Use of Images as Reflective Discrepant Events: Pathways for Elementary Teachers to Reconsider Practice in relation to their Views of Science Teaching and Learning

by

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INTRODUCTION

Embedded in the minds of science teacher educators and in the mission statements of many science teacher education programs is the idea of reflective practice. The research surrounding reflection spans the gamut from defining reflection (Bleakley, 1999; Calderhead, 1989; Cruikshank, 1985; Gilroy, 1993; Korthagen, 1993; Schon, 1987; Tremmel, 1993; Zeichner & Liston, 1987) and developing curriculum and programmatic approaches to facilitate reflection (Adler, 1991; Borko & Michalec, 1997; Han, 1995; Hargreaves & Jack, 1995; Hill, 1997; Hawkey, 1995; Hole & McEntee, 1999; Newman, 1996) to examining the developmental process associated with reflection (Leat, 1995; Pultorak, 1996). Even though extensive and intensive efforts such as curricula and programmatic approaches to developing reflection over an extended period of time are preferred, they are not always feasible. In the cases where interactions with teachers are delimited to specific time frames of a few hours or a few days, tools to encourage reflection are invaluable. This article discusses the use of images as plausible tools in encouraging reflection on the part of practicing teachers when time constraints are operative.

In this piece, elementary teachers are asked to consider their views of science teaching and learning. The teachers' views influence what they attend to and what they perceive they need in order to do a better job (Smith, 1990); consequently, it is important to assist teachers in articulating and reflecting upon their views. The following questions are addressed in this piece: 1) What images do practicing elementary school teachers have of teaching science? What views of teaching science are associated with these images? 2) What images do practicing elementary school teachers have of children learning science? What views of learning science are associated with these images? 3) What is the usefulness of images as reflective discrepant events?

CONCEPTUAL UNDERPINNINGS

The selection of images as the medium through which views of teaching and learning science were elicited and examined was based upon several assumptions, many of which emanate from Paivio's (1991) dual-code theory. Furthermore, the use of images is well documented in the science education literature. Researchers and educators extensively employed Draw-A-Scientist (DAST) or a revised version of it to elicit views about science and scientists.

In examining the notion that images more than words enhance cognition, Paivio conducted numerous experiments. Based upon the experimental findings, Paivio proposed the dual code theory. The central premises of the theory address how experiences are mentally represented and how these representations are activated. According to the dual-code theory, experiences are captured mentally and are represented in concrete ways that reflect the original events. These mental, concrete representations can be activated via two systems that are independent but supplementary: verbal

cognitive system and nonverbal cognitive system. Linguistic and perceptual-motor information are represented and processed by the verbal and nonverbal cognitive systems, respectively. The two systems become interconnected for an experience when the linguistic and perceptual-motor information pertaining to a situation are associated. Paivio asserts that this interconnectedness between the two systems is enhanced when pictures represent the experiences because pictures are more likely to be mentally encoded in both image and verbal form. Upon the aforementioned premises of dual-code theory, images accompanied by written descriptions were selected as this study's primary mechanisms for eliciting the elementary school teachers' views. Furthermore, as purported by Tobin and Tippins (1996) in their study on the use of metaphors in altering science instruction, practicing teachers amass a reservoir of practical knowledge that is accessible mainly through images. In this inquiry, images were deemed plausible tools for accessing and reflecting upon this practical knowledge; this plausibility is implied in the research utilizing DAST

Building upon the work of Mead and Metraux (1957), Chambers (1983) introduced DAST as a way to investigate at what age children first developed the stereotypical images presented in the research of Mead and Metraux. The initial procedures for DAST asked participants to draw a picture of a scientist. The drawings were then analyzed with respect to a pre-determined list of seven criteria illustrating the elements of the standard, stereotypical image of the scientist. Each drawing was assigned a score from one to seven; the score indicated the degree to which the stereotypical image of the scientist was present in the drawing. Since the introduction of DAST, researchers employed DAST in the study of images in relation to gender at the elementary and middle school level (She,

1998); with respect to academic major at the college level (Roenthal, 1993); and with regard to cultural backgrounds of pre-service teachers (Rubin, 2003) and racial backgrounds of students (Finson, 2003). To supplement the information obtained via images, many of the studies utilizing DAST also used interviews, questionnaires, and written descriptions. The idea underlying DAST was even extended to Draw-a-Science-Teacher-Teaching Checklist (Finson, Riggs, & Jesunathadas, 2000). In some of the studies employing DAST, images were not only used to elicit students' and teachers' views about scientists, science, and science teaching, but were also used to sensitize students and teachers to the stereotypical nature of their views and the need for change (Mason, Kahle, & Gardner, 1991; Moseley & Norris, 1999). In essence, the images were used as tools to facilitate reflection which was one foci of this investigation.

Reflection, a notion that has permeated educational thought and discourse for several decades, is defined in various ways. One definition delimits reflection to the ability to analyze one's teaching (Cruikshank, 1985). Another conceptualization of reflection involves making tacit knowledge explicit in order to facilitate thinking while acting, reflection-in-action, and thinking after an action, reflection-on-action (Schon, 1987). A third definition casts reflection as critical inquiry with three distinct tiers: technical, contextual, and ethical (Zeichner & Liston, 1987). Technical refers to the efficient application of knowledge in reaching specified goals; contextual emphasizes the reason and implications of selected actions and ethical juxtaposes action, justice, and equity with the goal of establishing a humane society. Regardless of how it is conceptualized, improved practices are the desired outcomes of reflection.

The author contends that changes in practices are unlikely unless the individuals reflecting become dissatisfied with their current situations. One way to induce dissatisfaction is through the use of a discrepant event (Posner et al., 1982). A discrepant event is a situation that overtly contradicts what individuals believe such that their beliefs are challenged. In this article, images are examined as discrepant events with respect to two types of reflection: reflection-on-action and technical reflection. In order to accommodate aspects of the research setting, these two types of reflection were selected a priori.

RESEARCH CONTEXT

The participants, seventeen teachers of K-6 children, were enrolled in an advanced science methods course of a Master's of Education (M. Ed.) program offered by a doctoral I institution located in the southeastern United States. As described in the College of Education's documents (e.g. course catalog, course syllabi, NCATE report) of the institution constructivism was the guiding philosophy of the M. Ed. program. According to Good, Wandersee and St. Julien (1993), constructivism has at least fifteen "faces" ranging from contextual constructivism to socio-historical constructivism. Identifying and discussing the forms of constructivism enacted within the degree program are beyond the scope of this piece but common components of the various forms are important in understanding the teachers' reflections. Two commonalities in the varied perspectives on constructivism exist with regard to the learner and the facilitator of learning: learners assume an active role in learning by intentionally making meaning and the facilitators of the learning design environments conducive for the intentional and active construction of meaning. The instructor who was affiliated with an institution

other than the institution offering the M. Ed. Program taught the advanced science methods course in a way that corresponded to the previously mentioned general tenets of constructivism.

The advanced science methods course was held at a local middle school for sixteen hours a week for four weeks during June 2001. The instructor, same as author, was prepared at the graduate level of study in a constructivist setting, had worked for many years in teacher education programs that were guided by the philosophy of constructivism, and had participated in many professional development opportunities designed to develop constructivist teaching. In the four-week session, the teachers' prior and personal experiences were continually elicited. There were numerous opportunities for them to connect their experiences to the knowledge bases of the course that included constructivism and other philosophies of teaching and learning. Concept mapping, whole and small group discussions, case studies, role-playing, microteaching, and problem-based projects were a few of the techniques used by the instructor to facilitate the teachers' constructions of understandings. The advanced science methods course was the eighth course, midpoint of the M. Ed. program, for all but five of the teachers comprising the cohort. In addition to the background knowledge on educational theory, child development, and action research acquired from the courses taken prior to enrollment in the advanced science methods course, the participants brought a wealth of teaching experience to the course. The participants' number of years of teaching ranged from four to twenty-six years (see Table 1). As part of the course, the teachers completed two "for credit" non-graded (e.g. “A”, “B,” etc.) assignments. These assignments were evaluated for completion and for thoroughness through the assessments of check plus, check, and

check minus. These "for credit" assignments served as data for examining the use of images as reflective discrepant events.

Table 1. Number of teachers by number of years of teaching experience

Number of Teachers	Number of Years Of Teaching Experience
2	4
1	5
1	7
1	8
4	9
4	17
1	18
1	21
1	26

METHODOLOGY

At the beginning of the advance science methods course, the teachers were asked to use images to respond to the questions “What images best illustrate how you view teaching science?” and “What images best illustrate how you view children learning science?” The submitted assignments consisted of drawings, actual photos, magazine pictures, computer clipart and cartoons (see Appendix B for examples). The teachers were also asked to include written descriptions and explanations about the images. Instructor feedback regarding the images was not given to the teachers. At the end of the advanced science methods course, the teachers revisited their images and submitted a paper. The paper examined the images in relation to how they viewed science teaching and learning and with regard to constructivism, the philosophy purported to underlie the teachers’ graduate program and the philosophy that the teachers espoused throughout the four-

week session. If the teachers' submissions did not correspond with constructivism and the teachers viewed the submissions as illustrative of their practices then the images could induce teacher dissatisfaction. In order to ascertain the cases in which the images may have acted as discrepant events, the images were analyzed for correspondence with the general tenets of constructivism. The images were initially analyzed in isolation of the supplementary written materials. The written descriptions and explanations about the images were consulted afterwards for the purposes of credibility, assessment of how adequately the researcher represents and interprets the situation (Guba, 1990). The assumptions underlying the analyses and subsequent interpretations of the images come from iconography.

Leeuwen and Jewitt (2001) summarized three layers of meaning operative in iconography. Representational meaning is a consequence of practical experience; iconographical symbolism encompasses ideas and concepts that are typically associated with the representation, and iconological symbolism results from the underlying principles and attitudes of the larger context such as a nation or religion. The analysis and interpretation of the teachers' images occurred at the first and second layers of meaning. In accordance with the representational and iconographical symbolism levels of meaning, practical experiences and the receptivity to certain concepts and ideas because of these experiences were considered instrumental and crucial in analyzing the images; as a result, the author analyzed the images.

In order to enhance the credibility of the author's interpretations of the elementary school teachers' images, a teacher educator who had worked for thirteen years with prospective and practicing teachers in a constructivist setting also examined the images.

The author and the teacher educator independently surmised the images as metaphors by using the prompts "teacher as…" and "student as…". When the summations of the images as metaphors were compared, the independent coders similarly interpreted 75% and 87.5% of the submissions that pertained to teaching science and to learning science, respectively (see Appendix A). The images recast in terms of teacher and student roles were then used to classify the teachers' views on teaching and learning science into two broad categories: predominantly constructivist and predominantly non-constructivist. With regard to teaching science in a predominantly non-constructivist fashion, the coders' independent classifications were in agreement 78% of the time but only 50% of the time for predominantly non-constructivist learning of science. In relation to teaching science in a predominantly constructivist way, the independent coders' classifications were in agreement 87.5% of the time and 77% of the time for children learning science in a predominantly constructivist manner (see Appendix A). Lastly, the recasting of the teachers' images as metaphors was then viewed in relation to the teachers' written descriptions and explanations. These written submissions discussed what was depicted in the images. Because one coder was unable to interpret one of the teachers' submissions, the findings pertain to sixteen of the seventeen teachers enrolled in the course. The instances in which the independent interpreters agreed in at least one aspect, either the teaching of science or children learning science, and in which the interpretations were substantiated by the written materials supplementing the images are reported. Descriptive summaries of what was contained in the images and the researchers' classifications of the teachers as predominantly constructivist or non-constructivist respond to the following questions guiding the inquiry: What images do practicing

elementary school teachers have of teaching science? What views of teaching science are associated with the images? What images do practicing elementary school teachers have of children learning science? What views of learning science are associated with these images?

FINDINGS

Based upon the images submitted by the teachers, the independent interpreters concurred on the identification of seven teachers as being predominantly non-constructivist in their views of teaching science and three of the seven as holding non-constructivist views of children learning science. Teachers as the conveyors or dispensers of information and students as inactive receivers of information were the dominant images. The images depicted the teacher in the foreground presenting information in whole-group or small-group settings by talking, writing on the chalkboard, or by reading. The images showed the students listening or taking notes. The written explanations accompanying the images substantiated the teacher and student portrayals. In contrast, the constructivist images displayed the teacher and the students in an active manner.

The constructivist images depicted students as learners who explore, manipulating materials to find out what they can; who investigate, studying phenomena by way of close and systematic examination; and who experiment, testing personal and scientific propositions about phenomena. Both of the independent interpreters identified nine of the teachers as having a constructivist view of learning science; the interpreters agreed that seven of the nine also portrayed teaching science as a constructivist act. The images of constructivist teaching corresponded with the metaphors presented in the literature

(Tobin & Tippins, 1996) except the images exemplified one primary function of the teacher whereas the metaphors tended to capture many roles of the teacher. The elementary school teachers having a constructivist view of teaching science portrayed in the images and described in their writing the teacher as facilitator, providing scaffolding conditions for the students' personal construction of understanding; as guide, orchestrating the achievement of learning goals; and as mediator, coordinating the diverse knowledge sources such that canonical scientific understandings were a part of the student constructions.

In summary, the interpreters were in total agreement with regard to the teachers' views of teaching and learning science in eleven cases: 1) three teachers were considered predominantly non-constructivist in their conceptions of both teaching science and children learning science, 2) seven teachers were considered predominantly constructivists in their conceptions of both teaching and learning science, and 3) one teacher with a constructivist view of learning science was believed by the interpreters to have a non-constructivist view of teaching science. Of the remaining five, the interpreters agreed that three were predominantly non-constructivist in their view of teaching but did not agree upon these teachers' orientations to learning science and concurred that two teachers held a constructivist view of teaching but did not agree on the teachers' view of children learning science. With the aim of investigating if the images were useful mechanisms through which the elementary teachers reflected upon and became dissatisfied with their views in relation to their practices, the teachers' papers submitted at the end of the four-week session were consulted.

First, in their essays the teachers addressed how the images represented their practice and then they used constructivism as a standard to critique their practice. All the teachers indicated in their essays that prior to participating in the course they believed they taught in a constructivist manner and created an environment conducive to learning in a constructivist fashion. The interpreters' classifications of the teachers' views as non-constructivist was a site of contradiction and introduced the possibility of the image assignment acting as a discrepant event. Whether or not dissatisfaction was induced was dependent upon the teachers' reflections as conveyed in the final paper.

As determined by the images, the interpreters classified seven teachers as being non-constructivist. Of the seven teachers classified as non-constructivist six essays acknowledged contradictions and five of the six indicated dissatisfaction. One teacher did not discuss the images in relation to her practice and with respect to constructivism. In brief, the image assignments functioned as discrepant events for six of the seven teachers classified as non-constructivist; the teachers' preexisting views of their practices as constructivist were challenged. Each teacher chose a particular path in resolving the contradiction and dissatisfaction.

The first teacher began the essay by acknowledging the contradiction. The teacher stated that although the images appeared non-constructivist they were constructivist because the images illustrated the use of different instructional strategies. The teacher equated constructivism to varying the teaching methods used. In the end, the teacher resolved the contradiction by retaining the pre-existing view of constructivism and did not reconsider her practices. Unlike the first, the second teacher recognized the contradiction, embraced the dissatisfaction, and contemplated ways to alter her practices.

The second teacher stated that she believed her images on teaching science and her instructional practices were predominantly non-constructivist but her beliefs about children learning science were constructivist, an assessment that corresponded to the interpreters' classifications. In her essay, this teacher entertained steps to change her teaching in a manner more consistent with constructivism, her philosophy of choice. Similarly, the third teacher whose images indicated a non-constructivist view of both teaching and learning science concluded her essay with actions intended to bring her practices more in alignment with her held philosophy of constructivism. The second and third teachers resolved the contradiction and subsequent dissatisfaction by replacing an old understanding with a new perspective. Like the two previous teachers, the essays of the remaining three teachers acknowledge contradictions between their images and their practices with respect to constructivism. In contrast to the earlier teachers, the essays of the last three teachers did not indicate a clear resolution. The essays presented glaring contradictions.

At the outset of the essays, the teachers stated that there was a mismatch between their views about teaching and their practices but then proceeded to justify the mismatch (e.g. the pressure of standardized tests). All three of the teachers concluded the essays with arguments of why their views and practices were indeed constructivist.

In sum, the contradictions and subsequent dissatisfaction insinuated in the essays of six of the seven teachers (86%) classified by the interpreters as having views that did not correspond to the teachers' constructivist assertions imply a plausible use of images as reflective discrepant events. As in the work of Mason, Kahle, & Gardner (1991), the images proved effective in sensitizing teachers. In the previously mentioned study, the

images produced from the Draw-A-Scientist-Test made teachers more aware of the stereotypes regarding science and scientist; in this study, the images made the teachers more cognizant of their views about constructivism and their practices in relation to constructivism.

CONCLUSION: IMAGES AS REFLECTIVE DISCREPANT EVENTS

In this inquiry, the images served as a non-threatening, non-intimidating medium through which the practicing elementary school teachers viewed their practices from a philosophical position. As indicated in the findings, the images were useful tools in ascertaining what it means to teach science and for children to learn science to the participating elementary school teachers. Via the identification of teachers whose images did not correspond to their philosophical assertions and the scrutiny of the data submitted by these teachers, the findings also indicated images were useful in facilitating the teachers' examination of their own instructional practices. As entertained in Pavilio's dual-code theory, the teachers used the images as concrete representations of their practices. In turn, the concrete representations raised the consciousness of the teachers. This conscious-raising involved teachers thinking about the instructional practices they implemented with their students which is indicative of reflection-on-action. Reflection-on-action was followed by technical reflection; the teachers contemplated how to apply what they knew about constructivism in reaching their goals of teaching and children learning in a constructivist manner. In their end-of-course essays, the teachers illustrated a greater awareness of what they perceived to occur in their practice with respect to constructivism and what they would like to occur in their practice with regard to constructivism. The images juxtaposed the teachers' preexisting views and new

understandings of their practice. For six of the seven teachers, this juxtaposition of old and new understandings resulted in contradictions and subsequently dissatisfaction; it created a situation in which the preexisting views of practice were challenged. A similar situation of dissatisfaction is documented in the DAST literature. When images were used to illuminate the stereotypical nature of students' perceptions of science and scientists, graduate and secondary students in science education reported frustration and anger with themselves (Moseley & Norris, 1999). In resolving the contradictions and subsequent dissatisfaction, the teachers in this study contemplated various courses of action. Although the uses of images in the actual alteration of practice, the teachers' implementation of their contemplated courses of action, are topics for another inquiry, the study's findings demonstrate the usefulness of images as reflective discrepant events. Images as scaffolds for teachers to reconsider views of their practices in light of what they espouse is a promising start to altering practice. This reconsideration of practice is imperative since , the teachers' views ultimately determine what they attend to and what they perceive they need in order to do a better job (Smith, 1990).

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Appendix A
Interpretation of Images

Teacher/Aspect	Interpreter 1	Interpreter 2	Dis/Agreement
1-KB Teaching Learning	 Conveyor of info Manipulator	 Dispenser of info Handler	 Agreement Agreement
2-PC Teaching Learning	 Holder of knowledge Absorber	 Receptacle of info Recipient of info	 Agreement Agreement
3-LC Teaching Learning	 Guide Discoverer	 Dispenser of info Investigator	 Disagreement Agreement
4-DG Teaching Learning	 User of technology Receiver	 User of technology Self-assessor	 Agreement Disagreement
5-MH Teaching Learning	 Facilitator Experimenter	 Dispenser of info Experimenter	 Disagreement Agreement
6-CH Teaching Learning	 Provider of resources Manipulator	Provider of resources Handler	 Agreement Agreement
7-BH Teaching Learning	 Guide Active learner	 Guide Explorer	 Agreement Disagreement
8-Bhu Teaching Learning	 Provider of support Explorer	 Coach Explorer	 Disagreement Agreement
9-QJ Teaching Learning	 Deliverer of info Receiver	 Dispenser of info Recipient of info	 Agreement Agreement
10-LM Teaching Learning	 Deliverer of info Sharer	 Dispenser of info Peer collaborator	 Agreement Agreement
11-JN Teaching Learning	 Conveyor of info Receiver	 Dispenser of info Recipient of info	 Agreement Agreement
12-MP Teaching Learning	 Creator of opportunity Active explorers	Creator of opportunity Explorers	 Agreement Agreement
13-CP (tossed out) Teaching Learning	 Provider of materials (no response given)	Provider of materials Knowledge seeker	 Agreement Disagreement

14-LR Teaching Learning	 Director Investigator	 Director Investigator	 Agreement Agreement
15-AS Teaching Learning	 Catalyst Active explorers	 Instigator Explorer	 Agreement Agreement
16-RS Teaching Learning	 Creative resource Observer	Creator of opportunity Observer	 Disagreement Agreement
17-MS Teaching Learning	 Planner Investigator	Provider of materials Investigator	 Agreement Agreement

Rate/ Percentage of Agreement for teachers' submissions pertaining to teaching:
12 out of 16 for approximately 75%

Rate/ Percentage of Agreement for teacher's submissions pertaining to learning:
14 out of 16 for approximately 87.5%.

Appendix B

Examples of Images