Empowering Non-Traditional College Students

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THIS PAPER briefly examines the social, political, and educational milieu of those who are “outsiders” inside traditional US higher education. We discuss the ideology undergirding various approaches to mathematics education. Here the focus is on responding to the intellectual and affective conditions of non-traditional students and their need to examine critically and act on their milieu. This pedagogical approach aims to prefigure and support transformation of the U.S. society.

Societal, political, and educational contexts

In the United States, as in other nations, large numbers of individuals are prevented from realizing their potential in mathematics [McKnight et al. 1987, 111] and in mathematics-related fields. This mathematical disempowerment of individuals and the accompanying alienation that many experience are due, in large part, to the effects of the interactions among the social, political, and economic structures of the U.S. Political economy functions both as a determining factor and as a social filter in the phenomenon of unrealized potential and alienation. In regard to scholastic achievement, for example, attitudes toward race, gender, and class, which are both given birth and reinforced by the political economy of the U.S., restrict the access of ethnic and racial minorities, women, and working-class students to mathematics and mathematics-related fields [2].

1. Revised version of a paper delivered by the authors at Sixth International Congress on Mathematics Education, Budapest, Hungary, July 1988.

2. This is a special case of how sex, gender and class interact to influence the social function of education generally [Apple 1979]. The view that interaction of these variables can account for differential achievement has recently gained currency in the established mathematics-education community [e.g., Reyes and Stanic, 1988].

3. That these pressures were successful in democratizing access can be understood by examining the strong counter-measures which were implemented. Shor [1986] analyses the various waves of reaction.

In the late 1960s, the interplay of two dynamic and contending forces, one economic and the other social and political, contributed to a restructuring of higher education. On the one hand, the economy began to require an increasing proportion of labor to be incorporated into the mass production of information, communication, and finance. On the other hand, the social and political struggle against U.S. involvement in the Vietnam War and the Civil Rights Movement were at their height. Under these pressures, higher educational institutions opened their doors to new kinds of students, ones traditionally considered as “outsiders” [3]. A significant proportion of these outsiders or, as we shall refer to them, “non-traditional” students were not adequately prepared to meet the conventional expectations of post-secondary institutions. This inability was due to both cognitive and psychological constraints engendered in students by social, political, and scholastic biases of the society. These biases produce a stratification of the society educationally and, in turn, determined that many non-traditional students were to be women, ethnic and racial minorities, and working class teenagers and older adults. They comprise the population of students with whom we have been working for several years in colleges.

In many cases, non-traditional students are in the first generation of their families to attend college, and thus are without a family tradition of post-secondary education to guide and support their scholastic efforts. For many, their previous encounters with educational institutions have diminished significantly their academic self-esteem, in general, and their view of themselves as capable mathematics learners, in particular. In secondary school, many were tracked into non-college-bound curricula and labeled as failures by educational authorities. Too often, non-traditional students enter post-secondary institutions without adequate preparation, academically or psychologically, to meet successfully the challenge of traditional mathematics curricula.

This underdevelopment of non-traditional students is further exacerbated by misconceptions and beliefs about mathematics acquired in their primary- and secondary-school experiences. For instance, they tend to believe that mathematics is an arcane body of knowledge, containing immutable, eternal truths which are external to humans and, therefore, can be discovered only by “gifted,” “sagacious” minds. In accord with this belief about the nature of mathematical knowledge, many non-traditional students also hold the misconception that mathematics is learned by completing repetitious exercises and arduously memorizing facts and procedures. Most
insidious, however, is their belief that the mathematics they are expected to master cannot be further developed, at least not by them.

Responding to the large influx of non-traditional students, higher educational institutions have established remedial mathematics courses, but this has been done within a set of existing institutional imperatives. The structuring of remedial courses is constrained by such imperatives as degree requirements, required course load for full-time status, and institutional withholding of degree credits, none of which address the cognitive and other educational needs of non-traditional students. Adding to the structural disjunction, those assigned to teach remedial courses tend to be either part-time faculty, receiving substandard recompense, or full-time faculty considered (and considering themselves) to be at the bottom of the faculty hierarchy. Students become aware of the self-image of faculty as well as the value, or lack thereof, that the institution places on remedial courses and on students who need such courses. The combined effect of these environmental features is a stigma which affects both faculty and students, and negatively influences the effectiveness of remedial courses.

The Ideology of Remedial Instructional Approaches

This stigma contributes to and is reinforced by the poor performance of both dominant instructional methodologies and non-traditional students. To understand this, we need to examine the philosophies behind the instructional approaches under which non-traditional students are taught mathematics. Giroux's [1982] categorization of the ideologies underlying various approaches to native-language literacy is useful in understanding the problematic nature of traditional mathematics pedagogies and the promise of some alternative ones. Giroux [338] views ideology as a “dynamic concept that refers to the way in which meanings and ideas are produced, mediated, and embodied in forms of knowledge, cultural experiences, social practices, and cultural artifacts.” He argues that by examining the ideology behind various pedagogies, we can analyze how schools sustain and produce meanings, and how individuals and groups produce, negotiate, modify, or resist those meanings.

Giroux’s category of instrumental ideology focuses on principles of prediction, efficiency, and technical control. Knowledge is seen as objective and external to the knower. Facts are stripped of the subjectivity of class formations, race, and gender and celebrated for their supposed neutrality. The focus of instruction is on atomized content, the mastery of which constitutes the central problematic. This ideological perspective underlies traditional mathematics pedagogies and has its crudest expression in remedial instructional methods which concentrate on lower-order cognition—mechanical proficiency and rote memorization—omitting any insight into the nature of mathematics as a way of thinking and seeing and the uses of mathematics in understanding the world. At best, this kind of functional “math literacy” results in a fragmented knowledge of discrete mathematical algorithms, without an understanding of how mathematical knowledge is generated or used to examine and transform economic and social realities. At worst, it results in a blind pursuit of value-free scientific knowledge with little tolerance for questions concerning the ethical nature and consequences of the practical application of knowledge. This belief in value-free knowledge produces, for example, nuclear weapons without awareness or questioning of the interests and choices that direct the application of mathematics.

Giroux’s category of interaction ideology centers on the human dimensions of knowledge, viewing knowledge as a social construction. It regards meaning, as opposed to mastery of content, as the central problematic. This ideology underlies “humanistic” mathematics pedagogies which focus on alleviating “math anxiety” [4], individualizing instruction at the students’ own paces, and problem solving with a stress on process over product. In such pedagogies, there are important moments when students can grasp the nature of mathematics and their ability to do mathematics. Though interaction ideology is concerned with cognitive dissonance and moral development, it omits notions of political conflict and power differences among socioeconomic classes and racial, ethnic, and gender groups. That is, “power and freedom collapse into an exaggerated notion of human will as well as a blindness towards those larger social forces that promote economic and cultural disintegration” [Giroux, 348].

Interaction and Instrumental Ideologies are dominant in instructional methods of mathematics and are reproduced, particularly the former, in remedial mathematics courses. The long-term success rate of these methods has proven to be dismal as evidenced by the fact that these students find themselves again and again in need of remediation. For those who do succeed, their increased facility in basic skills tends to be short-lived. These ideologies leave students with little or no insight into the nature of mathematical thinking and certainly without recognition of their ability to generate mathematics; they serve only to confirm students’ beliefs that they are incapable of understanding mathematics and to reinforce the logic of existing relations of domination.

While remedial courses have often lacked original and imaginative teaching and learning models and have failed to promote modes of thought and to develop tools with which students can break with the predefined, they have also been places where innovations in mathematics pedagogy and challenges to dominant ideologies have taken root. New approaches and methods, fundamentally different from traditional ones, have developed due to the interplay of theo-

4. A critical approach to this topic can be found in Frankenstein [1984].
retical and concrete influences which are both internal and external to the fields of mathematics and education. These influences have included changes in the theoretical perspectives concerning the nature of mathematics and the learning process and the effects of non-traditional students stimulating instructors to re-examine methods in light of the instructional failure and theoretical collapse of the instrumental paradigm [5].

The interaction of these influences, as we view them, have led to the development of mathematics pedagogies which fall within Giroux's third category, critical ideology. This ideological perspective, which owes much to Freire's [1970, 1973] pedagogy of the oppressed, extends the complex role schools play as institutions that mediate and sustain the logic of the state and the imperatives of capital, to include the important concept of human agency where, in a dialectical process, people both participate in their own oppression and struggle to resist. As Giroux [p.354] says, at the core of Freire's notion of critical literacy is "the insight that culture contains not only a moment of domination but also the possibility for the oppressed to produce, reinvent, and create the ideological and material tools they need to break through the myths and structures that prevent them from transforming an oppressive social reality." Furthermore, critical mathematics pedagogies take the view that the cognitive processes owned by speakers of any language are akin to those involved in thinking mathematically [Gattegno 1963, 1970]; that students require situations to mathematize and only a minimum of givens; and that from these they can generate mathematics both inductively and deductively [Gattegno 1984]. This critical ideology and its pedagogical manifestations are the foundations of the three instructional techniques—reading, articulation, and ethnomathematics—discussed briefly below and elaborated elsewhere [Frankenstein 1987, Hoffman and Powell 1987, Powell 1986a].

Reading and articulation: The construction of meaning in both society and mathematics

To support non-traditional students in their attempts to construct meaning in mathematics and society, reading and articulating are processes to which we attend explicitly. By reading, we restrict our reference here to non-textbook readings related to mathematics and mathematics learning. Students read excerpts from the mathematics education literature and critically reflect on the reported findings and their own mathematics learning in light of these findings. For example, students read excerpts from, "Mathematics in the Street and in the Schools" [Carraher et al, 1985], a study conducted in Brazil among sons and daughters of street vendors who assist their parents in their businesses. The study found that "performance on mathematical problems embedded in real-life contexts was superior to that on school-type word problems and context-free computational problems involving the same numbers and operations." Students are asked to reflect and comment on the study. Their reflections are made public in small-group and class discussions and through writing. In the above example, the discussions help students to make explicit and recognize the variety of situations in their lives in which they competently use and understand mathematics.

The social construction of meaning in society through mathematics can be an important part of our individual and collective struggles to make our lives more democratic, just, and humane. Students read newspaper articles on topical social, political, and economic issues and the mathematics of these issues are examined. Here the focus is on understanding and interpreting, through discussions and in writing, the statistical information and arguments presented [Frankenstein 1987, 6]. Statistical data can clarify issues and reveal aspects of the underlying structures of the society. Critical mathematics literacy involves the ability to ask basic statistical questions in order to deepen one's appreciation of particular issues and the ability to present data to change people's perceptions of those issues. An understanding of numerical data prompts one to question "taken-for-granted" assumptions about how a society is structured, enabling us to act from a more informed position on societal structures and processes. For example, an analysis of data collected and published by the U.S. government reveals that the U.S. economic system functions as "socialism for the rich" (e.g., in 1975 the maximum Aid for Dependent Children welfare payment to a family of four was $5000, while the average tax loophole for each of the richest 160,000 taxpayers was $45,000 [Babson & Brigham 1978]). For another example, the International Association of Machinists uses statistical data in their argument for peace conversion and have documented that, contrary to popular mythology, "as the military budget goes up ... machinists jobs in military industry decline" [Anderson 1979].

Further, critical interpretation and reflection are processes which also can be stimulated and promoted by articulation activities. In such activities, students reflect explicitly on cognitive and affective aspects of their mathematical experiences and articulate these reflections in speech or in writing. Talking about mathematics is facilitated by small-group, collaborative work. The results of these small-group deliberations are publicly heard and debated in class discussions.

5. More space than we have is required to provide evidence for this conjecture. However, for an analysis of a parallel paradigm shift which occurred in the teaching of composition, see Hairston (1982).

6. For a text which teaches basic mathematics through real statistical data about the world, see Frankenstein (1989).
Collectively, but not without dissenting positions, meanings are thus constructed.

Articulation in the context of mathematics can also be facilitated through writing. Students are engaged in exploratory, speculative writing as a vehicle to externalize their reflections and constructions of meanings of mathematics. This type of expressive writing can be a valuable end in itself as well as a starting point in which feedback and revisions are grounded. Revising, then, is a process through which students write more deeply and elaborately about mathematics. This type of expressive writing can be facilitated through writing activities, including multiple-entry logs [Hoffman and Powell 1988], free writing, and journals (or learning logs) [Lopez and Powell 1989, Countryman 1985, Stempien and Borasi 1985]. For example, students write journals to monitor their learning, to formulate questions, to describe observations, and conjectures; they also write to express their affective responses to the mathematics they are learning and as a way to gain control of anxieties and other emotions which prevent them from doing mathematics well. We provide written responses, which are intended to be non-judgmental, to statements, interpretations, questions, discoveries, and misconceptions in students’ journals. Responding in this way establishes a medium for direct, personal “dialogue” between instructor and students; and, students are reassured that their concerns were taken into account. Writing also requires students to take a more active role in determining the content of their learning.

When non-traditional students take steps to determine the content of their learning through the independent use of learning tools, it is indicative of their involvement with an empowering process. Writing is an effective reflective tool for students to articulate and explore their evolving understanding of both mathematics and society and themselves in relation to them. Whether writing is empowering can be measured by the extent to which it can be used as an independent learning tool. Evidence that writing is empowering was provided by a student who, beyond the course in which it was introduced, continued to use multiple-entry logs in a mathematics course for which writing is neither required nor monitored. The significance of the example can be appreciated once we briefly describe multiple-entry logs.

One way students create a multiple-entry log is to create a sheet of loose-leaf paper width-wise into three equal sections. Into the left-hand column, students copy portions of “text” which particularly interests or strikes them. The word “text” is interpreted broadly to mean a selection of prose or mathematical expressions from the textbook, lecture, problem set, or any other course material as well as selections from mathematical discussions in which one engages or, as it were, witnesses. Once a “text” is selected, students write in the middle column a comment, an evaluation, a summary or any other type of reflection of their “text.” Finally, the most crucial and critical aspect of maintaining multiple-entry logs is for students, some period later, to reflect again or “meta-reflect” on previous “text”-reflection entries and, in the right-hand column, to update their reflections. The excerpt in Figure 1 below is from the multiple-entry log of a student who was in the second week of a college algebra course [7].

### TEXT

Doug is paid double time for each hour worked over 40 hours in a week. Last week he worked 46 hours and earned $468. What is his normal hourly rate?

### REFLECTION #1

He only worked 6 hours overtime. That means only 6 of those hours were double time. I’m not sure how to set up the problem. The $468 represents the amount he was paid for the regular 40 hrs. plus the 6 hrs. overtime which were double time.

Whatever his hourly rate is, for the 6 hrs. he worked overtime it will be doubled. Let x represent his normal hourly rate. He normally works 40 hrs/wk., so 40x represents a typical weekly earning. 6(2x) represents the six hrs. worked overtime at double his normal hourly pay.

\[
40x + 6(2x) = 468
\]

\[
40x + 12x = 468
\]

\[
52x = 468
\]

\[
x = 9
\]

His normal hourly rate is $9/hr. For the six hours he earned $18/hr.

### REFLECTION #2

Although the problem doesn’t ask how much he earned per week without overtime, I can now answer that question. Also I can answer the question of how much he earned for the 6 hrs. he worked overtime.

\[
40($9) = \$360/wk
\]

\[
6(18) = \$108 \text{ for O.T.}
\]

After reflecting on this problem, I have come to the conclusion that if I can represent an unknown quantity with a variable I could find the other unknown quantities of a problem using that variable.

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**Figure 1.** The multiple-entry log of a student engaged in writing as an independent tool to learn college algebra.

7. Currently, this student and one of the authors are collaborating on a research project to determine whether writing, such as multiple-entry logs, can be used as an independent learning tool.
The above example of a multiple-entry log, produced independent of directions from an instructor, illustrates several interesting aspects of the types of writing students produce using this tool. First, the entries in the middle and right-hand columns are examples of personal or expressive writing which are both reflective and analytical. Second, in the middle column, the student states that he is “not sure how to set up the problem,” as if by declaring this, it allows him to go on. Third, he uses the writing to explore his understanding of the problem. Specifically, he seems to wrestle with the significance of Doug having worked 6 hours overtime and the impact this has on the pay he received for the week. Fourth, as the student writes, his understanding of the problem seems to deepen, and he discovers a way to express one of the unknown quantities. He determines that the variable “x” can represent Doug’s normal rate of pay and that “2x” would therefore stand for his overtime rate. Then, the student establishes an equation: Doug’s “typical weekly earning” plus his overtime earning equals his total earnings for the week.

In the right-hand column, which contains the student’s second reflection, he discusses two important insights. The second of these is a generalization of the particular instance in which he became aware that if one unknown quantity could be denoted by a variable, then the same variable can be used to assist in the representation of other unknown quantities in the problem. Later, of course, he will need to specialize to determine the domain for which his insight holds. The point, however, is that the process of generalizing is an important aspect of mathematical thinking, and the act of writing reflectively afforded the student an opportunity to engage in metacognition and to think deeply about mathematics at his level. This is the potential that articulation activities have for empowering non-traditional students.

**Ethnomathematics and cultural affirmation**

Ethnomathematics, a cultural anthropology of mathematics, is defined by D’Ambrosio [1985] as “the mathematics which is practised among identifiable cultural groups, such as national-tribal societies, labor groups, children of a certain age bracket, professional classes, and so on.” Further, Fasheh has stated that “ethnomathematics means working hard to understand the logic of other peoples, of other ways of thinking,” and Gerdes posits that “mathematics is the union of all ethnomathematics” [8]. Ethnomathematical research focuses on methodological differences in various cultures’ mathematics, such as the contrasting uses of the period and comma in mathematical notation, or how learning is affected when notational conventions of numeration of one cultural-linguistic group is uncritically adopted to the cultural-linguistic system of another [Powell 1986b]; it can involve analyzing conceptual differences in various cultures’ mathematics, such as the classification structures of other languages, where, for example, in the African language Setswana, things are classified by what they do, rather than by what they are, as in Indo-European languages [Berry 1985]. Ethnomathematical research has shown that the basic notions of mathematics are similarly developed in all children, regardless of social class, race, and culture [Ginsberg 1982]; that what counts as mathematical knowledge needs reconsideration, since, for example, the geometric knowledge of basket weavers [Gerdes 1986] and the group structure of kinship relations [Ascher and Ascher 1986] have been found to embody complex mathematical structures; and that the contributions of various cultures to mathematics have been distorted and hidden, such as, the false portraits of Euclid, a historically famous mathematician, who lived and died in Egypt, but who is depicted as a “fair Greek,” “not even sunburned by the Egyptian sun” when “there is not a shred of evidence to suggest that he was anything other than [an African person of Egypt]” [Lumpkin 1983, Zaslavsky 1983].

**AN EXAMPLE**

of how this research can be used in the curriculum involves a discussion of the following problem:

Many Western anthropologists have claimed that the other cultures they studied were “childlike” and “primitive.” Marcia Ascher, a mathematician, and Robert Ascher, an anthropologist, argue that “there is not one instance of a study or a restudy that upon close examination supports the myth of the childlike and primitive.” They go on to quote other anthropologists and conclude that “cultural differences in cognition reside more in the situations to which particular cognitive processes are applied than in the existence of a process in one cultural group and its absence in another” [Ascher and Ascher 1983, 131]. A clear example of the kind of distortion or racist misunderstanding that has occurred involves a frequently repeated anecdote in math history books. It tells of an exchange between an African sheep herder and what is variously described as an explorer, trader, or anthropologist. It is intended to show that the herder cannot comprehend the simple arithmetic fact that $2 + 2 = 4$. It describes how the herder agrees to accept two sticks of tobacco for one sheep, but becomes confused and upset when given four sticks of tobacco after a second sheep is selected. Can you think of another interpretation of the sheep herder’s confusion?

Through reflection and discussion of this problem, one becomes aware that from the sheep herders perspective, sheep are not standardized mathematical units. When students realize that there is a logic to the sheep herder’s reasoning, they develop a greater respect of their own reasoning. Moreover, in turn, they become motivated to search for the logic in how they solve mathematical problems.

At present, we, and others in the International Study Group on...
Ethnomathematics [9], are working to expand the ways in which these topics can be incorporated meaningfully into the classroom. We have found five important reasons for integrating an ethnomathematical perspective into curricula. First, the additional examples obtained by considering the mathematics of non-Western peoples provide a rich source for illustrating and applying mathematical concepts and theorems. Second, it gives a more accurate account of the history of mathematics and the contributions of non-Western peoples to it. Third, an ethnomathematical teaching perspective encourages instructors to have students examine their methods and ways of conceptualizing mathematics. Such examinations can be done through class discussions, writing, and student-instructor interviews. Instructors can then build from the mathematical structures understood by their students. Fourth, while students reflect on and re-conceptualize their mathematical knowledge, they come to realize that they already know more mathematics than traditional evaluations reveal and develop confidence that they can learn even more mathematics. Fifth, since our students are culturally and racially diverse, they are culturally affirmed by the results of ethnomathematical research. They acquire an appreciation for the contributions of their communities and of other peoples to the history of mathematics. In addition, they gain respect for their own intellectual work, breaking through the view that "the intellectual activity of those without power is always characterized as non-intellectual" [Freire and Macedo 1987, 122].

Conclusion

Both as a sector within the U.S. society and as individuals, non-traditional students are not without power, especially intellectual power. The atmosphere created in mathematics classes can be structured to encourage this realization, and this can best be done when, to use the language of Gattegno, "teaching is subordinated to learning." One implication of this is that the instructor and the content are no longer the focus of attention. To accomplish this aim, one which can lead to the empowerment of non-traditional students, as with any other group of students, instructors must engage students in the use of their powers of perception and action and in dialogue. In this dialogue, students must be considered and treated as equals. This dialogue could include discussions of teaching styles, the nature of mathematics and learning, the constraints and short-comings of the system in which the course exists, and strategies for change. Further, instructors and students could interact as co-researchers to design instructional and learning techniques and assess their effectiveness [López and Powell 1989] as well as to act on ways of effecting institutional change. Together, they can develop ways of overcoming the effects of racism, sexism, and classism on instructional methods and student achievement in mathematics. These efforts, by necessity, will be directed towards structurally transforming the negative educational and societal conditions in which the dialogue exists.

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Molecular genetics, the reigning paradigm in biology, promises to transform the living world through manipulation of the DNA molecule. Genetic engineering of plants and nonhuman animals is already well underway, and proposals for genetic engineering of humans and human embryos for medical purposes are increasingly frequent. Genetic manipulations confined to the body cells of individual persons ("somatic" gene modification), if found to be effective in treating rare, life-threatening diseases, would almost certainly come to be advocated as a therapeutic procedure for more common health-threatening conditions such as obesity and hypertension. And genetic modification of the reproductive cells, or the early embryo, for the purpose of prospectively correcting inherited defects or predispositions to disease ("germ-line" genetic engineering), while not on the short-term medical agenda, is considered by many to be a reasonable prospect because of recent dramatic results along these lines in animal experiments. According to one prominent medical geneticist "the animal studies raise the possibility of future genetic manipulations in humans" [Motulsky 1983].

Given the magnitude of what is being proposed and attempted in the name of molecular genetics, it is reasonable to ask whether this field of science has indeed developed a conceptual framework which is adequate to this program. Scientific and philosophical analysts earlier in this century, particularly in the Soviet Union, were critical of a view of living systems centered totally around the gene [see, for example, Zavadovsky 1931]. Because this critique of idealist and metaphysical trends in genetics eventually became caught up in that debacle of arbitrary state intervention in scientific thought and practice known as Lysenkoism, left-oriented analysis of biological ideas has been scarce during the past 40 years. Suggestions that genetics, in particular, may be encumbered by a class-laden perspective, have

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