SRS-ESTR and through supporting written comments.

Indications are that the SRS-ESTR instrument, as used in this study, is highly reliable and is valid for those using the rationale paper process to support learning in science methods courses as described in this study. This gives the authors a high degree of confidence in the claims that students in this study realized multiple values in writing their elementary science teaching rationales. This was indicated by the consistently high means for each item on the questionnaire. Evidence from this study indicates that the rationale is a cornerstone activity in the pedagogical and philosophical development of future teachers who made their learning environment choices purposefully at both sites. Studentsí pride in their work and confidence in the value of their ESTR are noteworthy and offer insight into the formation and enduring beliefs and complimentary practices of these future teachers.

From the studentsí views and the authorsí perspectives, the ESTR itself is an effective concluding performance activity. It has value for learning as a means of assessment toward student perceptions and successes toward meeting methods course goals. That is, provided the major goals of the course include the development of research-based elementary science rationale that supports the vision of the teaching/learning milieu in their future science classrooms.

The process of surveying our studentsí beliefs and perceptions toward teaching science after their rationales is only one piece of the puzzle. No one would argue that many variables influenced the respondents documented positive views toward the rationale paper experience. However, the positive trend details evidence that these individuals had, in the least, entered student teaching with a more positive attitude toward science and science teaching and a greater confidence in their pedagogical choices of appropriate strategies. Longitudinal studies of these students that explore related and confounding factors are

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warranted at this point in further exploration of the rationale as a tool in preservice teacher development.

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Table 1

Summary of descriptive statistics and results of one-way ANOVA for site 1 (*n* = 40) and site 2 (*n* = 34).

		Descriptive Statistics				One-way ANOVA	
Question #	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**	**F**	**P (Sig.)**
Item 1	34	3	4	3.441	0.504	0.565	0.45
Item 1	40	2	4	3.350	0.533		

Item 2	34	1	4	2.794	0.770	17.264	0.00
Item 2	40	1	4	3.475	0.640		
Item 3	34	3	4	3.824	0.387	0.000	0.99
Item 3	40	3	4	3.825	0.385		
Item 4	34	3	4	3.529	0.507	0.056	0.81
Item 4	40	2	4	3.500	0.555		
Item 5	34	2	4	3.471	0.563	4.642	0.03
Item 5	40	2	4	3.200	0.516		
Item 6	34	3	4	3.794	0.410	0.388	0.54
Item 6	40	3	4	3.850	0.362		
Item 7	34	3	4	3.706	0.462	0.228	0.63
Item 7	40	2	4	3.650	0.533		
Item 8	34	2	4	3.676	0.535	2.740	0.10
Item 8	40	3	4	3.850	0.362		
Item 9	34	3	4	3.471	0.507	1.975	0.16
Item 9	40	2	4	3.650	0.580		
Item 11	34	3	4	3.382	0.493	9.707	0.00
Item 11	40	3	4	3.725	0.452		
Item 12	34	3	4	3.588	0.500	2.682	0.11
Q12	40	2	4	3.775	0.480		
Item 13	34	3	4	3.529	0.507	1.626	0.21
Item 13	40	3	4	3.675	0.474		
Item 14	34	2	4	3.441	0.561	0.468	0.50
Item 14	40	2	4	3.350	0.580		

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Item 15	34	2	4	3.471	0.615	0.023	0.88
Item 15	40	2	4	3.450	0.552		

Table 1

Continued

		Descriptive Statistics				One-way ANOVA	
Item #	N	Minimum	Maximum	Mean	Std. Deviation	F	P (Sig.)
Item 16	34	3	4	3.676	0.475	1.275	0.26
Item 16	40	2	4	3.800	0.464		
Item 17	34	2	4	3.147	0.657	0.021	0.89
Item 17	40	2	4	3.125	0.648		
Item 18	34	2	4	3.118	0.686	0.014	0.91
Item 18	40	2	4	3.100	0.591		
Item 19	34	1	4	3.235	0.741	0.369	0.55
Item 19	40	2	4	3.325	0.526		
Item 20	34	3	4	3.676	0.475	1.459	0.23
Item 20	40	3	4	3.800	0.405		
Item 21	34	2	4	3.088	0.621	0.066	0.80
Item 21	40	2	4	3.125	0.607		
Item 22	34	2	4	3.471	0.615	0.595	0.44
Item 22	40	2	4	3.575	0.549		
Item 23	34	2	4	3.353	0.646	2.171	0.14
Item 23	40	3	4	3.550	0.504		
Item 24	34	2	4	3.118	0.591	0.488	0.49

Item 24	40	1	4	3.000	0.816		
Item 25	34	2	4	3.412	0.557	1.762	0.19
Item 25	40	3	4	3.575	0.501		
Item 26	34	1	4	2.853	0.702	4.654	0.03
Item 26	40	1	4	2.450	0.876		
Item 27	34	2	4	3.412	0.557	1.762	0.19
Item 27	40	3	4	3.575	0.501		
Item 28	34	3	4	3.529	0.507	1.095	0.30
Item 28	40	3	4	3.650	0.483		
Item 29	34	3	4	3.382	0.493	9.707	0.00
Item 29	40	3	4	3.725	0.452		

Note:

1. Using $p < 0.05$ level, items 2, 5, 11, 26 & 29 were eliminated before further data analysis were performed. Also, the researchers had agreed to remove question 10 prior to any analysis.

2. Item sets with significant differences (i.e., $p < 0.05$ level) are noted in the grayed area.

Table 2

Summary of descriptive statistics for the full data set ($N = 74$).

Item #	N	Descriptive Statistics			
		Minimum	Maximum	Mean	Std. Deviation
Item 1	74	2	4	3.392	0.519
Item 3	74	3	4	3.824	0.383
Item 4	74	2	4	3.514	0.530
Item 6	74	3	4	3.824	0.383
Item 7	74	2	4	3.676	0.500
Item 8	74	2	4	3.770	0.455
Item 9	74	2	4	3.568	0.551
Item 12	74	2	4	3.689	0.495
Item 13	74	3	4	3.608	0.492
Item 14	74	2	4	3.392	0.569
Item 15	74	2	4	3.459	0.578
Item 16	74	2	4	3.743	0.470
Item 17	74	2	4	3.135	0.648
Item 18	74	2	4	3.108	0.632
Item 19	74	1	4	3.284	0.631
Item 20	74	3	4	3.743	0.440
Item 21	74	2	4	3.108	0.610
Item 22	74	2	4	3.527	0.579
Item 23	74	2	4	3.459	0.578
Item 24	74	1	4	3.054	0.719
Item 25	74	2	4	3.500	0.530
Item 27	74	2	4	3.500	0.530
Item 28	74	3	4	3.595	0.494

Table 3

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Item-to-total correlations for final set of 23 common ESE-ESTR items ($N = 74$).

Item #	Item-to-Total Correlation
Item 1	.44
Item 3	.55
Item 4	.54
Item 6	.49
Item 7	.61
Item 8	.62
Item 9	.67
Item 12	.56
Item 13	.62
Item 14	.46
Item 15	.63
Item 16	.69
Item 17	.54
Item 18	.55
Item 19	.51
Item 20	.69
Item 21	.57
Item 22	.60
Item 23	.62
Item 24	.15
Item 25	.70
Item 27	.53
Item 28	.65

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