The Alchemy of the Mathematics Curriculum: Inscriptions and the Fabrication of the Child

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School subjects are analogous to medieval alchemy. There is a magical change as mathematics, science, and social sciences move from their disciplinary spaces into the classroom. The educational and social psychologies have little or nothing to do with understanding disciplinary practices. They are intellectual inventions for normalizing and governing the child’s conduct, relationships, and communications. The author examines this alchemy in standards-based mathematics educational policy and research for K-12 schools. He argues that (a) the emphasis on “problem solving,” collaboration, and “communities of learning” sanctify science and scientists as possessing authoritative knowledge over increasing realms of human phenomena, thus narrowing the boundaries of possible action and critical thought; and (b) while reforms stress the need for educational equity for “all children,” with “no child left behind,” the pedagogical models divide, demarcate, and exclude particular children from participation.

KEYWORDS: inequality, policy, politics of research, reform standards, school knowledge.

The ways that children are talked about in research and policy literature do not vary significantly across school subjects. This is obvious in the curriculum standards of current school reforms (see Popkewitz & Gustafson, 2002). For instance, the national music curriculum standards are fundamentally about the child’s ability to participate through informed decision making or problem solving, develop skill in communication (defending an argument, working effectively in a group), produce high-quality work (acquiring and using information), and make connections with a community (acting as a responsible citizen). The national mathematics standards deploy a similar terminology, prescribing a path of cognitive development for children whereby
they become autonomous and responsible for their own learning, problem solving, and thinking processes.¹

How might we think about this similarity of language across school subjects? One approach is to think of school subjects as formed through a kind of alchemy. Pedagogy can be thought of as analogous to the medieval metallurgy that sought to transmute base metals into gold. A magical transmutation occurs as academic knowledge is moved into the space of schooling. The governing principles of the alchemy are no longer those of mathematics or science but those of pedagogy. The focus on children’s communication and the selection of curriculum content conform to the organization of the school grade levels, class timetables, and models of children’s development for primary and secondary schooling.

Alchemy is a necessary part of schooling. Pedagogy translates academic knowledge into the world of schooling. Because children are neither mathematicians nor historians, translation tools are needed for instruction.² The alchemy of school subjects, however, is not one thing but many. It is achieved through an assemblage of inscription devices that translate and order school subjects. I use the notion of inscription device to consider the intellectual tools or types of maps produced by educational research. Pedagogical inscription devices order and classify the objects of teaching—the categories that classify the child’s thought process and the “nature” of disciplinary knowledge organized for instruction (for a discussion of inscriptions, see Foucault, 1979; also see Latour, 1986; Rose, 1999). The significance of inscription devices is that they render the thought of a child visible and amenable to governing. The concept of governing used here refers to the visualizing and inscribing of distinctions that classify and order a child’s conduct, action, and participation. “Problem solving” is one inscription device that demarcates, preserves, and makes administrable what are perceived as the salient features of a child’s inner characteristics and capabilities.³

This article focuses on mathematics education as an exemplar of the alchemy that takes place in the school curriculum. It textually analyzes the inscription devices related to constructivist⁴ and social linguistic research traditions that are cited nationally and internationally in efforts for standards-based reforms.⁵ My aim in the first section of the argument is to consider the standards of the standards-based reform (to play on a key term of contemporary school discourse) in its broader historical context of governing, that is, making the child legible and administrable for producing the future citizen. The standards of pedagogy, I argue, are in the ordering, mapping, and governing of the internal qualities and characteristics of the child as future citizen. In the second section I examine the psychologies of pedagogy as central to the alchemy of standards-based mathematics education reform. I argue that the imagination of mathematics is translated into the imagination of a pedagogical psychology. The psychological inscriptions focus on the interior dispositions or the soul of the child, fabricating the problem-solving child as a particular human kind for pedagogical intervention.⁶ It may seem odd to talk about school subjects and the soul in the same sentence because
modern pedagogy does not speak directly about the soul. Instead, it speaks about the governing of the conduct, personality, relationships, and emotions of the child. This modern soul takes shape from the pedagogical psychology that renders the child’s “problem solving” and participation in the social networks of a “learning community” observable and governable.

In the third and fourth sections I consider the pedagogical inscription devices of mathematical knowledge. As part of the alchemy, the psychological inscriptions travel as a crystallization of academic knowledge in which particular signs, symbols, and generalizing and justifying propositions of mathematics are mapped in the curriculum as stable structures. Although not the intent of reforms, the inscription of mathematics content produces an admiration for the majesty of scientific expertise and the conclusions of academic disciplines. This veneration is ironic. The curriculum is intended to increase children’s participation and problem solving, but in a world that is increasingly defined by the iconic expertise of science. Finally, these various inscription devices of pedagogy embody principles that normalize and divide and thus embody practices of social inclusion and exclusion. The mapping of children’s activities, such as problem solving, simultaneously creates a mapping of the individual who does not “fit” or act as a problem solver and is inscribed as the child left behind.

As I argue in the conclusion of this article, to study the standards of standard-based reform policy and research is to problematize the very groundwork of “thought” embodied in the inscription devices of school subjects. From the perspective of educational research, mathematics, like all school subjects, is “not only, an introduction to the next generation of some basic stock of knowledge, but also an introduction to a certain grammar” (Skovsmose, 1994, p. 5) that established boundaries for what can be achieved through intervention and who is qualified to participate. And, as with the social sciences, the educational sciences are “a constitutive aspect of that vast monitoring of social reproduction that is an integral feature of the state” (Giddens, 1990, p. 181; also see Wagner et al., 1991). With this in mind, I consider in the conclusion how the conventions and traditions of pedagogical research work against rendering the academic fields, and their traditions of working and producing knowledge, more accessible to children.

The Standards of Standards: Making Legible and Administrable the Child as Future Citizen

School improvement in various subject areas has centered on curriculum standards (see, e.g., Ravitch, 1995). Debates about standards focus on what should serve as a foundation for curriculum content and which populations are served or hindered by that content (see, e.g., Boaler, 2000). The effects of the standards, however, are not fully described in the publicly stated curriculum goals or the disputes about which groups benefit from the standards. The effects that I am interested in are embodied in the principles that order and make visible children’s thoughts and actions for supervision. These
standards of pedagogy are produced historically as part of the conditions for the governing and self-governing of citizens. By the way of illustration, let me interrogate two seemingly commonsense purposes of educational research to explore this notion of standards.

It is common for educational research to be thought of as finding the correct strategies to replace children's "intuitive" reasoning with new sets of rules for "acting" and "seeing." One mathematics educational research project, for example, posits its purpose as identifying how "connections are formed between new information and existing knowledge structures or when new information leads to cognitive conflict and, therefore, to the reorganization of existing structures in order to resolve that conflict" (Warfield, 2001, p. 137). The words "connections" and "reorganization" in this sentence do not refer merely to playing with what is already present in children's minds. The research formulates and classifies what is and what should be understood as the standards of the child's own abilities to reason. Another research project, at first glance, deals with merely finding more effective procedures for increasing the understanding of mathematical content. "The lesson was not just getting Arthur to rethink his assumptions, but helping everyone to see why those assumptions had led him to the conclusion that 7\(\times\) would end in a 1" (Lampert, 1990, p. 53). The reforms of mathematics education are spoken about as producing particular kinds of students and teachers who have "a different relation to the subject matter than they would have in a conventional pedagogical situation of a 'knowledge telling' exchange" (p. 53).

However, looking more closely at the research narrative, it is clear that these projects are meant to develop understanding not only of mathematical content but also of standards of communication, participation, and social relationships in the classroom. How can we explain the normalizing and administering of the inner qualities of the child? One approach is to consider modern pedagogy as historically related to the art of governing the modern state. Standardizing measures of comparison were and still are important to make possible the free and equal citizen. For example, before the 18th century, it was difficult to govern a state because of variable measurements. Each local area had its own units of measurement (a hand, a foot, a cartload, a basketful, a handful, a within earshot) that resisted any central administration (Scott, 1998, pp. 25–33). Taxes were varied and unsystematic before the production of census standards. People without patronyms could not be tracked. By the end of the 18th century, the practices of governing had changed. Governing entailed seeking the right classification and the correct sorting devices for charting a course of action. Standards produced reliable means of enumerating, locating, and regulating the population of the state, gauging its wealth, and mapping its land, resources, and settlements. The academicians of pre-revolutionary France sought a uniform metric system for making the nation "revenue-rich, militarily potent, and easily administered" (p. 31, italics in original).

But governing meant more than merely mapping the health and territories of the citizenry. The standards that mapped people and resources were
important to democratic government and to the freedom and liberty of the modern citizen. For example, the Encyclopedists, writing immediately before the French Revolution, saw the inconsistency among measurements, institutions, inheritance laws, taxation, and market regulations as the greatest obstacle to making the French a single people with equal rights (Scott, 1998, p. 32). If the citizen lacked equal rights in relation to measurements, it was argued that the citizen would also have unequal rights in law and thus could not enjoy liberty and freedom. The uniform measures were established to transform the people of the nation into citizens of the nation, in the belief that “the uniformity of customs, viewpoints, and principles of action—will, inevitably, lead to a greater community of habits and predispositions” (in the words of the historian Ken Adler, quoted in Scott, p. 32). The metric system was at once a means of administrative centralization, commercial reform, cultural progress, and democratic change to ensure the freedom of the citizen. The language of the mathematics reforms maintains this historical concern with governance through creating standards of comparison with regard to who the child is and should be. That function of the reforms is further discussed later in this article.

This governing of freedom is one of the ironies of the modern republic, liberal democracy, and pedagogy. “Citizens are not born; they are made” (Cruikshank, 1999, p. 3). Democratic participation was “something that had to be solicited, encouraged, guided, and directed” (p. 97). Modern governing thus linked two seeming opposites: the freedom and will of the individual and the political liberty and will of the nation. And social science has played a practical role in this liberal government by developing the technologies of citizenship and participation.

This context of governing involved a relation between the formation of the modern nation and the modern school in the 19th century. The self-governance of modern pedagogy replaced the older Puritan notions of instruction. Whereas the Puritan “converting ordinances” related to evangelizing works that would bring about one’s salvation, the modern school subjects were designed to save the soul through the works of science. School has connected the scope and aspirations of public powers with the personal and subjective capacities of individuals.

Modern school subjects had little to do with the cultural practices of knowledge production in academic fields (Popkewitz, 1987, 2000; Goodson, 1985; also see Depaepe, 2000). The secular concern was for the moral and physical well-being of children, who embodied the will of the nation and its images of progress. The teaching of modern English literature in the British mass schooling of the 19th century, for example, emerged through two different historical movements that did not evolve from prior “cultivating” aspects of writing or reading (Hunter, 1988). First, there was the public concern for the administration of social problems as mass schooling was opened up to the “inarticulate and illiterate” of the working classes. Second, the subject of English related to the governmental provisions for social welfare. The narrative structures and ethical messages of literary texts were seen as helping
the reader to become a moral agent. The lessons in moral conduct were to be accomplished by making the stories relevant to the everyday experiences of working-class children. Mathematics education went through a similar transformation; it was now expected to help children to become ethical and self-directed individuals (Stanic, 1987).

In line with this moral function of pedagogy was the use of psychology to replace the salvational converting ordinances of the Puritans: trials to test the faith of prospective or delinquent members of the community. The Puritan notions of the administration of the soul for divine grace were replaced in modern pedagogy with practices constituting self-will organized through the rationality of science. The sciences of the mind targeted the soul, the interior being of the child. Pedagogy was to reconfigure the rules and standards of action and participation.

It is relatively easy to recognize that the various psychologies of instruction were historically concerned with a normalizing pedagogy and were not intellectual practices to understand the fields of practices in science, history, or mathematics. The psychological inscription devices focused on the interior of the child, the rules and standards of “reason” that enabled human progress and individual self-betterment. For example, Dewey’s “method of science” sought to identify universal principles of how children should think in a world of uncertainty. Such universal principles were joined with a Congregational New Theology and epistemology to govern the moral being and self-development of the child (see, e.g., Kuklick, 1985). Vygotsky’s psychology, a mainspring of current curriculum reforms, was intended to bring the social ideals of Marxism into the organization of the psyche for managing everyday life (Popkewitz, 1998b). G. Stanley Hall’s notion of adolescence combined romantic visions, Christian ethics, social biology, and science into principles to order children’s growth and development (Baker, 2001). Edward Thorndike’s psychology was influenced by the administrative needs of the school as well as by the need to produce the moral health, happiness, and prosperity of the child and future citizen.

Today’s “converting ordinances” of pedagogy are talked about differently than in the past. The governing of the child is told as a modern salvation story that prepares the child for an uncertain future that has different qualities from the future that Dewey or Hall envisioned. In a statement resonating across school subjects, the National Council of Teachers of Mathematics (NCTM, 2000) argues that change is “a ubiquitous feature of contemporary life, so learning with understanding is essential to enable students to use what they learn to solve the new kinds of problems they will inevitably face in the future” (pp. 20–21).

This telling of a salvation story by the NCTM is not new to schooling. Modern schooling has continually linked the individual to narratives of social or economic progress and the revitalization of democracy and personal betterment (see, e.g., Meyer, Boli, Thomas, & Ramirez, 1997). The governing principles of these salvation stories are intended not merely to save the soul but also to join two registers of modernity: social administration and free-
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dom. As Wagner (1994) argues, “The history of modernity cannot simply be written in terms of increasing autonomy and democracy, but must be written rather in terms of changing notions of the substantive foundations of a self-realization and of shifting emphases between individualized enablements and public/collective capabilities” (p. xiv). Wagner’s argument of the relation between individual enablement and public/collective capabilities is directly applicable to the psychological inscriptions invoked in the pedagogy of school subjects and thus requires that one attend to the alchemy to make visible this relation.

The Psychological Tools of Pedagogy: Inscribing and Normalizing

The notion of alchemy in contemporary reform appears oxymoronic. Current mathematics education research and standards, for example, are concerned with children’s learning the cultural values and ways of knowing of the discursive community of mathematics. Yet, in practice, the standards serve a different function. In the four subsections that follow, I explore an assemblage of practices that produce the objects of teaching. First, I examine the translation of mathematics into the imagination of a pedagogical psychology. Second, I explore five elements of the inscriptions that overlap to constitute the alchemy: (a) the re-imagining of mathematics in pedagogy; (b) psychology as the pedagogical “eye”; (c) problem solving as an ordering device to classify and govern the child; (d) fabricating the problem-solving child as a human kind for pedagogical interventions; and (e) research on classroom “communities” and communication processes that relate individual self-realization with public or collective capacities. In the third and fourth sections I discuss two other elements of the alchemy, the inscriptions that stabilize mathematical knowledge and the distinctions that produce principles of social inclusion and exclusion.

Re-Imagining Mathematics in a Discourse of Pedagogy

Teaching reforms are characterized as bringing instructional norms into closer proximity with those found in the academic discipline of mathematics. This view comes out of the belief that the outcomes of mathematics are bound to the norms and culture of its processes of discovery. For example, mathematics education is thought of as a process of doing rather than one of learning about static entities. “Knowing” mathematics, according to the NCTM’s Curriculum and Evaluation Standards for School Mathematics (1989), is “doing” mathematics (p. 7). This focus on process and doing marks a distinction between the processes of discovery and the reconstructed logic of mathematics. The reconstructed logic emphasizes the formal, deductive procedure of justification that occurs as an end product of inquiry. It systematizes conclusions so that others can test the results, such as methodological discussions of empirical research found in journals. However, reformed mathematics education strives to focus on the processes of discovery in mathematics, not its reconstructed logic. In this view, to be educated in mathematics is to think of
it as “a community of knowers who share in the construction of beliefs or knowledge” and whose knowledge “is created through discursive processes and negotiation of meaning carried out in accord with the norms of the group” (Nelson, Warfield, & Wood, 2001, p. 6).

The following section discusses the overlapping practices through which mathematics is translated into mathematics education. First, I examine the manner in which an interest in thinking about “the community of mathematics” in the curriculum is transmogrified into a pedagogical “eye” that focuses on the moral qualities of the child. I then explore and analyze three inscription devices: (a) the classifying of the mind through the ordering of a child’s problem solving; (b) the making or fabricating of a particular type of problem-solving child or human kind; and (c) the inscription of “the community of learners” that overlaps with that of the problem-solving child to produce particular standards and rules for social interaction and communication.

Psychology As the Pedagogical “Eye”

One expression of this active, constructed quality of learning is embodied in the phrase “discourse community.” Children are to be treated as if they were mathematicians. The student is to “stand back from his or her own personal knowledge to evaluate its antecedent assumptions, argue about the foundations of its legitimacy and to be willing to have others do the same” (Lampert, 1990, p. 32).

This “doing” of mathematics is not only about cognitive learning but also about one’s moral being and involvement in the world. Lampert (1990), for example, calls for moral courage in learning mathematics for a child to express a tentativeness and an attentiveness to its nonlinear qualities. Mathematics education should “strive for the use of intuition and the practices of conscious guessing, the taking of risk, and a problem solving that zig-zags in which refutations and proofs are accomplished” (pp. 30–31). Nelson, Warfield, and Wood (2001) reach a related conclusion: The classroom is to provide the same communal norms and practices as the academic field. “From the field of mathematics come ideas about the nature of the discipline itself,” they write. “Mathematics is not taken to be only a static, bounded discipline with a rich record of knowledge to be transmitted, but a humanistic field that is continually growing and being revised” and that consists of “‘ideas created by human beings, existing in their collective consciousness’” (R. Hersch, mathematician, quoted in Nelson et al., p. 6).

But as the discourses of mathematics education are examined more closely, it is not mathematics that is the site of intervention. It is the governing of the child as a moral agent. The homage paid to the “doing” of mathematics is quickly transmogrified into sociopsychological conceptions of child development. The study of mathematics education, if I return to the NCTM standards (1989), is about the psychological ordering of the mind, assessing “what students know and need to learn,” and having students
actively building new knowledge from their experience and prior knowledge," and using "knowledge flexibly, applying what is learned to one's setting appropriately in another" (pp. 11, 18, 20). For example, the introduction to a special issue on studies of mathematics education in a leading mathematics education research journal begins with an analogy to mathematics as highly differentiated "with countless currents, separating and merging" with "the proliferating paradigms" (Editors, 2002, p. 251). But the analogy is not to think about a pedagogy concerned with "the proliferating paradigms." The analogy has other purposes. It is to suggest that the mathematics educators need "a grand unification" theory that brings together the many pedagogical psychologies.

Like a fish swimming in water, the psychological rule over pedagogy is so much part of the mentality of education that one does not question the medium of pedagogical translation, but only which terms are more effective or how to unify them. The lenses for "seeing" and "thinking" mathematics in schooling are now treated as if they were, in fact, what mathematics is.

But there are consequences to the framing of the rules and assumptions in mathematics education. These can be likened to the Heidelberg School of landscape painting in Australia. It was produced by German and French painters trained in European romantic traditions that migrated to Australia in the middle of the 19th century. The painters sat in their studios in a suburb of Melbourne to paint the landscapes of Australia. They brought European images into the construction of the Australian nation. The painters' pastoral images of Australia mimicked the lush greens of northern continental Europe. The painters' "eyes" were so well trained that they seemed not to notice that the verdant greens of northern Europe had little place in the muted hues of the warmer climate of Australia.

A similar naturalizing process affects the construction of school subjects. The pedagogical "eye" is so naturalized that psychological inscriptions are assumed as having their rightful place in the translation and transportation of academic fields into school subjects.

Governing the Soul: Problem Solving As Ordering the Interior of the Mind

Pedagogy as "converting ordinances" to remake the soul travels on the surface of policy and research rather than as a hidden agenda. The federal policy explicated in the policy document No Child Left Behind (Bush, 2001) for example, expresses such a concern for the soul as it tells a story of improving the quality of American schooling to make for a more inclusive society. But the direction of that improvement is through the remodeling of the child's soul or inner being and dispositions. In the foreword to the statement about the administrations' education policy, school reform is "to build the mind and character of every child, from every background" (Bush, 2000, n.p.). If we turn to the reforms of mathematics education, the image of the soul is also evoked. The statement of professional principles and standards of mathematics asserts that teaching is the "shaping" of dispositions and the
monitoring of children’s "capacities" and "inclination" for learning: "Effective teachers recognize that the decisions [teachers] make shape students' mathematical dispositions and can create a rich setting for learning" (NCTM, 2000, p. 18, italics mine). The teacher is to "monitor students' capacity and inclination to analyze situations, frame and solve problems, and make sense" (p. 19, italics mine). The modern soul as the site of intervention is also expressed in research. Effective instruction is to have children "want to" as well as "be able to" (Brousseau, 1997, p. 12).

The soul is fashioned and shaped through the psychological maps of the child's problem solving. Current research focuses on "sites of practice" (National Research Council, 2002, p. 95). This phrase refers to the describing and classifying of children's utterances during a lesson, or to the researchers' narration of their own teaching as a method of introspection about what constitutes "good" teaching and learning. In one genre of research, a researcher describes her teaching to identify the process whereby "teachers and students form communities of discourse that come to agree on working definitions of what counts as knowledge and the processes whereby knowledge is assumed to be acquired" (Lampert, 1990, p. 34). Another research report catalogues children's responses in mathematics lessons to establish a system to classify, calculate, and eventually assess performance. The tasks of multi-digit division, for example, are described and ordered as "guess and check," "take numbers apart," "counting back," "adding groups," "division forms," and "division by subtraction" (Warfield, 2001, p. 141-142). A different modeling of children's problem solving is research that classifies children's thought processes in a sequence that requires the child to "know," "think," "revise," and "explain" (Lambert, p. 34, italics in original).

Whatever the merits of the different approaches to classroom observation and cataloging, they are never merely descriptive of some natural reasoning of the child, idiosyncratic to a particular classroom, or descriptions of good teaching practices. The procedures of data collection and interpretation embody particular sets of rules related to intellectual traditions for ordering and generalizing school practices. These intellectual traditions are themselves culturally bound and historically situated. There is no structuring or coding of experience without prior mediating structures of thought (see, e.g., Fendler, 1999; Britzman, 1991).

Equally important in considering the alchemy, the techniques for visualizing and inscribing the characteristics of "thought" produce a practical universe of objects and relationships to which things can be done. The pedagogical focus on the communication patterns of the mathematics classrooms are avenues of such remodeling of moral character, with social-linguistic and constructivist research inscriptions to assemble the cognitive and moral comportment of the individual. In a widely cited text, it is asserted that instruction is "regulating the interaction among children rather than just regulating the individual action" (Cazden, 1986, p. 450, italics mine).

The principles of ordering problem solving appear as the objective, impartial management of the capabilities of people who are to become autonomous
learners in the classroom. But this remodeling practice of teaching of children's thought is not impartial management; in a manner similar to the historical invention of standard measurement or the Puritan practice of trials of belonging, the remodeling of thought has a particular historical configuration. In part, it devolves from the church's pastoral, confessional power to scientific strategies of governing the moral development and liberation of the individual (Foucault, 1983; in relation to education, see Kirk, 1998; Lesko, 2001). In a crucial sense, the attention given to the classifications of thought and communication are to remodel the dispositions, sensitivities, and desires of the child.

**Fabricating Human Kinds: The Problem-Solving Child**

Pedagogical research is not descriptive of classroom practices, nor is it about mathematics per se. The pedagogical alchemy is a normalizing practice. Its psychologies are the mapping tools that prescribe parameters that student communication and teaching are to follow. Problem solving is one inscription device that maps inner characteristics of the child to be acted upon. In this section, I introduce two further concepts to consider how that inscription of problem-solving functions in the alchemy.

One concept is that of human kinds (see Hacking, 1995). I speak of human kinds throughout this section and the following ones, where I consider how the intellectual tools of pedagogy produce certain types of individualities for pedagogical action. I discuss one human kind here, the child as a problem solver, and another later, the disadvantaged child. I call them human kinds because they are not merely terms but embody particular types of individualities or determinate classifications that have distinct chronological, physiological, and psychological characteristics administered by the school.

The second concept is that of fabrication. I use the word in considering a double quality of research. Fabrication directs attention to how linguistic categories and distinctions of educational research are both fictions and creators of "things." As linguists say, language functions simultaneously to-construe and to construct. G. Stanley Hall, for example, used the notion of adolescence to respond to perceived events in the world of childhood. It was a fiction to study and calculate—that is, to make suitable, fit, or adaptable for the purpose of administering—a particular human kind. The fiction of adolescence provided a way to think about and act on the child as having stages of development and growth. Neither "adolescence" nor "problem solvers," the subject of this section, are objects that you can touch but are ways of thinking, "seeing," and feeling about "the things" of the world that were (and are) deemed important.

But such fictions are not merely about thinking. The fabrications of research make possible new techniques for structuring reality as new phenomena and effects are imagined. One consequence is the production of kinds of people who are in need of salvation or rescue, with teachers and other education specialists characterized as informed rescuers. Books are written and programs offered for parents and teachers to ensure adolescents' psychological health—and to aid in the cognitive development of children.
to turn them into problem solvers. And as the new expertise fills "needs," it simultaneously produces those needs by comparing one child to another or to a norm.

The double meaning of fabrication—as a fiction and a maker of "things"—is a quality of social science. That is, social science, in general, plays a kind of double role as a maker of fictions and a maker of things (see, e.g., Hacking, 2002). Educational research and pedagogy are fields whose categories and distinctions produce fabrications of human kinds. What is significant for educational research, then, is not the existence of human kinds, but a reflexivity about the particular fabrications produced in the name of school subjects.

In this way the child as "problem solver" can be understood as a fabrication. The term is a fictional category invented to aid thought about matters of schooling deemed important for teaching and learning. The NCTM's Principles and Standards of School Mathematics (2000), for example, suggests that an important goal of instruction is children's problem solving. Problem solving is stated as a strategy for learning to deal with the uncertainty of the future—"[the] ubiquitous feature of contemporary life" discussed earlier—and learning how to meet the obligations of the individual in a democracy.

This concern with problem-solving abilities to face the "ubiquitous" uncertainty of the future and to promote democracy has only tangential relations, if any, to the cultural norms of the mathematical community. The reference to the uncertainty of the future embodies political and social values of participation and individual autonomy in a liberal democracy. Such norms may be part of the external political norms of the nation that surround the mathematical field in the United States, but they are not necessarily an appropriate description of the intellectual culture and network of relations that form that academic discipline.

The fiction of the "problem solver" functions like other examples of fabrication, creating a human kind. There are programs to help children at various ages to master problem-solving skills, remediation curriculums for children having trouble, assessment procedures, and research projects that make finer distinctions in describing children's abilities. Profiles of the "problem-solving" child and strategies to help children who are not able to perform properly are invented. In one observation of a teacher, for example, the researcher asserted that the classroom interaction between a teacher and her students was considered successful because the teacher's "mathematical understanding contributed to her being able to learn about her children's thinking in ways that extended beyond the strategies they used to solve this problem" (Warfield, 2001, p. 143).

What is the particular human type fabricated as the problem solver? The narrative of the National Standards of Teachers of Mathematics (2000) places the learning of mathematics in a political context in which a child is ethically obligated to work continually toward self-improvement and self-motivation: "A major goal of school mathematics programs is to create autonomous learners" (p. 21). As suggested earlier, this human kind that manifests continuous self-improvement and autonomy has little to do with the logic of mathematics
knowledge, or with the learning of the individual outside some system of cultural and collective values. The autonomy assigned to the problem solver is possible only within social and cultural narratives that make that kind of individuality possible. Sutherland and Balacheff (1999) address this issue when they argue that school and mathematics education, in particular, are the “'modern’ social answer to the need to enable children to become citizens—that is, members of a society who have access to . . . a shared culture and who are empowered with intellectual and emotional tools to face problems within the workplace and everyday life” (p. 2).

The vague and general notions of society and individual autonomy serve as banalities, accepted as truths that have no known origin and do not need to be questioned. But the narratives of autonomy do embody particular political rationalities. Ball’s (2001) narrative about her own teaching as a research “site of practice” illustrates these political images and narratives of a human kind. The teaching is narrated as children’s using their everyday life and interests in learning how to problem solve. Learning mathematics is also “to create a practice that is responsive to students’ ideas, interests, and lives. I strive to hear my students, to work with them as they investigate and interpret their worlds. I want to respect who they are, as well as who they can become” (p. 13). To instruct properly is to

hear below the surface features of children’s talk and representations . . . so [teachers] will not miss the mark by considering a student wrong who has in fact an interesting idea or is carrying out a non-standard procedure, but one with mathematical promise. Suspending one’s desire for students to get answers right and thinking mathematically about what a child might mean are among the most difficult problems of teaching. (p. 19, italics mine)

The research can be interpreted as creating a more participatory approach in teaching. It carries a progressive language of “a classroom in which differences are valued, in which students learn to care about and respect one another, and in which commitments to a just and democratic society are embodied and learned” (Ball, 2001, p. 13). In a similar vein, Nelson et al. (2001) argue that teaching entails the “vision of mathematics instruction that [takes] seriously the fact that children construct their mathematical knowledge” (pp. 6–7). The researchers continue that “the work of teaching would consist of developing instructional contexts in which students could move from their own, intuitive, mathematical understandings to those of conventional mathematics” (pp. 6–7).

But the narration about teaching, even at this level, is not about mathematics. Its rules of conduct relate to particular contemporary liberal democratic norms of participation and action. As articulated in the earlier discussion of standards, the principles that are operant in Ball’s description of teaching link the “freedom and will of the individual” with collective norms about the “political liberty and will of the nation” (Cruikshank, 1999). The suspension
of the teacher's "desire" for the child's right answer as discussed by Ball (quoted above) has a double quality. It involves being responsive and relevant to "students' ideas, interests, and lives" (Ball, 2001, p. 13), but it is also a pastoral strategy, discussed earlier as a confessional practice of psychology, as it opens up to scrutiny and makes administrable the inner thoughts and characteristics of the child.

Community and Classroom Communications in the Struggle for the Soul

The fabrication of a human kind brings two different inscriptions together. One is that of the problem-solving child. The other is related to "community," an intellectual tool that relates the psychological categories to social discourses. The problem-solver is expected to learn thinking skills by participating in a classroom community—"community of discourse," "community of learners," "community of mathematicians." Earlier 20th-century notions of the classroom spoke about a place of socialization in which the child was to internalize universal, collective norms of identity that are preestablished. Today's reforms involve the continual forming of identity mediated through the communication systems of the classroom community (see, e.g., Steffe & Kieren, 1994, 1995; Cobb et al., 1991; Cobb, Yackel, & Wood; 1992; Cobb, 1994). The classroom community is thought of as a "participation structure" in which communication theories are concerned with the ongoing processes that create identity.

As discussed earlier, the classroom is rhetorically associated with the mathematics community. The "community of discourse" is said to make possible the networks of participation in which children are actively engaged in the tasks of learning that are thought to be models of the field of mathematics. The NCTM (2000) calls reformed teaching "building a mathematical community of learners" (p. 145). Lampert (1990) speaks of the classroom as a "discourse community." Community is a place where truth is reached by children "figuring out what is true, once the members of the discourse community agree on their definitions and assumptions" (p. 42, italics mine). That truth is redefined in the structure of mathematics knowledge. Students "put themselves in relation to the establishment of valid arguments in the discipline" as their answers are located as "mathematically legitimate" (p. 54). The "participation structure" of the classroom is where children's "interactions are parallel to the standards of arguments in mathematics' communities" (p. 35).

As one group of mathematics researchers suggests, "Classrooms are mathematical communities writ small and key reform documents envision the classroom as a mathematical culture governed by roughly the same norms of argument and evidence as govern discourse within communities of scholars in the disciplines themselves" (Nelson et al., 2001, pp. 6–7).

The classroom community is a social space of moral relations in which individuals have obligations and allegiances. Community of learners, discourse community, and community of knowers are phrases that direct attention to the development of "shared norms" based on an "equilibrium" and "consensus" about knowledge (Cobb et al., 1992; Cobb, 1994). Community
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is collaboration that produces stability and harmony in meanings and understandings. “Collaborative learning” is used to “arrive at a taken-as-shared interpretation of the problem” (Simon, 1995, p.120).

As with problem solving, community is an inscription device that places the individual in particular cultural spaces (see, e.g., Cronon, 1996; Rose, 1996). The evocation of community is intended to revive the ideals of a democracy by producing greater representation of those directly involved in schooling. Community embodies a salvation theme about involvement and empowerment, in which problem solving produces the responsible citizenship of the child. But the notion of “community” in pedagogy is also a governing practice. The notion of community overlaps with the inscriptions of the child as a problem solver. It is a pattern of “converting ordinances”—maps of cultural interaction—that regulate the problem solving of children as individuals continuously involved in self-improvement, autonomy, and responsible life conduct.

The civic ideal of community is related to the sublime, where beauty and awe of God’s creations of nature are found through face-to-face relation. John Dewey, who worked with the Chicago reformers and social scientists at the beginning of the 20th century, deployed the notion of community. His notion of community reworked religious themes with political images of an American identity. Dewey’s notion of community and method of problem solving were to provide the rules and standards of “thought” through which the individual could deal with the contingencies of daily life and the participatory institutions of a liberal democracy. That Dewey’s insights have been important and influential cannot be denied, but by thinking historically about these insights within the alchemical frame one can appreciate how pedagogy and curriculum are selectively formed—and how the specifics of the measures recommended in our research have been guided by unexamined assumptions of similar vintage. The child is one thing with Dewey and Hall, another in the reform mathematics of contemporary pedagogy (Popkewitz, 1998b).

Pedagogical Inscriptions, School Subjects, and the Iconic Images of the Expert

One might counter my argument about the inscriptions of the alchemy by saying: “Call it what you may—a normalizing pedagogy or governing of the soul—but the alchemy is necessary and psychology is important to pedagogy. Curriculum is about producing children who are productive, moral, and ethical citizens.” Such a reading of curriculum ignores the normalizing and governing practices that have little to do with cultural practices or a “discursive community” of mathematics. This section explores the inscription devices that classify what counts as mathematical knowledge in the curriculum. The content of mathematics, I argue, is viewed as consisting of stable structures of conventional ideas that function to elide the social and cultural mooring of mathematical knowledge. One consequence is that the problem solving, increased classroom participation, and talk of “empowerment” in the
curriculum may reduce rather than open the range of phenomena for scrutiny, action, and critical thought. The following and last section considers principles of social inclusion and exclusion in the alchemy.

The Subject "Content": Crystallizing Mathematics by Assembling Boundaries of the World of Problem-Solving

The problem solving of the curriculum is organized around "the conventional ideas" of mathematics. The notion of conventional ideas is one that assumes that mathematics has a "nature" and logical "structure" that children are to be taught (see, e.g., Simon, 1995, p. 20; also see Cobb et al., 1991). "Conventional ideas," "nature," and "structure" refer to a belief in an essential, deep, and underlying universal core knowledge of mathematics that a curriculum selects for instruction. This assumption of structure appears in the statement, for example, that teaching mathematics is "the development and justification of use of mathematical generalizations" (Russell, 1999). The statement presupposes a fixed and stable logical structure of knowledge that is the object of children's learning.

The language of curriculum is revealing as it relates to the inscription of conventional ideas, a notion of a structure. School subjects are classified as "bodies of knowledge"—systems of concepts, proofs, generalizations, and procedures—that children must learn. The linguistic quality of the words of the curriculum—"bodies," "content," "content coverage," "conceptual knowledge"—treats disciplines as inert; unchanging, and unambiguous "things" (concepts or proofs) that children learn. Principles and Standards of School Mathematics (NCTM, 2000), for example, assumes that mathematics consists of logical and analytic structures. In accordance with the standards, students are expected to

identify the characteristics of various quadrilaterals in grades 3–5. In grades 6–8 they may examine and make generalizations about properties of particular quadrilaterals. In grade 9–12 they may develop logical arguments to justify conjectures about particular polygons. (p. 16)

With the structure of knowledge identified, flexibility in learning is to reduce the conflict and tension between children's meanings and the given content. Children's construction of knowledge involves finding multiple ways of making apparent the presupposed logical and analytical foundations of mathematical properties. School mathematics, for example, is "to distinguish between the meanings that students give to representational systems in terms of their current ways of knowing and the mathematical structure that the system embodies for adults who know mathematics" (Cobb et al., 1991, p. 5, italics mine; also see Simon, 1995).

The selection of conventional mathematical ideas (its language and symbols) inserts an a priori structure that is learned through a teacher's "discussion and negotiation of meaning with students to add to the tools they are
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able to use to enhance their thinking" (Lampert, 1990, p. 47). In classroom dialogue students are to internalize and make their own the logical standards of conventional mathematical ideas:

The ideas that governed classroom interaction came to parallel the standards for argument in the mathematical community more closely, as truth came to be determined by logical argument among scholars. (Lampert, p. 35)

But there is a double quality to the pedagogical operations, because the solution to the mathematical proposition posed to students is already known. Students are to enact a semblance of a mathematical argument that models a mathematical community (or one might say, the image of a fictive mathematical community). The teacher must observe the interactions of students as related to the norms of forming a logical argument. Yet the classroom focus on students' learning the rules of argument is not only a process of modeling of truth. It is also a process of normalizing the inner characteristics of the students through modeling of the social as a means of constructing knowledge.

The attention to the "structure" and "nature" of mathematics seems ironic in current reforms that speak about the social construction of knowledge.

The irony of this pedagogical practice is that the "uncertain" and "ubiquitous future" that the mathematical standards refer to is in fact not so uncertain or ubiquitous after all. The "ubiquitous future" is fixed and ordered by the truth-telling practices embodied in the "nature" and structure of conventional mathematics. Problem solving gives an illusion of flexibility, while the notions of nature and structure stabilize and regulate the uncertain future. At the same time, the inscriptions of the problem solver redefine the parameters of human agency, and what is open for scrutiny is circumscribed by the expertise that stabilizes and harmonizes the world of participation—issues that I now discuss.

The Eliding of Mathematics As a Field of Cultural Practices

The attention given to the logical "structures" and the "nature" of conventional mathematical ideas elides mathematics as a field of cultural practices. Mathematics, like other school subjects, involves an amalgamation of institutions, authority relations, analogies, memories, and images that come together at different times and places to order and classify the objects of reflection and action. To borrow from Bakhtin’s discussion of literature, the dynamics and possibilities of the knowledge of mathematics are “permeated with concrete judgments, they knit together specific objects and with belief systems of certain genres of expression and points of view particular to particular professions” (1981, p. 289). Mathematics, in Bakhtin’s sense, can be considered as a field of competing intellectual traditions whose relations form that academic field. As a particular system of generalizations and procedures of inquiry are crystallized
in the curriculum, the conditions of participation, norms of inquiry, and rules and standards of recognition and truth that form the field of mathematics are omitted. The NCTM's principles and standards, for example, refer to “mathematical sciences” in determining what is to be treated as core knowledge. This designation may refer to the distinction between applied and applicable mathematics as opposed to mathematics “for its own sake,” although it is not clear in either the 1989 or 2000 documents. But this designation of “scientific mathematics” as the field of mathematics obscures the variety of traditions and networks of associations through which knowledge is produced in the field of mathematics. Thus the field of mathematics is reduced to a particular crystallization of a subfield as the conventional ideas are selected.

At this time, it is possible to ask, What is lost when conventional ideas from a subfield of an academic discipline are inscribed as the organizing principles of pedagogy, such as those derived from “scientific mathematics”? Hacking's (2002) discussion of science and mathematics offers some partial answers to this question. Hacking argues that mathematics embodies differing ways of thinking about and creating new objects. Each style of reasoning in mathematics, Hacking continues, opens up different objects for scrutiny and provides classificatory schemes by which lives are experienced, truths authenticated, and futures chosen. Hacking compares algorithmic and combinatorial styles of reasoning with spatial styles of reasoning in mathematics (p. 2). The different reasoning styles are “self-authenticating.” That is, each style “introduces its own criteria of proof and demonstration, and ... it determines the truth conditions appropriate to the domains to which it can be applied” (p. 4). Thinking of mathematics in this way directs attention to its practices as being more than “a group of techniques for bringing new kinds of facts to our awareness” (p. 4).

Hacking directs attention to the field of cultural practices in disciplines that produce ways of finding out the truths that work in an immense world of institutions, authority relations, “connotations, stories, analogies, memories, [and] fantasies” (2002, p. 9). The various styles of reasoning introduce different registers of debates about the ontological status of the objects “seen” as true. Approaching science and mathematics as fields of cultural practices that construct their objects and truth statements, he argues, is a way out of the controversies that divide philosophy and education into realist and antirealist camps. It is a way to overcome the unproductive separation of epistemology and ontology and the division between subjectivist and objectivist worldviews.

It is also possible to ask about the different practices that constitute the alchemy of school subjects: What do we make possible and impossible to think about mathematics when the selection of “conventional ideas” is brought into relation with educational psychologies and social psychologies to govern students and teachers? To juxtapose current models, it is possible to think of mathematics as consisting of particular ways of reasoning about the objects available for reflection and about the possibilities for how lives are experienced and agency effected. From one vantage point, one can think of
“doing” mathematics as making the familiar strange, examining the mysterious and unfamiliar, and questioning precisely that which is taken for granted and “conventional.”

This way of approaching mathematics is lost from the different vantage point of standards-based reforms. The reductions and crystallizations of conventional ideas produce a particular iconic image of expertise. This view can be explored through McEneaney’s (2003) study of science textbooks in which similar pedagogical inscriptions are used. McEneaney found a dramatic pedagogical change in the narratives and images of science in classroom textbooks over recent decades. Curriculum has been rewritten to produce greater student involvement and participation, personal relevance, and emotional accessibility. But the changes in student participation have also inserted an iconic image of the scientific “expert.” Scientific expertise entails wider claims of control, mastery, and authority over the classification and interpretation of the natural world. The students’ participation and problem solving are exercises that enable them to learn the majesty of the procedures, the styles of argument, and the symbolic system that confirms the truthfulness of the experts. The conclusions of academic expertise are treated as being located outside the bounds of children’s questioning and problem solving. Their questioning and problem solving serve as mere procedures through which to ascertain the given reality.

This assertion of expertise is embodied in mathematics education. Mathematical formulas are consecrated as models of truth for decision making in daily life. Although conceptions of “participatory structures” and a “community of learners” emphasize children’s involvement, that involvement directs the children’s attention to propositions that have already been confirmed in the a priori world of schooling and mathematics education research. Mathematics is a tool to test and confirm a given empirical world. The NCTM’s (2000) principles and standards, for example, assert that curriculum should “offer experiences that allow students to see that mathematics has powerful uses in modeling and predicting real-world phenomena” (pp. 15–16). The French theory of didactical situations, which considers itself a variant of constructivist pedagogy, reasserts the idea that mathematics education should illuminate an a priori nature to society. Mathematics functions in the curriculum as a highly formalized body of knowledge whose ontological status serves as a model for testing reality that is separate from questions of epistemology (see, e.g., Brousseau, 1997).

These assertions about children using mathematics to “model” and “predict real-world phenomena” are thought of as embodying the obligation of educating the citizen in a democracy. Mathematical knowledge, it is asserted, empowers the child in a world increasingly defined through science and mathematics. But there is a paradox in this empowerment. The inscription of mathematical content makes visible the increasingly given qualities of the world (physical, social, and personal). The child is an agent who uses the formulas and proper applications of the modeling techniques of mathematics to test and attest the given-ness of the external world. Problem solving
becomes a strategy to make apparent the expertise of science as the arbiter of truth and falsehood. "When a student is in charge of revising his or her own thinking, and expected to do so publicly, the authority for determining what is valid knowledge is shifted from the teacher to the student and the community in which the revision is asserted" (Lampert, 1990, p. 52). Problem solving is an "efficient strategy" (p. 49) for accessing and confirming the external world.

In this alchemy, children as future citizens become both more and less active participants. They are more active in the sense of the modeling of particular arguments and questionings of conventional mathematics, but less active in defining the terms and extending the possibilities and boundaries of their engagement. The alchemy makes the child a tourist and/or a consumer in the world of mathematical propositions that seem to beckon as so many enticing paths but in the end lead to a single destination. On the one hand, participation, problem solving, and collaboration give children flexibility in learning how to appreciate the majesty of that already-given reality. On the other hand, and equally important, the pedagogy fixes the cultural relations ("community") in which the Platonic images of mathematics are sought and disowns the fragility or conditionality of the world by assembling a particularly programmed agency for the child in its stead. Where uncertainty is to lead to exploration, there is certainty of outcome. Mathematical reason is a regulated enactment of the competency of the future citizen.

Pedagogical Inscriptions As Practices of Inclusion and Exclusion: Normalizing and Dividing the Child

The alchemy, I have argued, is formed through an assemblage of inscription devices. Among the inscription devices discussed are the fabrication of a child as a problem solver and as a member of a community. This process joins the psychological categories with social categories concerning communication patterns and classroom interactions. But the selection of a mathematical "content" plays a part in the alchemy as it overlaps with the psychological inscriptions. Mathematics is stabilized through the concern with "conventional ideas" and a logical structure of mathematical knowledge. Although the aims of problem solving and belonging to a community are described as student "empowerment," the alchemy inserts the expertise of science as a secure model for telling the truth of a given reality while obscuring the social mooring of the academic field. In this section I focus on another intellectual tool of the alchemy, the production of standards of social inclusion and exclusion.

The problem of social inclusion and exclusion is framed by a language of equity in the educational reforms. The reforms and standards are thought of as redressing the lack of academic success among particular groups or populations in society. The commitment to equity is expressed through the continual reiteration of the phrase all children—all children will learn, the program is for all students, the imperative is to provide all children with high-quality programs, and so on. "All students, regardless of their personal
characteristics, background, or physical challenges, must have opportunities to study—and support to learn—mathematics" (NCTM, 2000, p. 12). The reiteration of “all” stresses the inclusiveness of teaching for “improving the academic performance of disadvantaged children” (Bush, 2001, p. 2). Class, race, gender, and disability, among other social factors, are no longer to matter in achieving school success.

Although the reform is intended to right social wrongs and provide a more just school and society, the inscriptions of the alchemy have different effects. The reference to all children in the reports represents both more and less than a simple principle of equity. The phrase “all children” not only reiterates a political and social principle but also functions as a pivoting point to distinguish two human kinds in the standards and research—the child who has all of the capacities to learn, problem solve, and achieve in schooling, and the child who is of a different human kind, the disadvantaged. The phrase “all children” inscribes a set of distinctions around images and narratives that relate to the earlier discussion of the problem-solving child as a human kind. The standards-based reforms, I argued, fabricate a human kind whose problem solving involves being autonomous, dealing flexibly with change, and remodeling oneself through the social norms of collaboration, through patterns of communication, and through a network of relations that use mathematics to test a presumed reality. The human kind of the problem-solving child is differentiated and set apart from the inner characteristics and personhood of students who are not up to the standards for action and participation. Let me explore this further through the reform discourses.

The reform documents and research quickly move from the characteristics and standards of the child who learns to a discussion of “some children” whose capabilities leave them behind. The NCTM (2000), for example, categorizes the child who is not problem solving as one who psychologically has “low expectations.” The psychological quality of “low expectations” relates to other social characteristics that form a distinct human kind. The children are those “who live in poverty, students who are not native speakers of English, students with disabilities, females, and many nonwhite students [who] have traditionally been far more likely than their counterparts in other demographic groups to be the victims of low expectations” (p. 13). The children who do not embody the norms of autonomy and collaboration are also “students who are not native speakers of English, for instance, and may need special attention to allow them to participate fully in classroom discussions ... [as] students with disability may need increased time to complete assignments, or they may benefit from the use of oral rather than written assessment” (p. 13).

The social and psychological distinctions are placed in more general categories, such as being located in an urban or rural setting (NCTM, 2000, p. 373). The child so located is one of a population of “poor and minority students” (p. 368) who have “unique mathematics needs” and thus are in need of rescue through additional help so as not to be at a disadvantage (p. 75) when starting school.
It is possible to consider the above distinctions and divisions in light of the previous discussion of inscriptions and the fabrication of human kinds. First, the assemblage of social and psychological categories that produce the "disadvantaged" human kind is not the result of any single category or label but is formed through an amalgamation of distinctions that overlap as characteristics of an individuality in need of rescue. Second, while the overt purpose of the narratives is to include the excluded child, the inscriptions of the alchemy normalize and establish difference in pedagogy. The practices of inclusion are continually placed against the background of something simultaneously excluded (see Popkewitz & Lindblad, 2000). Third, the categories of need and rescue do not arise from standards-based reforms alone. The discourses of mathematics reform are themselves embedded in a more general, authoritative system of reason that shapes, frames, and fashions the ways in which schooling and its reforms are acted on (Popkewitz & Lindblad). If one examines nationwide teacher education programs for urban and rural children (Popkewitz, 1998c), one finds similar fabrications of human kinds. The urban child and the rural child embody similar sets of qualities and characteristics that require rescue and remediation. A continuum of value is established that differentiates and classifies what the child is and should be and whether the child fits the map (Popkewitz, 2004). The human kind called "disadvantaged child" is in perpetual preparation but never achieves the norms of the "average" (Popkewitz, Tabachnick, & Wehlage, 1982, chap. 4).

Some Concluding Thoughts on the Alchemy, Pedagogy, and Research

In 1932, the historian Carl Becker wrote an important analysis of the shift in philosophical thought that occurred in the 18th century. In his book, *The Heavenly City of the Eighteenth-Century Philosophers*, Becker argued that 18th-century thinkers moved away from the idea of knowledge that resided in God toward one of knowledge that resided in nature, whose rules could be applied toward human progress in the secular world. This shift in focus did not involve changing the basic rules of knowledge. In many ways, the pedagogical reforms are analogous as school subjects are viewed as responding to a changing society by making academic knowledge more accessible. But the rules and standards of pedagogical "thought" naturalize and stabilize the world by focusing on the practices of governing the child that leave the rules for interpreting academic knowledge unchanged. For more than a century, we have thought that we are changing the rules of knowledge to make schools and society more humane and more just. It is these rules that I have challenged in this analysis through problematizing the habitual ways of working and thinking of school subjects.

Why is the alchemy of school subjects significant? The different practices that order the inscription devices are a way to think about the politics of pedagogy. But this politics is different from that emphasized in contemporary policy and research about equity and diversity. For example, con-
temporary research focuses on the social groups represented in mathematics classes, or the interests that benefit or are handicapped through the social processes of classroom teaching. I focus on a different and often neglected side of the politics of education, that is, the function of pedagogical knowledge as a governing practice that also orders exclusions (Popkewitz & Lindblad, 2000). I argue that the various practices assembled in the alchemy produce the standards of reform. These standards are to be found not in the formal statements of principles and "outcomes" but in the distinctions and principles that produce a normalizing pedagogy.

The politics of the alchemy is important in this context. The inscription devices that constitute the school subjects have little to do with the practices related to those fields of inquiry. But the intellectual tools of pedagogy have significance as the overlapping practices construct the objects of schooling. First, as I have argued, the crystallizing or stabilizing of mathematical reasoning based on "conventional ideas" removes the cultural or social moorings of school subjects. Second, the inscriptions are normalizing pedagogies that produce difference. The differences congeal as human kinds—the problem solver and the disadvantaged child—as a continuum of values is established. In this process of normalization, exclusion is not an act of deliberate avoidance but is essentially related to inclusion of the child mapped as the learner. Third, the problem-solving strategies taught in school subjects may actually reduce the spaces that are open for participation and action because scientific expertise is viewed as constituting social realities for children to work on. Fourth, contemporary reform and research, for historical reasons discussed earlier, lack the analytic tools to engage in a self-reflective examination of the rules and standards that constitute questions of equity and justice. The problem of reform and its study is not the particular categories or labels that are used but the assemblage of inscription devices that fabricates a determinate classification of the child left behind.

The notion of assemblage plays an important part in understanding the alchemy. Contemporary pedagogical research tends to separate the issues of "knowledge content" from what a teacher does with that "content." The culturally contextualized models of school learning, such as "situated learning" and out-of-school mathematics learning, are examples. While seeking to undo the consequences of social differentiations and to give value to diversity in teaching, they function to reinstall the inscription devices that naturalize mathematics as a content in service of a normalizing pedagogy. The culturally contextualized models do not question the double construction of school subjects that form the alchemy: how the inscriptions of school content and the psychological maps of the child's thought are woven together and connected as principles of governing.

My final point relates to the self-reflexivity of the categories and distinctions that order school subject research (see Popkewitz, 1997). This reflexivity relates to the epistemological obstacles, to use Gaston Bachelard's (1984) famous term, by directing attention to the shortcomings of reason and the acts of cognition that structure it. Knowledge, Bachelard argues, is won
against previous knowledge by making possible what could not be “seen” before. With this in mind, it is possible to think of one epistemological obstacle to undoing the alchemy: the distinction between text and context. This distinction is sometimes expressed as the division between ideas, discourse, or theory, on the one hand, and the “real world” of classroom behaviors or teacher beliefs, on the other hand. Standards-based reforms, like much policy-related curriculum research, assume that it is “the real world” of teachers and children that is being investigated and that problem solving naturally exists in the context of children’s minds and classroom interactions. My earlier discussion of fabrication helps to explain how the division of theory and practice obscures not only the role of research and policy discourses in the formation of these tenets, but the role of the inscription devices of pedagogy in fabricating the practical universe of schooling and its school subjects. If I may return to the analogy that I started with, what needs to be questioned are the base metals of the alchemy that are sublimated to produce the golden universe of schooling and its school subjects. I focus now on two other epistemological obstacles embodied in the alchemy: the analytical reading of academic fields in curriculum and the culture of redemption in educational research.

A different epistemological obstacle to “unthinking” the alchemy is the way of reading science, mathematics, or other school subjects. If one thinks about the interpretative strategies that constitute school subjects in this discussion, they typically involve a particular analytic reading of the academic fields. This analytic reading looks at the logical characteristics found in the central concepts and/or procedures of, for example, mathematics. It enables researchers and curriculum designers to search for “conventional ideas” and structures that stand as “entities” independent of the cultural practices of science or mathematics. The “entities” of school subjects are “the things” worked on as logical forms in the normalizing project of pedagogy. As Valero (2003) suggests, mathematics is a logical content placed in the service of producing the cognitive development of students (also see Bishop et al., 1996).

This analytical reading ignores how words and their concepts are embedded in styles of thinking or reasoning that relate things and people to the knowledge and methods of science. Studies of science, technology, and mathematics, for example, can be read as exploring the fields of relations through which an academic field defines its problems, approaches, and knowledge systems. The concepts and generalizations of science are formed through a play of rules and an ensemble of practices. In this sense, an assemblage of practices in science functions to regulate how judgments are made, conclusions drawn, rectification proposed, and the fields of existence made manageable and predictable (see, e.g., Knorr Cetina, 1999; Foucault, 1966/1973; Hacking, 2002; Kuhn, 1970; Latour, 1999; Nasar, 1998; Wagner, 2001). This complexity of reading the practices of science is expressed by Bakhtin: “Language is not a neutral medium that passes freely and easily into the private property of the speaker’s intentions; it is populated—overpopulated—with the intentions of others. Expropriating it, forcing it to submit to one’s own intentions and accents, is a difficult and complicated process” (1981, p. 294).
The translation of science studies into pedagogy requires different intellectual tools and strategies for thinking about and ordering the practices of an academic field than are found in current curriculum models (see, e.g., Spivak, 1992, for a discussion about reading for translation). This alternative reading would focus on relations or assemblages that construct disciplines, historicizing how the subject is constructed and changes over time, and on the epistemes or the systems of thought that make possible particular types of knowledge in a field. That is, pedagogy needs intellectual tools that consider the relation between the knowledge (concepts, generalizations) and the cultural practices that enable the production of that knowledge. Such a reading of science or mathematics for pedagogy, among other school subjects, would require a way of thinking that does not crystallize the conclusions and propositions of a field or produce a psychological reductionism.

To engage in such a reading does not eliminate the problem of the alchemy, nor does it deny a place for educational psychology in curriculum construction. Rather, it suggests that in constructing pedagogies we should turn to fields of scholarship concerned with interpreting the intellectual styles, rules of thought, and practices through which knowledge is generated in academic disciplines. The psychologies of instruction in standards-based reforms are inventions to normalize the child and thus are inadequate for purposes of translating mathematics, science, or other academic fields into curriculum projects.

A different epistemological obstacle is related to the salvation themes that underlie the pedagogical research projects of school subjects. The redemptive culture is expressed in the set of assumptions that define research as useful or practical. In the above discussion of standards-based reforms, the salvation themes are related to preserving the future of participatory democracy and rescuing children who have not succeeded. Research is viewed as providing the expertise to produce social and personal progress through remodeling the child, or what I have called changing the soul.

Salvation themes, which can be classed among the normative goals of society, are important in working for a more just and equitable society and schooling. In the context of research, however, the redemptive culture has different implications and consequences, because it establishes a relation among the interpretations of educational phenomena, social and personal practices, and predicted futures through the inscriptions of science (Popkewitz, 1998a). The redemptive claims about useful knowledge in research are particular historical practices and are effects of power. Despite the good, and even sometimes radical, intentions of curriculum reforms to empower others, the relations of empowerment in pedagogy are relations of power in and of themselves (see, e.g., Cruikshank, 1999). Any attempt to promote subjectivity through governing "thought" is neither benign nor neutral. Research, even that which is designed to directly influence daily practice in the classroom, cannot overlook as unproblematic the "subject" who is to be reformed and how that subject is constituted, for example, through the alchemy. What seems democratic in "problem solving" and collaboration, as I have argued in this
Popkewitz

article, may be neither democratic nor useful when the internments and enclosures are diagnosed.

When the scientific and strategic discourses about change are placed together, redemptive claims made about the future (enfranchisement and democracy) constitute the social position of scientists as messengers who appear in the name of the people—whether those people are classified as lacking voice, oppressed, or learning disabled. As various researchers have argued, to conflate scientific discourses (whether one professes progressive politics or not) with the strategic discourses for social change misconstrues how pedagogy—its content and subjectivities—is produced through inscription devices (see Ingólfr Ásgeir Jóhannesson, 1998). To conclude, I have undertaken a reading of research on school subjects that goes against the grain. The intent is not to deliver a polemic against the efforts of educational research. Nor is it to argue, per se, against educational psychology, children’s problem solving, or community—themes with high cultural currency in contemporary reforms. Rather, my intent in focusing on the texts of research and reform policies is to disturb and contest the objects of reflection and action, and to ask what orders truth and falsehood in pedagogy as a set of governing practices. To borrow from Foucault:

The work of an intellectual is not to mold the political will of others; it is, through the analysis that he does in his own field, to re-examine evidence and assumptions, to shake up habitual ways of working and thinking, to dissipate conventional familiarities, to re-evaluate rules and institutions and starting from this re-problematization (where he occupies his specific profession as an intellectual) to participate in the formation of a political will (where he has his role as a citizen to play). (1989, pp. 305–306)

Notes

An earlier draft of this article was presented as an invited lecture at the International Mathematics and Education and Society Conference, Helsingor, Denmark, April 2002. As I prepared this article, I appreciated the comments from the Wednesday Group Seminar and also from Jim Bishop, Nuria Gorgorio, Ruth Gustafson, Jamie Kowalczyk, David Shaffer, Ole Skovsmose, Nora Smith, Dar Weyenberg, and Aaron Weinberg.

1 For critical discussions of this, see, e.g., Valero, 2003; Bishop, 1991; Bishop et al., 1996.

2 French didactics gives explicit recognition to the need for translations into pedagogy, but without questioning the alchemy itself. See, e.g., Brousseau, 1997.

3 My concern is with knowledge in the French sense of savoir—the historically formed rules and standards through which knowledge forms and organizes the objects of the world—not with knowledge as content or entity.

4 Mathematics educators make distinctions between different strands of pedagogical research. For example, see Cobb and Bowers’s (1999) distinction between cognitive and situated learning perspectives of constructivism, and Hershkowitz and Schwartz (1999). See also Sutherland and Balacheff (1999), who clarify the distinctions between constructivist psychologies and a theory of didactical situations. In relation to the argument in this article, the different strands and nuances of research are internal discussions to the rules and standards of the same alchemic strategy in constituting the curriculum. I discuss some of the similarities in Popkewitz (1991). I do not consider other mathematics education traditions, such as ethnomathematics or the tradition of the Freudenthal Institute in Utrecht, Netherlands.
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5 The principles and standards of the NCTM is circulated nationally and internationally as an exemplar of the reformed curriculum (see, e.g., Valero, 2003).

6 This is not to suggest a determinism but to denaturalize the ordering principles of pedagogy by treating them as historically produced and thus possible to resist. This is discussed in the concluding section.

7 My concern is with the state defined in terms of the conditions of governing, not the state as legal-administrative apparatus, such as the U.S. Congress. Considering the conditions of governing directs one’s attention to the amalgamation of cultural practices that order and thus govern the objects of reflection and action. The making of the self-responsible citizen makes possible the modern nation and the school (Meyer et al., 1997).

8 The use of psychology in the curriculum was not a forgone conclusion. William James spoke against it; G. Stanley Hall defended it as a central discipline in forming the soul.

9 See Latour (1986) for a useful description of this issue in the work of Piaget.

10 To speak of alchemy and salvation is not necessarily mixing metaphors. The alchemists worked with magical powers in the hope of effecting a longevity if not an immortality that embodied God’s way. But I do not want to push the analogy too far, as analogies are always limited.

11 These distinctions are inferred in, for example, Lampert (1990) and are found in discussions of the philosophy of science (see, e.g., Kaplan, 1964) and in comparisons of science and mathematics (see Van Bendegem, 1996, 1999). Lakatos (1976) is used as an exemplar for this argument.

12 The policy document names U.S. president George W. Bush as author.

13 Introspection and journalistic styles of reporting have a long history in the social sciences. See, e.g., Danziger (1990) in psychology and Lindner (1990/1996) in sociology. But to talk about the styles of reporting does not mean that they are without coding and structuring devices that order and classify what constitutes “experience” and “practice.”

14 I refer to this research in relation to mathematics education because it is given as an authoritative reference for the strategies taken.

15 Fabrication provides a way to undo the divisions between nominalism and realism or the distinctions between subjectivism and objectivism in philosophy and educational research (see Hacking, 2002).

16 Although it is possible to talk about norms of community and notions of participation, democracy, and individualization in science or mathematics, these notions and their nuances do not necessarily collapse into or directly overlap with the political rationalities and political regime of a nation. Thus they need to be investigated rather than assumed in pedagogy. One can compare the meanings of collaboration in the French and U.S. scientific communities, for example, to understand how norms of partnership and cooperation differ in relation to the different cultural and political regimes in which science is produced (Rabinow, 1999).

17 The evocation of community as a metaphor is carried across Europe and the Americas and across ideological boundaries (Popkewitz, 1996). Conservative agendas about markets and privatization deploy notions of community that are to revise the relation of the state to the agency of the individual. The Left speaks about community in relation to strategies of empowering marginalized groups.

18 Other notions of constructivism that circulate in the social sciences and philosophy are not reducible to psychology and provide some ways out of the dilemmas of the alchemy discussed here. This is discussed briefly in the concluding section.

19 I discuss this notion again in the conclusions to recognize a certain Platonic quality of mathematics that co-exists with its conditions of cultural production.

20 I appreciate Sal Restivo for making this distinction as I thought about this issue.

21 For considering the social sciences as fields of multiple intellectual traditions and discourses that are relational, see, e.g., Cherryholmes, 1988; Popkewitz, 1977; Wagner, 2001.

22 This provides a way to undo the binaries that have underly debates about science and mathematics that are concerned with uncertainty and certainty—idealism and realism. These can be thought of as a double inscription. Platonic notions of certainty in mathematics exist even when we consider the cultural qualities that produce its systems of knowledge (Restivo, 1993). The Platonic certainty of mathematics is continually worked on through a field of cultural practices as mathematicians produce its foundations. For example, mathematics can be
thought of as embodying a logic that is about the truth of the world, as a collection of synthetic propositions and the a priori of Kant; or as the relations of classes determined by its context (such as the properties of summing and discounting, and measurement problems). Even if a Platonic notion of certainty is accepted, the seemingly self-evident classes of the categories of numbers embody norms of ranking and divisions that relate to the cultural resources available for the classifying. One can think of the classification systems of social surveys or the types of mathematical problems related to development of computer sciences or by DARPA for defense projects to consider the issues of epistemic drift in the field of mathematics through resources, both internal and external to the field.

2See note 19 in relation to the doubleness of certainty (Platonic notions) and uncertainty in mathematics.


25The categories and distinctions, with minor variations, are typical of the more general U.S. reform movement, as well as those embodied in international statistics and European efforts related to problems of social inclusion and exclusion (see Popkewitz & Lindblad, 2000; Lindblad & Popkewitz, 2001).

26This transmogrification of school subjects is also one of the limitations of critical pedagogy.

27For an example of the analytical reasoning that treats categories as “pure thought,” as ahistorical objects, and thus fails to recognize the phenomena under scrutiny, see, e.g., Schrag (1999).

References


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