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Young Children's Emotional Practices While Engaged in Long-Term Science Investigation

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Abstract: In this article, the role of young children's emotional practices in science learning is described and analyzed. From the standpoint of performativity theory and social-constructionist theory of emotion, it is argued that emotion is performative and the expression of emotion in the classroom has its basis in social relationships. Arising from these relationships is the emotional culture of the classroom that plays a key role in the development of classroom emotional rules as well as the legitimation of science knowledge. These relationships are reflected in two levels of classroom dialogue: talking about and doing science, and expressing emotions about science and its learning. The dynamics of the negotiations of classroom emotional rules and science knowledge legitimation may dispose students to act positively or negatively toward science learning. This analysis is illustrated in the experiences of a teacher and her students during a 3-year ethnographic study of emotions in science teaching and learning. This research suggests the importance of the interrelationship between emotions and science learning and the notion that emotional practices can be powerful in nurturing effective and exciting science learning environments.
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Science educators have recently argued that emotional issues in science teaching and learning have long been underrepresented themes in research (Barker, 2001; Zembylas, 2001, 2002a, 2004; Zembylas & Barker, 2002). This is not surprising, as Mem Fox pointed out in a discussion about the role of emotional issues in literacy education, a discussion of ideas that could also be suitable for science education:

> Matters affecting the heart are far more elusive than those affecting the mind. There's no simple way to measure the role of the heart in teaching children [. . .]. It can't be recorded in numbers. It can't be caught in a statistical net. It can't be pre-tested or post-tested. Its subjects can't be divided into control groups because the affective aspects of any given situation are unique to the situation at the moment of its happening and cannot be replicated. Measuring such indefinables as the effects of expectations, happiness,

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> eagerness, fondness, laughter, admiration, hope, humiliation, abuse, tiredness, racism, hunger, loneliness, and love on the development of literacy is so difficult even within ethnographic research, that to my knowledge it is attempted rarely.
>
> But the affective won't go away. It's always there, whether researchers admit it or not. The plain old fact of the matter is that teachers and children have hearts, and those hearts play an enormous part in the teaching/learning process. (cited in Goldstein, 1998, p. 30)

My own interest in the emotional issues of science teaching and learning is rooted in my previous experiences as an elementary school teacher. Loving science and my young students seemed to be essential features of my teaching practices. Gradually, I began to see how my pedagogical decisions and practices in science were suffused with emotion. I became fascinated with how my personal excitement and passion for some science topics (e.g., astronomy and space science) transformed my teaching and my students' learning and gave us immense joy and excitement in ways that allowed our learning experiences to become valuable and meaningful. Other times, I puzzled when my personal boredom with teaching some mandated curriculum topics ''infected'' my own students and made me feel guilty for being unable to inspire them. Still other times, a lack of knowledge about a scientific topic made me feel incompetent, worthless, frustrated, and angry with myself because I felt I was incapable of performing my job successfully.

My interest in the emotional practices of teachers and children is also due in part to the fact that I recently conducted a 3-year ethnographic case study of a teacher in an early childhood classroom. The goal of the study was to examine how young children's emotional practices contribute to the classroom *emotional tone*; that is, the general emotional culture in a classroom. The classroom emotional tone may often be a contributor to the motivation—that is, the desire for action—of children and teachers in taking or avoiding certain actions. For example, in this study, I observed that many ''exciting things'' happened in the classroom. The children were generally excited about doing science; were very focused and immersed; frequently expressed joy, fascination, and wonder when they were engaged in science investigations; and did not show a great deal of frustration or anxiety. The teacher gave explicit attention to the children's emotional development and, as the years progressed while doing this research study, I increasingly came to view the emotional practices of the teacher and the children as significant elements of a particular emotional tone that characterized life in the classroom.

Attention to the role of emotion in science teaching and learning may be needed to accomplish the goal of positive attitudes toward science, a goal viewed by science educators as an important outcome of science teaching and learning (e.g., AAAS, 1993; NRC, 1996). Zembylas's (2002a) report of a case study of a teacher's teaching in her early childhood classroom provides details about the ways in which teacher emotion can contribute both to the educational experiences of children and to the professional experiences of the teacher herself. As he suggested, ''If we want progress in science education, we need to look more carefully at the emotions of science teaching [and learning], both negative and positive emotions, and use this knowledge to improve the working environment of science teachers,'' and added that, ''when the emotional aspects of science teaching and science teacher development are considered seriously, it is safe to say that what is at stake in science teacher education and science curriculum reform and how best to enrich them, will never look the same again'' (2002a, p. 98). Other studies (Alsop, 2001; Watts & Alsop, 1997; Watts & Walsh, 1997) dealt with the emotional aspects of science learning and the consequences for the teacher. These studies raise a number of important questions that are relevant to the need for teachers to have greater awareness of the emotional components of science teaching and learning.

There is an abundance of recent studies emphasizing the importance of emotions in education (e.g., Day & Leitch, 2001; Hargreaves, 1998, 2000; Hermann, 2000; Kelchtermans, 1996; Nias, 1996; Zembylas, 2003a,b). The study of emotion has become fashionable in educational research, with such concepts as ''emotional intelligence'' (Goleman, 1995), ''feeling power'' (Boler, 1999), and ''the emotional practice of teaching'' (Hargreaves, 1998). Research on emotions in education emphasizes how emotion is inextricably linked to the lives of children and teachers. This research also highlights how emotion, teaching, and learning are deeply interrelated in complex ways.

In this article, I analyze the children's emotional practices while engaged in long-term science investigations focusing on the classroom organization and the teacher's rationale for this kind of investigation, the nature of the emotional tone in the classroom, and the emotional practices of the children. This study builds on previous work in this area (Zembylas, 2001, 2002a, 2004) and looks at the role of emotion in science learning. The article is divided into four parts, the first of which presents the theoretical framework within which I analyze the children's emotional practices. I then outline the teacher's rationale for long-term science investigations, emphasizing the ways the emotional atmosphere is constructed in the classroom. I then describe the methodology of this study, presenting examples of analyses of the emotional practices of children as they took place in the classroom during the 3 years of the study. Finally, I consider possible implications of this analysis.

Performativity of Emotional Practices and Function of Emotional Rules

First, it is useful to make a distinction between ''emotion'' and ''attitude,'' because emotions and attitudes can have different meanings (see McLeod, 1992). Attitude is generally defined as a predisposition to respond in a favorable or unfavorable way with respect to a person, object, or idea (Hart, 1989). This definition has three components: (a) emotional response to the object; (b) behavior toward the object; and (c) beliefs about the object. In other words, this definition suggests that emotions contribute to attitude formation; they are not attitudes. Attitudes refer to a total situation that involves emotions, beliefs, and behaviors, whereas emotions are acts. This acknowledges the performative aspect of emotions. In addition, another distinction between attitudes and emotions is that the latter are relatively short in duration, whereas the former are often long term (McLeod, 1992).

The theoretical framework of this investigation is largely based on the idea of the *performativity* of emotion. In suggesting that emotion is ''performative'' I am drawing on Judith Butler's work. *Gender Trouble* (1990/1999) is considered by many as one of the initial efforts toward inaugurating the notion of gender as performative, which has radically altered the landscape in the social sciences. Performativity is a concept that in a very short time has gone from the relative obscurity of arcane philosophical discussions about language to a powerful idea that increasingly appears in all kinds of ways in the social sciences and humanities. Herein I build on this idea and propose the concept of performativity in developing an analysis of the notion of the ''construction of emotion'' (Harré, 1986), which does not posit any essential or pre-given nature of emotion lying behind one's actions. First, I briefly trace the theoretical roots of performativity and then analyze the advantages of the suggestion that emotion is performative.

The term ''performative'' was first introduced by the English philosopher, J. L. Austin. Austin (1962) suggested that it ''is derived, of course, from 'perform,' the usual verb with the noun 'action'' (p. 6), and has coined it to describe a particular kind of spoken utterance which is, itself, the performing of an action, a ''speech act'' (p. 40). He suggested that although many performatives seem to ''express'' the internal state of the speaker to an audience, he questioned whether that is necessarily a property of the performative itself or of the social context:

> There are numerous cases in human life where the feeling of a certain ''emotion'' or '''wish'' or the adoption of an attitude is conventionally considered an appropriate or fitting response or reaction to a certain state of affairs. [. . .] In such cases it is, of course, possible and usual actually to feel the emotions or wish in question; and since our emotions or wishes are not readily detectable by others, it is common to wish to inform others that we have them. Understandably [. . .] it becomes de rigeur to ''express'' these feelings if we have them, and further even to express them when they are felt fitting, regardless of whether we feel anything at all which we are reporting. (1962, pp. 78–79)

To put this another way, the context or convention does not merely provide an opportunity for the communication of an emotion but in fact it demands these ''expressions,'' and thereby creates the interiority of the subject. The convention or the social norm requires that the expression ''fits'' the context and indeed it attempts to prescribe in advance what (emotional) ''expressions'' are appropriate and which will receive social approval.

Whereas Austin suggested that a performative requires a fixed conventional context in order to work, Derrida (1972/1991) suggested that the very force of any speech act is its break with a context and its iteration beyond the intention or authority of the speaker; in other words, what is ''absent.'' Derrida's view suggests the recontextualizing force of performativity. Butler (1990/1999) engaged both Austin's and Derrida's ideas to theorize gender and suggested that, ''gender is always a doing, though not a doing by a subject who might be said to pre-exist the deed. [. . .] There is no gender identity behind the expressions of gender; that identity is performatively constituted by the very 'expressions' that are said to be its results'' (1990/1999, p. 25). Butler suggested that an expressive model of gender disguises the discursive production of the interiority of the subject—instead she concentrated on the surface politics of the body and inquired how acts, gestures, and desire ''produce the effect of an internal core or substance, but produce this *on the surface of the body*. [. . .] Such acts, gestures, enactments, generally construed, are *performative* in the sense that the essence or identity that they otherwise purport to express are *fabrications* manufactured and sustained through corporeal signs and other discursive means'' (Butler, 1990/1999, p. 173, emphasis in original).

Similarly, an analysis of emotion becomes more instructive when it focuses not on what emotional utterances *mean* but on what they *do*: what components of emotion they connect up; what connections they do not permit; what enables humans to feel, to desire, and to have disappointments and fulfillments. In other words, emotion can be theorized as performance, as practice. On the one hand, there is the dimension that explores those emotions that motivate or accompany these performances, or directly result from them. On the other hand, there is another dimension that examines emotions that are constituted, established, or even reformulated by these performances. The underlying grounds of performances—aesthetic performances, performances in everyday life, sports performances, learning performances—are ''ritual'' and ''play.'' These are categories, structures, rules, norms, and systems not easily identified, because they are often disguised as ethical codes, professional techniques, and specialized pedagogical knowledge.

My focus in this article is almost exclusively on emotions as performative acts. ''A performative act is one which brings into being or enacts that which it names, and so marks the constitutive or productive power of discourse. [. . .] For a performative to work, it must draw on and recite a set of linguistic conventions that have traditionally worked to bind or engage certain kinds of effects'' (Butler, 1995, p. 134). As Harré (1986) also pointed out, emotion words are not the names of distinct psychological states, because it has been demonstrated that the same psychological state can be associated with many emotions. In other words, introspection does not reveal the ''real'' emotion. Emotion is a practice not of corresponding to an inner state, but of

signifying the world and constituting and constructing the world. This implies that we cannot identify or understand one's emotions unless we take into account how this person evaluates an event, person, or situation (Stocker, 1996).

As numerous studies on have emotions suggested:

> the study of emotions [. . .] will require careful attention to the details of the local systems of rights and obligations, of criteria of value and so on. In short [. . .] emotions cannot be seriously studied without attention to the local moral order. [. . .] What is at issue in differentiating emotions are the rights, duties, and obligations of [. . .] people, *in that culture*. (Harré, 1986, p. 6, emphasis in original)

In other words, emotional practices are patterns that one finds in his or her culture and which are proposed, suggested, and imposed upon him or her by one's culture, one's society, and one's social group (Foucault, 1988). Rose (1990), clearly drawing on Foucault's ideas, provided a view that describes how emotions are constructed by norms and emerging discourses: ''Social conventions, community scrutiny, legal norms, familial obligations and religious injunctions have exercised an intense power over the human soul in past times and other cultures. [. . .] Thoughts, feelings and actions may appear as the very fabric and constitution of the intimate self, but they are socially organized and managed in minute particulars'' (p. 1). The words used in relation to emotions, therefore, are not labels for ''emotional states'' describing pre-existing entities but they are actions of practices serving particular ends as part of the negotiation of reality (Lutz & Abu-Lughod, 1990).

Hochschild (1975) was the first to use the term ''feeling rules'' to refer to norms and standards that reconstruct inner experiences in cultural, social, or organizational settings. Feeling rules, she wrote, ''define what we should feel in various circumstances'' (p. 289). Such rules differ from context to context, indicating what is acceptable and what is not. We know these rules from how others or we respond to inferences of emotional display. Emotional rules, just like other rules, delineate a zone within which certain emotions are permitted and others are not permitted, and can be obeyed or broken, at varying costs (Zembylas, 2002b, 2003b). Emotional rules reflect power relations and thus are techniques for the discipline of human differences in emotional expression and communication (Hochschild, 1979). This may take place through inscribing and recording of ''appropriate'' and ''inappropriate'' emotions, managing and utilizing emotions according to these inscriptions, and classifying emotional expressions as ''deviant'' or ''normal.'' Thus, for example, although the teacher and students in the classroom in which I did my study did not have a blueprint of what emotions to express or not, each child subconsciously knew how to act appropriately in specific situations as they arose. These largely implicit emotional rules negotiated by the teacher and students—which under some circumstances became explicit—constructed the social and emotional tone within which science was taught and learned and from which emotional practices derived meaning. In other words, emotional practices played a role in the construction of emotional rules that regulated activities in such contexts as a classroom during science instruction. For instance, it was common for the students to rush excitedly to the teacher and tell her about things that fascinated them during their science investigations. This was an emotional practice encouraged by the teacher and thus such acts were nurtured.

In summary, Butler's notion of performativity is particularly useful in helping us do two things in research that views emotion as performance: First, we are enabled to problematize the place of emotion as an *act* in (science) learning; and second, we enrich our theorization of the place of emotion in the practices of subjectification and possibilities of action, because performativity suggests a different conceptualization of emotion and action. This means that the enactment of emotion is an embodied affair and that there is a continual rediscovery of the emotions that become

embodied performances. Such performances are enmeshed in spaces, meanings, ambiguities, and contradictions of culture (e.g., ''classroom culture''). All these are interrelated in ways that cannot easily be separated from one another because they are part of the same phenomenon of performance. Thus, the notion of ''emotion as performative'' implies that emotions are practices, ways of knowing, habits, words, and social interactions. Also, it implies that emotions are used to account for someone's actions (Sarbin, 1986).

These insights are particularly relevant to my work because the children's emotional practices would seem to be an essential aspect of the classroom emotional tone and organization. It is therefore important to pay attention to the emotional rules that the teacher and children mutually construct when one analyzes the children's emotional practices as they occur in a classroom. These practices need to be explored in the social context within which they are performed and within which they acquire meaning. I argue that it was because the teacher I worked with and her students established a supportive emotional learning environment that I observed generally excitable emotions in their science learning during the 3 years of my study; this learning environment contrasted sharply with those of typical classrooms.

Overview of Classroom Organization and Emotional Tone

The study was conducted in a multiage public school classroom of first and second graders as part of a 3-year research project on the role of emotions in science teaching and learning. The teacher, Catherine Myers, was an experienced early childhood and elementary educator. She was selected for this study after a recommendation from a university faculty member who described her as ''an exceptional teacher who is enthusiastic about teaching science and who makes children feel excited about learning science.'' Catherine had been teaching for 25 years, and worked with children from kindergarten through fifth grade. For the last 10 years she taught multiage classes of kindergarten and first grade, or first and second grade. For the first 2 years of my study, Catherine taught kindergarten and first grade, and first and second grade; that is, she followed the same students for a second year. In the third year, she had all new students of first and second grades.

During the 3-year research project, Catherine and I met twice or three times every week for interviews and classroom observations. During these meetings we discussed events in the classroom, her personal reflections, stories from her life, and instructional issues pertinent to subsequent lessons. In doing so, we gradually developed a trusting friendship and teaching collaboration, and our conversations grew to include curriculum discussions and lesson planning as well as personal feelings and thoughts about the school organization, professional relations with her colleagues, and so on. I believe that my presence as a collaborator in Catherine's classroom was a meaningful contribution to her professional life and made her feel more comfortable in sharing how she felt about her teaching role, her students, her pedagogy, and the emotional politics at the school.

Catherine taught science almost every day using an in-depth, integrated inquiry approach to meet the diverse needs and interests of her students. Through this thematic, integrated curricular approach, students constructed their own knowledge while experiencing the connectedness between subjects, using authentic materials and activities that were relevant to the students' lives. Catherine's teaching encompassed a year of ''travel'' to a particular time and place to make science investigations more exciting. In the 3 years I was in her classroom, she developed year-long, integrated units of study on the themes of ''London,'' ''Japan,'' and ''History.'' She used these themes as the ''link'' among numerous investigation projects such as explorations of animals and insects at the Natural History Museum and the London Zoo or studies of herbal plants used by Native Americans. As she explained during an interview:

> The year-long inquiry is in itself a process which involves collaboration with group of children and their families. Each theme takes its own unique focus dependent on young children's interests, needs, and family community resources. These units are hands-on and project oriented, allowing children from all backgrounds to ''live out'' experiences of traveling to another time and place. I have developed this inquiry approach to meet the diverse needs and interests of my students. (September 18, 1998)

One of Catherine's primary concerns was the organization of space and materials in the classroom. ''I strive to create a community that nurtures the emotional, social, and cognitive development while honoring diversity. Catherine pointed out, ''I use space and materials to help structure the environment so that each child feels valued, supported, and personally 'connected' with the business of learning.'' The physical space in the room was divided into nine areas, allowing children to choose between independent, self-directed, or small-group work for portions of the day. Areas included a library, two project areas, and areas devoted to writing, computers, listening, science, mathematics, and art. Catherine encouraged her students to utilize the space in ways that accommodated their needs and interests. The use of space and materials changed over the course of the year as the needs and interests of the students evolved. Catherine reflected on the importance of classroom organization in creating a nurturing learning environment:

> Although I spend a great deal of time before school begins organizing materials and rethinking space, from the first days of school children become co-constructors of our environment. I ask for their input and children begin to demonstrate a growing sense of ownership and responsibility for classroom space and materials. They become involved in the decision-making process, actively participating in determining space arrangement, location of activities and selection of materials. They assist in creating, organizing and arranging materials. Children bring materials from home, design visual displays, and label and display information and their work. (July 8, 1999)

The emphasis on the construction of classroom ownership for the students and the strengthening of bonds between them reflected Catherine's view that science is a social, community activity as well as an individual activity. The role of social interactions was that of a catalyst for individual and group emotional development. For example, Catherine's general instructional approach reflected this philosophy. Her strategy included an introductory whole-class discussion followed by small-group work and then again a teacher-orchestrated, whole-class discussion of the children's problems, interpretations, and ideas. Whole-class discussions were important, as Catherine emphasized, for the creation of a caring community of science learners: ''I use group times as opportunities to model and demonstrate concepts about personal boundaries, respect, caring for others, and the inclusion of all members. As we come to know one another, sharing our work and thinking, we value and respect what each has to offer, creating a community of learners'' (September 30, 1997).

Another important contrast with traditional science instruction that contributed to the creation of communities of learners included: the complete absence of grading and instead the detailed writing of reports as feedback to each student; the one-to-one meetings with students throughout the year to discuss concerns and personal expectations and to celebrate individual successes; and the absence of ''drill-and-practice'' seat work. As a result, the construction and legitimation of science knowledge in Catherine's classroom was strongly linked to the social interactions and the classroom emotional tone being constructed by these interactions. Both Catherine and her students legitimated their own knowledge: ''Those terms 'right' and 'wrong' have little meaning, you know,'' she once said during a conversation, and added, ''My sense is that everything is a

continual refining of our understanding. Life is a series of discoveries. I am not sure where, if ever, this journey ends. This sense of wonder is the one I want my students to feel in science'' (November 17, 1997).

Because of the accepting and supportive emotional culture in the classroom, the children did not become embarrassed or defensive but might have simply said, ''I don't know'' or ''I disagree with my classmate.'' It was immediately apparent that Catherine accepted all answers in a completely nonevaluative manner, but she would always ask children to justify their thoughts. Her intention, as she pointed out frequently, was ''to encourage the children to verbalize their thoughts and feelings.'' Her role was to initiate and guide a genuine scientific dialogue between the students. She made it possible by capitalizing on students' contributions and excitement. Thus, rather than funneling the children's excitement, she took her lead from their excitement and encouraged them to build on each others' contributions as she guided explorations about science. As a result, the scientific meanings and practices institutionalized in the classroom were not decided in advance by Catherine but, instead, emerged during the course of conversations and investigations characterized by a genuine commitment to ''empathetic understanding'' (Zembylas, 2002a). In addition, the children, as she argued, ''were more likely to believe that one succeeds in science by attempting to make sense of things that are exciting to them and less likely to believe that success comes from following what the teacher tells them to do'' (December 2, 1997).

Catherine had to cope with a variety of institutional demands that tended to reproduce traditional instructional approaches among the teachers. For example, the teachers had to address all the school district's goals for science education. Also, the students were required to take a state-mandated accountability test. Those who failed this test had to attend remediation classes and, if necessary, repeat a grade. Catherine was well aware of this pressure and the fact that her colleagues and the community evaluated her almost exclusively in terms of these test scores. Thus, over the years, she developed her own system of assessment (both descriptive and quantitative) that was correlated with the district's educational goals and values. In this way, she was able to demonstrate that, despite the absence of ''drill-and-practice'' and ''teaching-to-the-test,'' the performance of her students in the state-mandated test did not differ significantly from the rest of the students and, in fact, often it was better. Consequently, she was able to gain a few friends among her colleagues and administrators. Her instructional philosophy about science was very clear:

> Since we construct what we know, a correct versus incorrect approach confuses children about the aims and possibilities of science. It distracts them from observing, comparing, and discussing their surroundings and experiences. I encourage children to track their assumptions (''What do you mean by that?'') and to compare observations with those of peers and with their prior understandings. This helps children to refine and deepen their knowledge. As a facilitator, I communicate respect for their observations by listening to each child and asking children to listen to one another. I acknowledge their language and thoughts by listening and restating observations. I frequently model and encourage ''scientific,'' or more precise language, in order to expand and enrich their communication. I act as a co-investigator, modeling the process of investigation and sharing my own wonder of the world. (March 25, 1999)

In summary, the major elements of Catherine's approach were: encouraging active involvement; respecting children as individuals; creating a community of learners; integrating school subjects and making connections; following children's interests; constructing an affective environment for learning; and acting as a co-investigator. Her goal was to offer the students many opportunities to be deeply engaged in exploring topics and ideas of their interest. Her emphasis was on empowering them to love science explorations, an ambitious goal that clearly went beyond short-term concerns about covering the content of a mandated curriculum.

The unique emotional tone and organization in Catherine's classroom was clearly fascinating to explore and raised several questions from which two are dealt with in depth: (1) How do Catherine and her students negotiate classroom emotional rules? (2) What is the impact of the outcome on how meaning is negotiated in science, or how is science is legitimated?

Methodology

To explore these questions, a qualitative, ethnographic methodology (Denzin, 1997; Miles & Huberman, 1994) was used as the basis for the data collection and analysis. The data sources from this study were classroom observations, in-depth interviews with Catherine, and collection of documents of all kinds. The data consisted of interview transcripts, field notes, and videotapes from classroom observations, and various documents such as lesson plans, a diary, philosophy statements, children's worksheets, and school records. I estimated that, during the 3 years I worked with Catherine (January 1997 to July 1999), I spent over approximately 200 hours in her classroom observing her teaching, and approximately 45 hours of interviews with her. The days selected for observation were based on when Catherine taught ''explicit'' science lessons—usually twice or three times per week for approximately 50 minutes each time.

Qualitative methodology made possible the analysis of the mutually constructed emotional rules between Catherine and her students. The children's emotional practices acquired meaning from and contributed to the construction and continual renegotiation of these rules. Therefore, the analyses of classroom dialogues (both whole-class and small-group interactions) focused on the negotiation of these emotional rules and the impact of these negotiations and rules on the legitimation of scientific knowledge.

My visits to Catherine's classroom lasted approximately 2 hours, and included 1 hour of observations and 1 hour of open-ended interviews with her. During my observations, I wrote notes, which I later compiled with the aid of the audiotapes and videotapes into a narrative record of each observation. In these records, I made sure that the sequences of activities and interactions were preserved. My fieldnotes were devoted primarily to descriptions of the activities, observations of Catherine and children's responses to and experiences with these activities, reflections on my own reactions in the activities, descriptions of Catherine's roles, how she seemed to feel, and preliminary analyses of what I was seeing.

Classroom dialogues and interview transcripts were analyzed using qualitative coding procedures as outlined by Strauss & Corbin (1990), along with other organizational tools suggested by Miles & Huberman (1994). I began with ''open coding'' by placing conceptual labels on selected segments of dialogues or transcripts to represent the preliminary themes emerging from the data. I then grouped these conceptual labels under broader categories, resulting in several major themes (''axial coding''). Rather than building a single storyline, as suggested by Strauss & Corbin (1990), for the purposes of this study it seemed more useful to think holistically about the data, focusing on the identification of major factors and experiences that appeared to contribute to the formulation of classroom emotional rules. A constant comparative approach was taken to build and confirm emerging theory (Lincoln & Guba, 1985). My interpretations of the major factors and experiences that appeared to contribute to the formulation of classroom emotional rules and meaning in science are presented in what follows.

Findings

To[1] illustrate the major categories of emotional rules contributing to classroom emotional tone and science knowledge legitimation, I draw some examples from the study. These examples

are organized around two themes: (1) construction of classroom emotional rules; and (2) construction of meaning in science. Each theme is discussed in what follows.

Construction of Classroom Emotional Rules

Catherine played a major role in initiating and guiding the mutual construction of classroom emotional rules. Her main goal was to help the children communicate their thoughts and feelings about what they understood and what got them excited in their science investigations. On numerous occasions, she brought specific situations to the attention of the whole class and asked the children to elaborate on how they felt. In effect she told them how they ought to construe a situation; as a teacher of young children, she was often setting the groundwork for the rules and creating the environment for children to go along or resist them. However, as will be shown, the issue in the evolution of classroom emotional rules was not about ''approving'' or ''resisting'' Catherine's rules; the children participated in a mutually constructed process in which they also contributed by reorganizing their emotional practices and enriching their excitement in learning science.

For example, Catherine and the children negotiated the science curriculum at the beginning of the school year by deciding what units they wanted to investigate and establishing their expectations. In September, they listed animals of interest, choosing what they wanted to study for the next month or so. Also, Catherine involved children in the social rule-making ''in order to give them a vested interest in the community and provide a starting point for co-constructing our social and emotional environment,'' as she explained, and added, ''We revisit these rules often, revising them based on children's changing needs'' (January 4, 1998). For example, early in the second year of my study, Catherine and the children spent a great deal of time developing strategies to help everyone feel included. However, in January, Catherine noticed that several children always chose to work together. Sheri expressed his frustration that Ali used to be his friend but now she ignored him. Ali and Sheri discussed the conflict and decided to bring it up at a class meeting. Catherine reflected on this event in her journal:

> This became a class meeting topic and centered on ways we include or exclude people in our community. This resulted in a series of powerful discussions. Children developed new sensitivities to ways to help others feel included. They brainstormed possible solutions and developed some strategies involving changes in our routine. First, during meetings they decided they would sit by someone they had not sat next to for a while. They developed a ritual of greeting these people with such comments as ''It is nice to see you,'' or ''I am glad to have a chance to sit by you today.'' They also decided that at least twice a week they should have a ''travel partner'' to work with for the morning, choosing classmates that they had not worked for a while. (January 4, 1998)

Catherine's theme of ''traveling'' to London—other times it was a journey to Japan or a journey back in time in a time machine—became truly a metaphor for lifelong learning. Her goal was to show the children that learning was a lifelong journey that never ended and that the success of this journey was directly related to their excitement and fascination with what they studied. In addition, in this process, children were learning how to mutually construct rules of co-existence and how to practice respect, communication, problem-solving, and cooperation.

The classroom organization as well as the discourse organization served not to transmit knowledge but to provide opportunities to construct and reflect on their own understandings and emotions in science. As Catherine wrote in her journal:

> I structure the environment by providing a variety of specimens, books, charts, and science journals. I use broad goals, focusing on children's questions and providing time for children to discover physical attributes on their own. In these ways, I encourage a climate that embraces discussion, questioning and wondering, providing further experiences to deepen understandings and opportunities to communicate observations and feelings about those understandings. (February 1, 1999)

Catherine and the children's mutual construction of classroom emotional rules as well as scientific practices and understandings were reflected in two different levels of classroom dialogues. At one level, they talked about and did science; at another level, they expressed emotions about science and its learning. When she and the children talked about and did science, Catherine's role was to guide the children to help them learn how to justify their thoughts. However, when they described how they felt about science and its learning, her role was to moderate the conversation, share her own emotions, and clarify the emotional rule that was being negotiated. Each level provided a structure for the scaffolding of the other; both levels indicated the centrality of emotional practices in science learning, how emotions were powerful in encouraging effective learning, and approaches to study science. These two levels will become apparent in what follows as examples of the evolution and implications of two emotional rules are presented: first, the rule that had to do with the nurturing of excitement in science and science learning; and second, the rule that had to do with the acceptance of making mistakes when explaining something, but the rejection of hurting each other's feelings. Theses rules or norms of practice were manifestations of a shared child-centered learning environment where care and concern for children and for each other was emphasized.

The nurturing of excitement in science and science learning. The following dialogue, which is taken from an episode that occurred in the middle of the school year during the third year of my study (January 24, 1999), illustrates the development of a fundamental emotional rule in Catherine and the children's classroom discussions: the nurturing of excitement in science and science learning. This rule is interrelated with the negotiation of meaning in science (the next theme) expressed in Catherine's emphasis that ideas should be justifiable. The dialogue centered on the growth of triops[2]:

John: The triops grow quicker than the chicks.

Karla: Yeah! It takes 21 days for chicks to hatch. It's supposed to take only 3 days for triops [to hatch].

Teacher: Karla, why are you saying, ''it's supposed to take only 3 days''?

Karla: Because we haven't tried it yet. That's what the flyer says. (*She points to the flyer that was given to all children and had information about hatching triops*.)

Andrew: There are other differences between growing triops and growing chicks.

Jason: Yeah! There are many differences! (*Several other children say "yeah, yeah."*)

Teacher: Okay. Great! What are some other differences between hatching triops and hatching chicks?

John: We need to give food to the triop eggs.

Teacher: (*smiles*) Wonderful idea! Can you say more about this?

[. . .]

Lisa: *(to Catherine*) Ms. Myers, is it safe to touch the triops?

Teacher: What do you think? (*looking at the whole class*).

Catherine did two things in this dialogue: First, she encouraged the children to express their ideas, emphasizing tactfully at the same time that they needed to justify those ideas; and second, she was clearly excited as the children began discussing the differences between chicks and triops. Instead of evaluating Karla's answer or providing the answer to Lisa's question and thus ending her wonder, Catherine presented the question to the whole class. The discussion continued:

Jonathan: I don't think it's safe. The triops have whiskers (*he points to the whiskers on the picture that Catherine showed them earlier*) that might electrocute you, you know?

Andrew, Alison, and James (*together*): Wow!

James: We shouldn't touch them. They might eat you!

Andrew: They'll suck your blood, if you touch them! We shouldn't touch them. No, we shouldn't!

Teacher: These are so interesting guesses! We need to remember that it doesn't mean that they will happen. So, how can we find out what might happen?

Alison: We need to investigate these ideas and find out what happens . . .

Teacher: Excellent! (*smiles*). We need to investigate these ideas!

The children clearly expressed their excitement first when they began naming the differences between chicks and triops and then when they started wondering whether it was safe to touch triops. Catherine's nurturing approach as she orchestrated the children's contributions to the discussion made the expression of emotions of excitement a natural response that stemmed directly from their investigations.

Children frequently expressed their fascination and excitement when engaged in science investigations by jumping up and down, hugging each other, rushing off to tell their classmates or Catherine when they discovered something amazing. Such emotional expressions occurred when the children used their imagination and were engaged in new discoveries. To illustrate, I present examples from a whole-class discussion and a small group discussion between Catherine and two students.

In the first example—an event that took place in the second year of my study (October 23, 1998)—Catherine and her first and second graders cut through a pumpkin and began analyzing its different parts. In this excerpt of the whole-class discussion that followed, one can notice the enthusiasm and the spirit of restlessness that accompanied Catherine and the children as well as her strategy of asking children for further explanations of their ideas:

Teacher: I hear lots of good observations. Some people are saying things like "It looks like . . . ." Other people are just describing "It has . . . " Lots of great ideas!

Anne: The inside of the pumpkin looks like a spider web, kind of.

Teacher: It looks like a spider web, kind of (*softly*). Why do you say a spider web?

Anne: Because it has strings going *this* way and *that* way (*she points to the strings going into opposite directions*).

Teacher: Wow! Wonderful observation! (*to Brandy*) Brandy, you said earlier that it looked like frost? What made you think of frost?

Brandy: Because it almost felt like I could feel the cold air.

Teacher: Because you felt almost like . . .

Brandy: Like in the freezer when the ice is from the top.

Teacher: So, it looks like in the freezer when the ice . . .

Brandy: When the cold smoke comes up . . .

Teacher: When the cold smoke comes up. OK. All right. Richard, did you have something?

Richard: It looked like your backbone!

Teacher: "It looked like your backbone," I heard you saying that. What made you think of the backbone?

Richard: Because there is like *this* line going straight down and then there is *these* little things (*he refers to smaller lines*) on the side going straight down by it.

Teacher: That's another possibility . . . . So there were lines going . . . there was a line going straight down and then there were lines, little lines going after the side?

Richard: Uh-huh.

Teacher: Okay. Absolutely incredible observations people have here! I am very impressed with your scientific skills in observing!

The relative merit or "scientific validity" of each of these ideas were never discussed in the whole-class setting, but this did not seem to be the main issue. Instead, an important issue in this particular discussion seemed to be the nature of children's emotional practices as those were embedded in the ideas expressed. These emotional practices were determined by the mutual construction of the emotional rule that made a child's expression of imagination and wonder acceptable. It should be clear from the sample episode that Catherine did not impose any emotional rule in advance. She did not have any explicit list of rules to enforce onto children;

indeed, no such list could ever be complete, and no such act could ever be accomplished unproblematically (see Cobb, Wood, & Yackel, 1993). Instead, the rule emerged gradually as Catherine and the children talked about science in the whole-class setting and, as such, there were interactional accomplishments. The emotional rule seemed to be: ''excitement and imagination is nurtured for all and by all at all cost!'' In other words, the nurturing emotional tone being constructed in the classroom, as was obvious in the exchanges presented, made possible the children's expression of thoughts and feelings full of excitement and imagination.

The second example, which took place a few weeks later that same year (December 3, 1998), again illustrates the excitement that two students, Julia and Ali, experienced when they figured out how the lever worked. The children were engaged in constructing a model of a time machine that travels through time, as a part of their long-term science investigation that involved travel back to the life of Native Americans before the first Europeans went to North America.

Teacher: How did you feel when you finally figure out how this lever worked?

Ali: I felt good! (*smiles*) I was very excited! Watching *Back to the Future* I got an idea about how I could build something similar for our own time machine.

Teacher: This is a wonderful feeling, isn't it? It's fascinating to watch you become so excited about this time machine! (*smiles*)

Julia: At first I didn't understand how it worked . . . (*she hesitates*) but now I think I have a pretty good idea how I want to build our lever. I want to try it out and see what happens . . .

Teacher: Good for you!

Julia and Ali's excitement at having figured out how the lever worked was indicated by the manner in which they smiled and expressed their satisfaction at their achievement. Catherine played an important role in nurturing this excitement by calling the attention of the entire class and explaining how the two girls did their research, what they found, and how they felt. This was crucial in the process of negotiating this emotional rule. She did not plan to do this in advance; this issue emerged as she talked to these two girls about their discovery. The manner in which Catherine capitalized on this unanticipated event by presenting it as a paradigmatic situation in front of the whole class in which she discussed the importance of feeling excitement about one's discoveries constituted a significant component of the process of negotiating emotional rules in the classroom. In other words, Catherine illustrated that the classroom emotional rule of ''nurturing the feeling of excitement''—that is, the feeling of satisfaction and pride in one's own accomplishments—was not only a socially acceptable emotional response but also something that was strongly encouraged and often came as a result of being persistent in solving a problem or trying different ideas and finding out what happened. Consequently, on the one hand, it makes sense to say that Catherine exercised her institutionalized authority to make possible the development of this emotional rule; it was obvious that Catherine played a crucial role in guiding its construction. On the other hand, the role of Ali and Julia was not at all passive in this event; after all, they were the ones who shared their excitement overtly and provided clear evidence of the results of their persistence in solving a problem. Catherine, from her part, wanted to emphasize the importance of how ''figuring out something'' created a ''satisfying feeling,'' and this was a valued goal to achieve in their classroom. But the children always participated in the negotiation that

occurred; it was by capitalizing on Catherine or the children's expectations that Catherine and, gradually to an increasing extent, the children, navigated the negotiation of emotional rules in the classroom.

The acceptance of making mistakes when explaining something, but the rejection of hurting each other's feelings. Another emotional rule that was important in this classroom is evident in the following event in which Catherine emphasized to the children that it was "okay to make mistakes." In this event, which took place during the second year of my study (March 9, 1998), two second graders, Callie and Anne, were working in their small group discussing how many toothpicks and marshmallows they needed to make their next model of a crystal they had studied. They had a disagreement about the number of toothpicks needed after they had calculated the faces and the vertices, and Callie realized she had made a mistake. Catherine was carefully listening to their conversation:

Callie: (*to Anne*) You were right and I was wrong. But really it doesn't matter. Both of us made enough mistakes and I'm glad we made them . . .

(*Catherine intervenes*.)

Teacher: You know what I was noticing too? It really is difficult to count the faces and vertices when we have a lot of them. As I was looking at *this* model I was thinking *here* is one and *here* is another, that's two and once I was touching those two, oh, four . . . I can easily make a mistake . . . (*she makes a short pause and then she looks at them*). Is it okay if we make mistakes?

Callie: Yes.

Anne: Yes . . .

Teacher: So, what do you do then?

Anne: You try it and see! (*smiles*) Then you try something else . . .

Teacher: (*smiles*) Aha! So, it's okay to make mistakes, because we all learn from them. What is really important is to try different ideas and figure out what happens!

In this episode, as well as the previous one, Catherine used children's emotional practices to endorse and sustain the performances from which these practices were derived. The children's responses indicated that they endorsed the classroom emotional rule that was being negotiated (e.g., being excited about science or making mistakes in the process of trying out ideas) and, through Catherine's interventions, contributed to sustain this rule. In particular, Catherine, Anne, and Callie seemed to concur that "making mistakes" should not make them feel bad, implying also that other children should not tease classmates who made mistakes. In the aforementioned episode, Callie did not seem to be uncomfortable with making a mistake. The relevant emotional rule was established long ago. After an episode in which a student teased a classmate for making a mistake earlier that school year, Catherine and the children discussed the issue and made a clear point to everyone in the class about this. Catherine summarized the discussion in which several children expressed their negative feelings when a classmate had teased them. In her comment, she reiterated the whole-class sentiment, or that it was not acceptable to hurt each other's feelings:

> In this classroom, boys and girls, it is *not* okay to tease each other because someone made a mistake. We all make mistakes, right? [*Many children shake their heads and say "yes."*] If we don't try our ideas and often make mistakes because some of those ideas don't work out, how are we going to find out what happens? I make mistakes all the time, don't I? [. . .] [*A few children say "yeah"; others shake their heads indicating so*.] I feel bad when someone teases me and says, ''Oh, you made a mistake! I don't make any mistakes!'' I am thinking, ''Well, everybody makes mistakes! That's how we learn! We learn from our mistakes! Why is this person teasing me then?'' So, it is *okay* to make mistakes in this class *but* . . . it is *not* okay to hurt each other's feelings. (October 17, 1997)

Through this comment in front of the whole class, Catherine also confirmed her own expectations from the children by clarifying that ''teasing each other for making a mistake'' and thus ''hurting each other's feelings'' violated an emotional rule. She emphasized that it was allright for them to make mistakes in their efforts to try out different ideas, and simultaneously emphasized that it was more important in science to learn from these mistakes. The question ''We all make mistakes, right?'' and earlier the question to Callie and Anne ''Is it okay to make mistakes?'' set the groundwork for the children to respond in ways that emphasized two things: first, to renegotiate and confirm the emotional rule that it was not acceptable to hurt each other's feelings; and second, to see that scientific inquiry was a form of social activity that involved trying out different ideas and thus making mistakes in the process. The children participated in the process of negotiation by enacting the emotional rules and thus validating them, or by renegotiating them, as it happened in the event with developing new strategies to help everyone feel included. The manner in which Catherine guided the negotiation of emotional rules during the course of these conversations was subtle, as exemplified by the rhetorical statement of the questions. However, she did not hesitate to state explicitly that, ''it is not okay to hurt each other's feelings.''

As the preceding examples illustrate, the process of negotiating classroom emotional rules involved both Catherine and the children together interactively, constituting which practices were accepted in individual and group actions. Catherine's expectations that the children justify their ideas, and the supporting emotional tone of the classroom, influenced the children's activities, because the children anticipated that they would have to justify their ideas and appreciated the nurturing learning environment. An important characteristic of this classroom was that it nurtured the belief that science should be personally meaningful and exciting, thus the children had the opportunity to view science as an activity under their control rather than a disembodied, subject matter area of knowledge. The children's acceptance of these emotional rules—that is, the expression of excitement and wonder and the avoidance of hurting each other's feelings—was obvious in their diligence and joy in working on their investigations, sometimes for hours without taking any breaks. There was indeed something remarkable about a class in which the children did not want to take breaks because they wished to continue working on their science investigations.

As this second rule documents Catherine's expectations, one might argue that she was said to establish or specify the rules for children. To be sure, Catherine was an institutionalized authority in the classroom (see Bishop, 1985), and expressed this authority by initiating, guiding, and negotiating classroom emotional rules. It was Catherine who typically initiated the mutual construction of rules and expectations. However, the children also played their part in contributing to the evolution of these rules. Catherine had to accept certain obligations for her own actions. If she expected the children to honestly explain their understandings and make mistakes, then she was obliged to accept these explanations rather than to simply reject them. In making their social and knowledge contributions, the children renegotiated their own role and others' roles in the classroom. The nurturing of such a supportive classroom emotional tone could not be done by

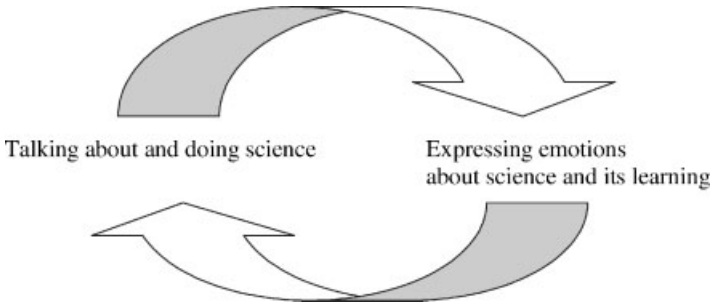

Figure 1. Two levels of classroom discourse.

Catherine only; the children had to trust her to respect their efforts, otherwise the classroom would look very different. This implies that it is neither a case of a change in a supportive classroom emotional tone causing a change in children's contribution to a productive learning community, nor a case of children first contributing to the evolution of a productive learning community and then changing the classroom emotional tone. Instead, emotional rules and the contributions of participating children co-evolve in that neither is seen to exist independently of the other.

Shifting from one level of discourse to another—from talking about and doing science to expressing emotions about science and its learning—Catherine and the children negotiated the classroom emotional rules. This relation is shown in Figure 1.

The two levels of discourse were interrelated and took place simultaneously. Discussions about science and science investigations were inseparable from discussions about how Catherine and the children felt about science and its learning. The implicit or explicit negotiation of emotional rules guided emotional practices in the classroom and influenced science investigations and discussions about science. Conversely, many emotions about science and its learning emerged through science investigations. The children's emotional practices in science learning were profoundly influenced by the experiences of science as a social activity in which ideas were tried and failed, and a sense of community spirit (e.g., a supportive emotional tone in the classroom) contributed to the successes and failures. This suggests the interrelationship between emotions and science learning and the notion that emotional practices can be powerful in nurturing effective and exciting science learning environments. For example, because children came to believe that science was fundamentally a process of trying out different ideas and making mistakes in an effort to find out what worked (e.g., recall the episode with Callie and Anne), negative emotions about science, such as frustration, discomfort, and anxiety, did not occur in Catherine's classroom. Even when negative emotional practices were expressed (e.g., hurting someone's feelings) these were directed at other children and *not* at science or Catherine. The process of legitimation of children's knowledge—that is, the negotiation of meaning in science—was intimately connected to the emotional tone in the classroom and the respective emotional practices. This process is clarified in what follows.

Construction of Meaning in Science

The evolving emotional rules in the classroom, as described so far, constituted an important component of the emotional culture in which Catherine and the children negotiated meaning in science. In presenting the following sample episodes from events that took place in the classroom, the goal is to illustrate two practices with which science meaning was negotiated and that had inextricable connections to the role of emotion in science learning: first, the function of some key

forms of intellectual practices used in talking about and doing science; and second, the role of aesthetic influences in learning science.

Forms of intellectual practices in talking about and doing science. Intellectual practice is the involvement with knowledge and, in particular, the critical interpretation of knowledge. As it might be obvious by now, the hallmarks of the ''learning process grammar'' (Cobb et al., 1993) in Catherine's science classroom included three key intellectual practices: participatory active learning; analysis/justification of ideas; and the nurturing of wonder and imagination. These forms of intellectual practice were advocated by negotiating a classroom forum in which the learning community legitimated its own knowledge. In other words, Catherine and the children enacted science learning as a critical organic intellectual practice in which everyone was actively (and often passionately) involved in his or her learning. The following examples demonstrate these intellectual practices. It will also become more apparent how these intellectual practices are interconnected with emotional practices.

In the next incident, which took place in the third year of my study (January 22, 1999), Catherine and August, a second grader, talk about the formation of rocks from volcanoes, as a part of a long-term investigation of the Natural History Museum in London. August noticed that some rocks have big crystals, whereas others have smaller ones. The discussion then shifted to an analysis of various hypotheses about how rocks are made inside a volcano. Notice first, how August was very conscious of the fact that justifying her ideas and providing evidence for them are important tasks in science, and second, how Catherine elicited further questions, often simply repeating August's explanations or expressing a pleasant surprise and excitement at August's evolving ''theory.'' Participatory active learning and the nurturing of wonder and imagination are intellectual practices enacted and constantly reinforced by both August and her teacher:

August: Maybe like some [rocks] are made like deep down in the volcano and those are probably the huge, biggest ones . . .

Teacher: Might be . . .

August: Where upper in the volcano it might break through the surface to get a little bit of air.

Teacher: They might have more air there?

August: Uh-huh. And they are right on top.

Teacher: It could be! (*smiles*) It's an interesting theory!

August: Let me see if there is any other pages on this book so I can show you an example of what I mean.

We can easily note that Catherine did not evaluate August's initial explanation—she said ''might be''—and then expressed her surprise at August's imaginative ''theorizing.'' This astonishment remained evident as the episode continued and Catherine genuinely admitted at one point that she had not thought of August's explanation and thus asked for further elaboration:

Teacher: You know what you can't see in the pictures is that you can't tell how sparkly or shiny they are . . .

August: Uh-huh . . .

Teacher: These are very shiny! (*She picks two rocks and rotates them.*)

August: Yes! When you look at them they look as if they are creating different colors.

Teacher: Like different colors. Boy, that would be difficult to try and get a picture of . . . to draw a picture . . . . You know, could you try drawing just a little piece of this *here* (*she points at August's journal*) to show some of the shape or maybe a close up of some of the crystals. You could add that to your science journal so we can have more information either *here* (*next to the text she wrote*) or over *there* (*on a new blank page*). Which side of *this* rock do you think cooled first? The inside or the outside?

August: The inside.

Teacher: You think the inside cooled quicker?

August: Yes. Probably there was like a hole in here so air can get in there somehow.

Teacher: So, there was a hole in there so air could get in. Hmm!

August: Uh-huh . . . . Like . . . just like a little . . . maybe like a big hole or . . . I don't know really . . .

Teacher: But you think there was air that was inside? . . .

August: Yeah . . ..

Teacher: At some point . . . . That could be. . .

August: Maybe it was so hot first!

Teacher: I didn't think about that! Can you tell me more about this?

August: Probably this took like 10 years to cool whereas the outside took a hundred years.

Teacher: Where did you find out about the hundred years?

August: In the big book about crystals.

Teacher: And, it said it took . . . and it takes a long time, yeah . . .

August: Uh-huh.

The structure of this conversation differs markedly from a typical school science interaction where information-seeking questions dominate. In this conversation, and as a result of prior negotiations of emotional rules, August felt comfortable in sharing her feelings and ideas and Catherine's replies completed the interaction without dismissing August's explanations as

"incorrect." The intellectual practice of justifying ideas and providing evidence for these is very much embedded in August's thinking. Incorrect answers were passed without comments and Catherine's encouragement indicates that August was acting in accord with Catherine's expectations. As Catherine explained in an interview after this episode:

> I accept all answers and what I do is ask questions. Asking questions that challenge something they [children] haven't considered. [. . .] I guess it seems to me as though it would be useless to simply say "yes, you are right," "no, that's not really it," because I guess to me that wouldn't be science. That would just be disseminating information. That wouldn't be getting children to think and to explore their ideas. That wouldn't be helping them challenge their own understandings of things. It certainly wouldn't be something empowering to them. And I'm sure that comes from my own experience in science back when I was younger. There were the kids who were the *scientists* or who knew something about science and the rest of us were *dumb.* [. . .] (January 22, 1999)

In a conversation we had the next day she added:

> You know if I look at it from the angle of which makes me feel better as I'm talking to a group of kids to say to them "Ah! You've got the right idea!" and tell everybody else in some way or another that they don't [then] it really comes down to this: Do I finish the discussion feeling I had two really bright kids in my classroom? Or do I finish the discussion feeling "Wow! What incredible thinking! Look at all these brilliant people I'm working with!" I'm not excited to think that I have one or two really gifted kids in my class. I want everyone to feel smart and excited! (January 23, 1999)

Catherine wanted her students to "legitimate their own knowledge," as she used to say. She wanted them to recognize themselves as having the power to actively and critically validate their ideas and to avoid being dependent on others (e.g., the teacher, the teacher's aid, or other adults) to confirm these ideas. She wanted the children to believe that they knew things and were excited about this learning. Catherine's attempts highlighted the importance of teaching to the children the intellectual practices of legitimation of knowledge through wonder, research, justification, evidence, and imagination.

This point also implied that a fundamental goal of science instruction, in Catherine's view, was the initiation of the children into the scientific practices of the wider society. In Catherine's view, science did not consist of timeless, objective facts unrelated to everyday life but was continually negotiated by communities of learners and involved interconnected ideas. Such a view is consistent with recent ideas in history and philosophy of science (e.g., see Capra, 1996; De Landa, 1997; Hayles, 1999; Knorr-Cetina, 1999; Latour, 1999). Consistent with these ideas, science activity in the classroom occurred within a context of intellectual practices that evolved within the classroom community itself and regulated social interactions. Thus, the children took it for granted that they had to actively pursue their learning and explain and justify their ideas; it was part of classroom intellectual practice that were supported by the nurturing emotional tone being constructed.

In fact, the few negative emotional practices that occurred when I was present took place when children were deprived of the opportunity to pursue their interests, such as when the teacher's aid or another child told them the answer to what they were investigating. Such events caused much frustration and boredom among the children. For example, in the first year of my study, Catherine had to confront her aid, after she had discovered that several children lost interest in what they were studying and said they were bored. After Catherine had several conversations with these children,

one of them finally said that, ''Andrea [the aid] told us the answer because she said we don't know these things. I don't feel like working on this project anymore'' (January 17, 1997). After this discovery, Catherine became furious and indicated to the aid how she should handle such cases.

In the earlier episode, the conversation between Catherine and August ended with a ''pleasant'' interruption. Throughout this conversation, another student, Jenny, was writing something in her journal about rocks but it seemed that she was listening to Catherine and August's conversation:

> Jenny: Listening to you talking about these it makes me wanna read more! I wanna read more about rocks and write more on that!
>
> Teacher: (*to Jenny*) Uh-huh! Great! I guess you are interested in them?
>
> Jenny: Yeah, I *like* the things I heard you saying . . . I *like* to read more and write about them . . .

Jenny's ''intervention'' was remarkable for two reasons. First, she displayed an extraordinary excitement and wonder at further investigating a topic simply by listening to a conversation that she liked. It is important to emphasize that such a positive emotional response was not a reaction to extraneous factors, such as receiving extrinsic rewards or ego satisfaction, but stemmed directly from an interest to engage in further science investigation. Second, such a notable display of intellectual practice in learning science led Jenny to make a choice of what direction to pursue in an investigation and implied a feeling involving some kind of aesthetic sensibility. Her last sentence, ''I like . . . '' indicated that aesthetic feeling might be an important factor in evaluating science investigations and making decisions about what to study. This is examined in what follows.

Aesthetic influences. It has been suggested that making decisions about what to study and evaluating problem-solving activity often have an aesthetic character (Silver & Metzger, 1989) and that there are aesthetic aspects in the process of learning and doing science (Flannery, 1991; Girod, Rau, & Schepige, 2003; Girod & Wong, 2002; Wong, Pugh, & the Deweyan Ideas Group at Michigan State University, 2001). In line with these recent attempts to identify aesthetic elements in science learning, I further suggest that aesthetic judgments—the feeling of beauty, the feeling that something is attractive—may be present in young children whose learning is nurtured in an emotionally supportive environment such as the one created in Catherine's classroom. Two examples are described.

The first example is from a dialogue in the second year of the study (March 1, 1998) between Catherine and four students as they talked about strategies to make a model of a crystal using toothpicks and marshmallows. Two students, Callie and Anne, seemed to have difficulties figuring out how many toothpicks they needed to make their model. Two other students, Richie and Marshan, figured out a solution. Catherine suggested to both groups that they exchange ideas about their strategies. This is an excerpt of their conversation:

> Callie: I like your strategy guys . . . . You got it pretty much worked out . . . . I think I wanna make squares and connect them around, like you did.
>
> Richie: You should remember that first you do the top and then the bottom and then you attach them.

Anne: I'd like to work from the sides though . . .

Callie: Yeah . . . I think we'll start from the sides.

Anne: (*to Callie*) Let's try this and see if we get the same answer as they [Richie and Marshan] did! (*Callie and Anne raise their eyebrows and smile*.)

Callie and Anne ''felt'' they should follow this particular strategy (with their own adaptation) because they were satisfied with it. The relation between the attractiveness of the strategy and the children's eagerness in finding a strategy seemed evident in the expression of an aesthetic judgment (''I like your strategy, guys''). This aesthetic judgment emerged as an important influence on Callie and Anne's behavior to construct their model of crystal. It is of interest to note that although they ''borrowed'' the strategy they liked—after their own strategies had failed—they adapted it almost immediately to choose what direction to follow. Their intellectual practice of ''Let's try this and see if we get the same answer . . . '' was intertwined with their aesthetic feeling. Their aesthetic feeling almost appeared to be serving as both a filter through which Callie and Anne expressed appreciation for the particular strategy and a guide for their decision for its adaptation. This relation is shown in Figure 2.

The reflexive relation proposed here corresponds to the two levels of classroom dialogue presented earlier; that is, talking about and doing science and expressing emotions about science and its learning. In other words, the relation between intellectual practices and aesthetic influences reflects the evolving emotional culture of the classroom. This relation can be summarized by saying that the children's intellectual practices influence and are influenced by their emotional practices. This idea also becomes apparent in the next example.

This example is from an incident that occurred during a small-group discussion in the first year of my study (February 10, 1997) in which four first grade students, Laurie, Trevoy, Shantez, and Trey, were writing in their science journals about pine trees. Then Catherine came and asked them to share things they included in their science journals. Shantez volunteered to go first.

Shantez: (*He opens a book on pine trees that he has in front of him and starts showing different pictures*.) Look at here! This is a wonderful tree! This is what I wanna draw in my journal . . . . Look at this too! It's huge!!! (*his eyes sparkle*) . . . . And this is a real one! (*he points at the size of a huge sequoia tree*).

Catherine: You say this is the real one. What do you mean? Tell us more about that.

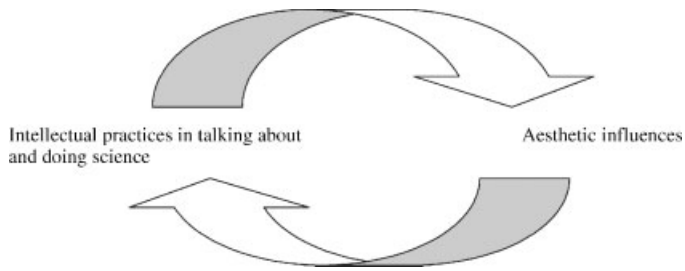

Figure 2. Reflexive relation corresponding to the two levels of classroom dialogue.

Shantez: When I watched TV about it and I saw it and that it've been so huge . . .I liked it a lot!

Catherine: Ah! That's why you want to draw it?

Shantez: Yeah . . . I think it's pretty (*smiles*).

Shantez "felt" he should pursue the study of this particular tree because he was satisfied with what he was looking at. The interaction of the content of investigation and Shantez's willingness to investigate this content appeared to be influenced by an aesthetic feeling. This aesthetic feeling served as a guide for his initial decision to draw this particular tree; his aesthetically based liking of the tree is an example of an emotional response to an object of investigation, and the response had an important positive consequence on his willingness to engage in the investigation.

Aesthetical judgments (e.g., of the type "I like . . . ") may serve as the basis for the choice of what to investigate. For example, in the two aforementioned incidents, Callie and Shantez expressed a sense of aesthetic sensibility for liking a strategy or liking a tree, respectively. This appreciation—which was also evident from the fact that they both smiled or that Shantez's eyes sparkled—appeared to have an aesthetic component and seemed to suggest that aesthetic responses and willingness to investigate something were closely linked. Callie and Shantez's choices—to follow a particular strategy or study a particular tree—may lack the sophistication of expert scientists, yet they indicate that a child's emotional response is linked to his or her intellectual practices. Obviously, the role of aesthetics in science investigations needs further exploration, such as examining the importance of specific aesthetic characteristics (simplicity, elegance, style) in science investigations and showing students how learning science may provide them with magnificent ways to view and live in this world. However, if the role of aesthetics in science investigations is an important aspect of the culture of science learning, educators need to explore whether science students should be immersed in this culture by providing experiences that allow them to appreciate and reflect upon aesthetic characteristics.

Discussion and Implications

The events analyzed herein emphasize the teacher and children's active contributions to the negotiation of both classroom emotional rules and meaning in science. This is a point that tends to be overlooked if one considers only the teacher as the one who drives this process. The analysis in this study indicates that the two levels of classroom dialogue identified earlier—talking about and doing science, and expressing emotions about science and its learning—are often intertwined and difficult to separate. In presenting the various episodes from the classroom, the goal has been to illustrate how young children's emotional practices contribute to the construction of the emotional tone of the classroom. Catherine frequently capitalized on the children's emotional practices to negotiate classroom emotional rules. In doing so, she implicitly or explicitly expressed her emotions and thoughts about these rules and influenced the children's emotional practices or was influenced by them.

One may point out that the analysis here is limited in that it ignores the connections with the broader social and political setting of the school, but this has been addressed elsewhere (see Zembylas, 2002a). In any case, the present study is useful as an attempt to address the complexity of emotional culture in the classroom, especially given the fact that the American tradition in science education has historically emphasized the role of students' cognitions (see Cobb, Wood, & Yackel [1993] for a similar argument in mathematics education). This research is significant in that

it adopts the perspective that emotions are at least as important as cognitions in science learning. The reflexivity between the two levels of classroom dialogue, as well as between children's intellectual practices and aesthetic influences, is a valuable finding that appreciates the interdependence of emotion and cognition in science learning. Thus, nurturing the development of children's intellectual practices and skills is directly related to the emotional tone of the classroom. It is notable that all the sample episodes presented in this study exemplify this connection and that intellectual growth was synonymous with emotional growth; these developments involved children's emotional practices. These episodes also illustrate the view suggested at the beginning of the article; that is, the emotional tone of the classroom provided opportunities for effective science teaching. The children were excited and reported that they felt enthusiasm when they were involved in science investigations; at the same time, they demonstrated remarkable intellectual practices.

Children's emotional practices are basically performances of their feelings and understandings of classroom emotional rules. The classroom is the site of constant emotional interaction centering on approval and disapproval for being right and being wrong. Such emotional ''judgments'' appear to be largely associated with the performative, cognitive, and evaluative aspects of emotion. This research shows the importance of the social and emotional context of science learning, and challenges perspectives that try to overgeneralize and oversimplify by leaving out the complexity and importance of emotions. This includes showing how children's emotional practices in science learning are interpersonally and socially complex; for example, to understand such practices we must also understand the sociological and interpersonal relations of children and their teachers; how understanding these relations involves understanding children's emotional practices; and how, at a still greater level of complexity, children's emotional practices can be understood only if we understand the world of their learning in science with those emotional practices, and that understanding this world involves understanding these emotional practices. It is readily apparent these understandings are intimately connected.

Another implication of this work is that the teacher should negotiate with the children a supportive emotional tone in the classroom in a manner that diffuses negative emotional practices such as frustration or boredom. Frustration happens when there is a failure of one's goals (Lazarus, 1991). Thus, consideration of children's goals, emotions, and interests is important in constructing a nurturing classroom culture. The construction of emotional rules that support and nurture science learning with respect to both negative and positive emotions needs to be thoughtfully considered. Catherine's efforts in this direction provide a good example.

In conclusion, learning environments in science are social and emotional environments, and learners are highly complex beings whose emotions interact with their learning in powerful ways. By theorizing emotion as being formed in classroom relationships and significant in the development and maintenance of emotional rules in the classroom, the role of emotion in learning is constructed at a much deeper level. Emotions shape learning experiences for students, and recognition of their significance merits further consideration in both learning theory and pedagogical practice in science education.

Notes

[1]All names of children and teachers used herein are pseudonyms.

[2]The triop is a kind of shrimp, a tadpole shrimp (scientific name *Triop longicaudatus*) that lives in freshwater, ephemeral ponds, ranging from 50°N latitude in western North America through Central America and into South America. In the United States, triops are found in desert habitats. They live in small pools that accumulate after flash floods in the summer. Because these pools are temporary, the tadpole shrimp consequently have short lifespans, completing their life cycles in a mere 20–40 days. However, several companies sell triop eggs that can be hatched for research and educational purposes.

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