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# Latino Students' Academic Literacy in Science Education

## Contextualizing Policies

*Raimundo Mora, Ph.D.*

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*This article reviews various interpretations of academic literacy that are being applied to science education, their limitations in terms of Latino students, and the case study experiences of three Latino students majoring in science. The author examines the ways in which factors he has identified in his experiences and research as crucial can be integrated to improve academic literacy programs. He recommends to planners of science programs methods to effect advancement in Latinos' academic performance.*

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I ncreasing minority participation in science is a major initiative undertaken by the U.S. government and private industry. Widespread concern has been amply documented in books and reports such as *Science and Technology Education for the Elementary Years*, *Changing America*, *Science for All Americans*, *In the National Interest*, *The Liberal Art of Science*, and *What Works*.<sup>1</sup> On the whole, these reports emphasize the importance of integrating in science underrepresented minority groups, particularly members of the Hispanic<sup>2</sup> and African-American communities. Yet little has been said about nonnative English speakers who are limited English proficient (LEP) — one of the fastest growing populations in American colleges.

During the 1991–1992 school year, according to the 1994 Aspira Institute for Policy Research report, there were 2.31 million LEP students in the United States, three-quarters of whom spoke Spanish as their first language. Forty-five percent of school districts with LEP students reported offering no instruction in the native tongue, a situation that helps explain why such students fall behind as they struggle to learn English.

Despite the concern and the initiatives cited above, statistical data published in *Science and Engineering Degrees* indicate that the measures undertaken have not been successful in integrating Latino students.<sup>3</sup> In 1977, 2.9 percent of all bachelor's degrees in science and engineering were awarded to Latinos, down from 4.14 percent in 1990. The total number of master's degrees in the sciences awarded to Hispanics was 2.7 of the total, down from 2.8 in 1990. Even with this slight increase in 1990, the number of science degrees granted does not correspond to the actual growth of the Hispanic population. According to the Census Bureau, the 1990 Hispanic population numbered 22.4 million, which represents 9 percent of the total U.S. population — 10 percent if Puerto Ricans are included — yet the paucity of numbers of Latinos in science speaks for itself.

As a participant in government programs directed at increasing the involvement of Hispanics in science and technology, such as the Foundation for the Improvement of

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*“A multicultural approach to literacy promotes integrative processes. It seeks to give voice to those who may have previously been silenced, a silencing that occurs most specifically in the context of schooling. Those who adopt this approach recognize that success or lack of success in school and the failure to learn to read and write may be more directly related to the distance between the discourse of the learner and the discourse of the school.”*

*— Raimundo Mora*

Postsecondary Education and the National Science Foundation, I realized that a main impediment to Latino students' entering and succeeding in science programs was their lack of a high level of English proficiency and background knowledge in science.

In fourteen years of teaching limited-English-proficient students, I have consistently found that we cannot separate language from content. For these students to acquire the language and knowledge they need to be successful in college, they have to bridge existing gaps between the education they bring from home with the requirements of U.S. universities. The more distant their familiar discourses from those of academia, the harder it is for them to acquire such knowledge. This extended process involves linguistic, cultural, and socioeconomic factors that scholars, educators, and policymakers all too frequently ignore. This conviction has led to my documentation of the academic literacy of students and my research of factors present in a community and a four-year college.<sup>4</sup>

In this article, I review some interpretations of literacy and expand these definitions beyond the coding and decoding of texts. I also examine how literacy integrates factors I have identified in my experience and research as crucial. To illustrate the interaction of these factors in the learning of academic literacy in English by selected students who are representative of two groups of Latino students whose primary language is Spanish, I use three case studies. By combining the theory of literacy with the case studies, I suggest ways to improve the programs that serve these students. I follow Freire's reminder that one of the main challenges of intellectuals in higher education is to be consistent in discourse and practice.<sup>5</sup>

In "Literacy in a Preparatory Science Course," I illustrate the gap between the literacy expected from students in an introductory science course and the literacy of a group of Latino students. In "Jesús" and "Ana," I depict the literacy of two groups of students that I have identified, with the help of Rutgers teachers, administrators, and counselors, as representative Latino students who are majoring in science. Jesús represents students who, starting college, do not have a strong foundation in science or academic skills in either their first or second language. Ana, on the other hand, represents students who are competent in English and Spanish and have a good background knowledge in science. Finally, I recommend methods through which science programs seeking to improve the academic performance of these students can become more effective.

I initiated the case studies in the 1994 Academic Foundations Center (AFC) summer program (see Appendix A) conducting joint interviews with Maria, a teacher in and the coordinator for the AFC's preparatory science courses, and Sam, another teacher; I interviewed selected students in separate sessions. Audiotaping the interviews, I then transcribed and organized them according to theme. I also analyzed lab reports by some of the students enrolled in the course, following principles of ethnographic research.

I use case studies because I believe that qualitative research and particularly ethnography is the proper approach for studying learners and the contexts in which they use literacy. Since case studies of selected students are a vital tool for bridging discourse and practice, they have strong implications for policymaking. According to Renato Rosaldo,

The truth of objectivism — absolute, universal, and timeless — has lost its monopoly status. It now competes, on more nearly equal terms, with the truths of case studies that are embedded in local contexts, shaped by local interest, and colored by local perceptions. The agenda for social analysis has shifted to include not only eternal verities and lawlike generalizations but also political processes, social changes, and human differences. Social analysis must now

grapple with the realization that its objects of analysis are themselves analyzing subjects who critically interrogate ethnographers — their writings, their ethics, and their politics.<sup>6</sup>

### **Defining Literacy**

Many attempts have been made to expand the concept of literacy beyond the traditional coding and decoding of words in order to better understand the complexities involved in teaching and learning literacy. These studies have emphasized the importance of two factors: the individual traits of the subjects whose literacy is defined and the contexts in which they have to use it. While some research has been conducted along these lines on first-language literacy, little attention has been paid to the acquisition of academic literacy by Latino students whose first language is Spanish.<sup>7</sup>

According to Donaldo Macedo, literacy cannot be viewed as simply the development of skills aimed at acquiring the dominant standard language.<sup>8</sup> He rejects traditional approaches to literacy and argues that they have become ingrained with a positivistic method of inquiry, leading to the abstraction of methodological issues from their ideological context; consequently, they ignore the relationship between the sociopolitical structures of a society and the act of reading. These approaches tend to lead practitioners to blame students when they fail to acquire literacy, rather than looking for explanations in the differences between the use of language in school and in the students' communities.

Johns, who documented what some faculty called "ESL [English as a second language] students' academic illiteracy," classified such illiteracy within the following areas: a lack of background knowledge; problems with interpreting and producing the macro purposes of texts; lack of planning in approaching reading or writing; a lack of "conceptual imagination"; a lack of essential vocabulary; the students' "unwillingness to be objective about their value system."<sup>9</sup>

I use this definition of illiteracy because it points out through contrast how a group of college professors view academic literacy and what they expect from their students. At the same time, I question its use of a deficiency model that has been historically employed to discriminate against immigrant speakers of languages other than English.

Academic literacy is an integral part of education. It is understood by those who advocate the widely accepted education concept that language instruction should be integrated with all aspects of the curriculum because language is essential to learning the knowledge represented in the curriculum. However, this concept has not been integrated into the curricula of most universities, where students' academic literacy is generally addressed only through a sequence of two English composition courses.

A multicultural approach to literacy promotes integrative processes. It seeks to give voice to those who may have previously been silenced, a silencing that occurs most specifically in the context of schooling.<sup>10</sup> Those who adopt this approach recognize that success or lack of success in school and the failure to learn to read and write may be more directly related to the distance between the discourse of the learner and the discourse of the school.

Literacy signifies control over secondary discourses beyond the primary discourse that we use to communicate orally with our immediate family. As a result, there are as many applications of the word *literacy* as there are secondary discourses, of which the scientific discourse is one. An implication of this interpretation is the great advantage of

one's secondary discourse being compatible with the primary one. Abundant research shows how mainstream middle-class children acquire secondary literacies through experiences at home, both before and during school, and how in school they practice a discourse they have acquired at home.<sup>11</sup> In contrast, many school-based secondary discourses conflict with the values and viewpoints in some nonmainstream children's primary discourses and in other community-based secondary discourses.<sup>12</sup> Farr documents that for some workers "to function in one's society" frequently means filling out forms and answering questionnaires.<sup>13</sup> Students who come to college from settings in which literacy is defined in these terms tend to be unaware of the purpose of academic literacy, which leads to frequent conflicts between teachers and students.

### **Literacy in a Preparatory Science Course**

The preparatory science course I studied was one component of a program designed for incoming students who were underprepared in science, mathematics, and English. The intent was to provide them with foundations in science that would help them succeed in college-level courses. Students were expected to learn about physics, biology, chemistry, and geology and were required to conduct one or two experiments in each field. For each experiment, they had to write a lab report and enter data in a book. According to the program coordinator, writing for this class followed conventions of the scientific world. Students needed to understand concepts and processes and write about them. They took notes from lectures, readings, and observations, recorded data, and wrote laboratory reports.

Both Maria and Sam commented that most of the students obviously did not know how to type, because their reports contained so many typos. Sam said that many students spaced inconsistently, switching from single to double, and even triple, spacing in the same report. He added that the students used a great amount of whiteout fluid to correct their mistakes, which made reading their reports very difficult.

Maria thought that students frequently did not make sense in their reports because they used words without understanding the concepts behind them. She explained that students who did not understand the point of an experiment had a hard time recording their data. Therefore, they wrote either unordered numbers in any way or whatever they thought would please the teachers. "Some students did not even write a narrative. They just presented the data, tables, and graphs." Maria also explained that students were unfamiliar with many conventions of writing and encountered many problems with the format of their texts. Both teachers pointed to the fact that the students did not know how to organize and present tables and graphics.

According to Sam, the grammar and punctuation in the reports affected the students' grades negatively. He found many incomplete and unclear ideas. When I asked him what the students had done to correct their errors, he replied that they didn't have time to do that because their schedules were tight. As soon as they finished one laboratory report, they had to prepare the next one.

Maria said that although students received instructions weekly on how to use the library, "they did not get to the point at which they could apply their library work to their writing assignments." She explained that in one of the experiments, few students had copied accurately from various sources how bacteria grew and what they grew on, what their nutrition was, and how they reproduced. She continued, "They did not include their sources, which is something they are expected to do in a college-level science

course. They also have to learn how to paraphrase so that they have an adequate understanding of the texts they study and do not plagiarize.”

In examining the lab reports, I found the same grammatical problems the teachers had pointed out: fragmentary and run-on sentences, inconsistency of verb tenses, and a lack of parallelism. Although some of the native-Spanish-speaking students tended to translate word for word from Spanish into English, I still found inconsistencies in the reports. Some demonstrated different levels of English proficiency from one section of their reports to the next. Without acknowledging sources, students seem to have copied in their methods sections the teachers' instructions from handouts and material from other sources. The discussion and conclusion sections tended to be very short and contained more of the students' own writing. Sometimes the conclusion consisted of only one sentence or there was a discussion but no conclusion or vice versa. Some reports contained hardly any text: just a few sentences, a table, and a graph. I also noticed a lack of coherence in the reports, partly because most students appeared to have omitted details of an experiment that they assumed the readers already knew.

The difficulties encountered by students in writing these reports was voiced by Jesús, an articulate student with rather limited academic skills in English. He said that he had a very hard time writing the reports because he could not focus on the conventions of academic English while he was trying to understand the experiment.

Maria commented that by the time science majors enter their third year, they are expected to write fifteen-page research papers; they should know what information they need, where to find it, and how to convey it to their readers. She emphasized that because the instructors did not have time to teach all these skills in one preparatory course, the students would have to acquire these skills by themselves. This is exactly what happened to Jesús.

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### **Jesús**

Jesús, a nonnative English speaker, was a student in the science preparatory course. According to his teachers, he was representative of bright students who wanted to major in science but had difficulties with the content of the science preparatory course. I interviewed Jesús during the 1994 summer and fall terms.

As teenagers, Jesús' parents had emigrated with their families from Puerto Rico to the Lower East Side of New York, where they met and married. Jesús, who was born in 1974, grew up as a native Spanish speaker. His parents and their relatives and friends spoke only Spanish. Jesús and his parents lived with his mother's parents from the time he was born until he was five. In 1979 they moved to Newark, where Jesús started kindergarten and began to learn how to read and write in English. Three years later, when he was in second grade, his parents separated and his mother moved back to Puerto Rico. Jesús went to live with his grandparents on the Lower East Side, where he attended third grade.

One year later, his mother took him to Puerto Rico, where he was placed in the third grade of a public school in Hormigueros, a small town on the west coast. He had to repeat third grade because of his limited Spanish proficiency. He explained, "To learn how to read and write in Spanish was difficult because the teachers didn't help me. I think they didn't like me. I was always in trouble . . . disciplinary problems. Mother had to come constantly to school to speak with the teachers. Then, I learned to put on the nice face."

When I asked him to explain what “to put on the nice face” meant, he said that he had to learn how to be more obedient, to behave more respectfully in class, and not to speak English. Apparently he was having problems learning not just academic skills in Spanish, but also norms of appropriateness different from those of New York and Newark. By the time he was in tenth grade, he seems to have adapted well to the Puerto Rican environment:

“By tenth grade, I started to do well, especially in chemistry and physics. I liked to do all the experiments. Sometimes I stayed after class until I finished doing them. The teacher told me that I had a natural disposition for science, so I decided that I wanted to become a scientist.”

By the time Jesús finished tenth grade, his mother had remarried and moved back to Newark with her new husband. Since his mother and stepfather worked and there was nobody to take care of him in Newark, Jesús again went to live with his grandparents on the Lower East Side. He repeated the tenth grade because of his limited English proficiency, an experience he describes as follows:

At home we spoke Spanish and in school we had to speak English. Since I spoke little English, I just sat quietly in class. For me, school was like a different world. The building of the school was like an American fortress in the middle of the jungle. Outside there was dirt and a lot of crime. Inside, the school was clean and shiny. They frisked us every day before entering school to make sure we weren't carrying weapons.

One year later his mother took him with her to Newark, where Jesús completed eleventh and twelfth grades. About this change, he said:

I could not follow the classes. I was under a lot of pressure. Fortunately, my teacher in Newark spoke with the principal and transferred me to the bilingual program. I didn't like being separated from the other kids but I liked that in this program there was a teacher who helped me with my English. This teacher started to spend her lunchtime with me. During lunch, we discussed readings that she had given me in advance. On Fridays she gave me lists of words that I had to define and then use in sentences that I had to compose during the weekend.

After coming back from Puerto Rico, he had started seeing his father, who had just married a native English speaker. When he saw them, his father and stepmother spoke to him in English so that he could practice. By twelfth grade, he said, he started to feel comfortable speaking English. This did not mean, however, that he could read and write in English.

Jesús said that he had problems in school because nobody encouraged him to study at home. But by the time he entered eleventh grade, he started to enjoy success. He attributes it to his competition with Pablo, his best friend. He explained that at the same time as they competed against each other for better grades, they helped each other to find more efficient ways of studying, organizing information, and concentrating.

Jesús entered Rutgers University in the summer of 1994 through the Educational Opportunity Fund (EOF) program (see Appendix A) of the Academic Foundations Center. Since his parents did not have enough money to pay for his tuition, EOF started to pay for the portion of the tuition that was not covered by federal and New Jersey financial aid. He also received a student loan so that he could live in the university dor-



mitories, where he has been since the fall of 1994. At the end of the fall semester, he applied for a scholarship to the Minority Biomedical Research Support (MBRS) program (see Appendix A), which he expects to enter in the fall of 1995. Meanwhile, he is taking basic science courses as well as English as a second language. His limited academic skills, however, are interfering with his performance in the science courses. For example, Jesús said that the teacher of the general biology course had given him a C because he had outlined an answer to the exam rather than written an essay. He concluded that he needed to learn how to write well and that because he now had a stable life he was going to be able to focus on his writing.

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### **Ana**

By the time I wrote this case study, Ana had finished her B.S. at Rutgers University in Newark and was offered a scholarship by the MBRS program to work on her Ph.D. However, she was hesitant to accept it. Ana was born in San Juan, Puerto Rico, where she attended elementary and secondary school in a private institution and two years of college in a private university. Before moving to Newark, Ana lived with her family, which consists of her parents, three sisters, and two brothers. Her father, a physician, supported Ana while she lived in San Juan. Ana explained that she decided to transfer to Rutgers because she wanted to attend a university with a good biology department. Her sister, who was at Rutgers completing a degree in political science, recommended Ana to the director of the MBRS program, who gave Ana a scholarship as soon as she was admitted to Rutgers because of her good grades and high scores in the placement tests. Ana described the MBRS program as follows:

When you are in the MBRS program you get a job. When you are accepted you are given a brief description of the researchers who need assistants and a brief description of what they do. You send your package to these researchers, and they select the applicant or applicants they want to work with. In addition, you get six hundred dollars to travel. That's why I could go to present [a paper] at a neuroscience conference in California.

The MBRS scholarship covered her tuition and paid her a salary to work in a laboratory of the Neuroscience Center. During the past two years she has also been working as a tutor for the Academic Foundations Center. In addition, her father has partially supported her.

The transition from one university to another seems to have been smooth in part because Ana had good foundations in mathematics and science. She explained that she had acquired these foundations while studying in Puerto Rico and that although she had learned them in Spanish, she could transfer her knowledge to English with no difficulty. She admitted, however, having problems with some terminology used by professors in the science courses during the first year. In her own words:

At the beginning, I thought that it was going to be difficult for me to follow science classes conducted in English. However, I discovered that since I was familiar in Spanish with most of the concepts we dealt with in class, I only needed to know the equivalent words in English, which were not so many. It was only in the courses of neuroscience that I felt a little lost. I was not familiar

with some concepts and vocabulary used by professors in this area, so I needed to read about the brain. I also read articles recommended by the teachers in the department. Gradually, I became familiar with their way of talking.

When asked about her writing in science courses, Ana said that by the time she finished English 102, she felt confident writing reports and expository essays in the science courses she took. She explained that she had learned to write scientific reports during her two years of university in Puerto Rico. Ana had also studied English in high school and taken intensive English classes afterward for two years before coming to the United States. During her first year at Rutgers, she took English 101 and 102, the composition courses that all students are required to complete.

After describing the MBRS program, Ana added that Professor Bako, the researcher who was her mentor, had been very helpful during her undergraduate studies. She explained that he had helped her a great deal to understand concepts and assignments that had presented difficulties in her work as a research assistant and in her science courses.

In one of our last interviews, Ana spoke about how hard it had been for her to adapt to the environment of Rutgers University. She complained that she had not been able to make friends among classmates or coworkers. Although she lived with her sister Patricia, the two seem not to spend much time together. During the four years of undergraduate studies, Ana spent most of her time in the university either taking classes, studying in the library, or working in Professor Bako's laboratory. Ana said that in Puerto Rico students studied in groups and helped one another with assignments, but at Rutgers students worked individually and there was no emotional support. Apparently, this was a serious problem for her. She insisted that I write about how, although she had found her studies intellectually stimulating, she was hesitant to continue because of the isolation she experienced in this environment. She said that she missed working with people who spoke Spanish and shared her culture. It remains to be seen to what extent the cultural isolation and lack of affective support by the scientific community in the university will influence her decision about graduate studies.

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## Discussion

Ana did not have to take a preparatory science course like the one I required of Jesús. Therefore, what is taught and learned in such a course reveals the kinds of skills and knowledge that students like Ana have, and students like Jesús are expected to have, to succeed in science courses. It also highlights pedagogical issues, such as the need to integrate language instruction into the science curriculum, which would require many more hours of class or coordinating science instruction with ESL classes. The student needs documented in the description and analysis of this course are better understood when they are analyzed against the context of the educational processes of Jesús and Ana.

Jesús has not had many opportunities to develop his academic skills consistently in either English or Spanish. His acquisition of English was interrupted by his move to Puerto Rico. Eight years later, his development of those skills in Spanish was interrupted when he and his mother moved back to Newark. Ana, on the other hand, had the opportunity to develop her academic skills in Spanish and use them to learn science foundations. Later she was able to transfer them into English. This transference is explained by the threshold hypothesis discussed by Cummins, whereby the knowledge

of the first language allows one to reach a threshold that allows for learning the second language.<sup>14</sup>

The cases of Jesús and Ana speak to some of the literature reviewed here, which suggests that the more distance there is between the language and discourse familiar to students and the language and discourse used in school, the more difficult it is for students to learn a subject. Even if Jesús had been born in the United States, he would not have had enough opportunities to participate in speech communities that include academic discourse. The fact that Ana's father was a physician probably made Ana familiar with scientific discussion at home. In addition, her middle-class upbringing makes it likely that in her home she acquired reading and writing skills compatible with those used in school. According to the research above, middle-class children acquire secondary literacies through experiences at home before and during their school years.

Research continues to find differences in dropout rates between socioeconomic groups. In 1992, according to the Aspira Institute for Policy Research, 44.7 percent of Latino students between the ages of sixteen and twenty-four from low-income families dropped out, compared with 25.2 percent from middle-income and 9.6 from upper-income families.<sup>15</sup> In the same year, more than half (52%) of all Puerto Rican children lived in poverty. In 1990, 37 percent of Hispanic children whose parents had a grade-school education or less lived in poverty, compared with 19 percent whose parents were high school graduates and 14 percent whose parents had continued their education beyond high school. Thus, there is a direct correlation between the education of these children's parents and their levels of poverty.

The academic difficulties in English and science that beset Jesús also seem to be rooted in his school changes. Most of his efforts in school seem to have been directed toward adapting to the different environments of Newark, New York, and Puerto Rico. His situation, however, is not unique. From 1897 to the 1960s, the U.S. government's language policy for Puerto Rico was mainly to increase the use of English on the island. A reverse migration brought thousands of children who were not proficient in Spanish back to Puerto Rican schools.

By the time Jesús went to live in Puerto Rico, the Department of Education had identified 78,041 students who had returned from the United States and required special Spanish-language instruction. They accounted for 11 percent of the island's total public school enrollment.<sup>16</sup> The 1978 amendment to the Federal Bilingual Education Act allowed Puerto Rico to serve the needs of students with limited proficiency in Spanish. This effort failed for a number of reasons, including inconsistent funding and a lack of prepared teachers, according to the Inter-American University. When its report was issued, only 10 percent of these students were receiving adequate instruction in English or Spanish as a second language. According to Llabres de Chameco, many returned migrants speak English well but do not read or write it. Some speak street Spanish well but do not read or write it.<sup>17</sup> This description fits Jesús.

The experiences of returned migrants with Spanish was similar to those faced by their parents in learning English on the mainland. Both groups were forced to study in a language that most of them did not understand and in which they were misunderstood by classmates, teachers, and administrators unprepared to deal with their needs.

While most studies of returned migrants have focused on the problems they face in acquiring academic literacy in Spanish and adapting to the island environment, little has been said about what happens to the learning process of students who, like Jesús, return to the mainland years later to continue their studies in English.

When I started to interpret my data about Jesús, I found that in Jesús' education there have been support communities and speech communities that were instrumental in his acquisition of literacy: the Bilingual Education program in secondary school, the EOF/AFC and MBRS programs in college. These communities provided the context for him to learn academic language and content. While they supported him along his way, it seems that he will need more of such help to achieve his educational goals.

While growing up, Jesús and Ana participated in a variety of speech communities, which are defined in functionalist terms by Sherzer as systems of organized diversity held together by common norms of speaking and aspirations.<sup>18</sup> In New York City, where Jesús lived twice, he participated in two speech communities: English in school and Spanish at home and with friends. In Puerto Rico, he had to learn the norms of the language used in Hormigueros, where he was discouraged from speaking English. In Newark, he participated in at least three speech communities. In school and in his father's home, he was expected to speak English, and at home both Spanish and English. Jesús' speech communities did not include academic discourse. In Puerto Rico, Ana used Spanish at home and school and English only in school. The use of language in these two settings seems to have been consistent. Also, she was probably exposed to a scientific community at home, in high school, and at the University of Puerto Rico. Participating in the MBRS program as soon as she entered Rutgers gave her the opportunity to learn a new scientific language and to practice in English the scientific dialogue she had acquired in Spanish.

Schumann states that how well and how fast students learn a discourse depends significantly on social factors such as intergroup relations.<sup>19</sup> Jesús is now expected to command a scientific terminology to perform successfully in his science courses. To learn it, he has to find ways to participate in settings where it is used. Relationships like those he established with his friend Pablo and his science teacher in Puerto Rico allowed him to advance intellectually. Now he has to find their counterpart in the university. Vygotsky noted that the cooperation between students and their teachers, or peers who function as teachers, is central to students' cognitive development.<sup>20</sup> From this perspective, failure may be blamed on a social system that does not provide linguistic minority students with the appropriate social interactions necessary for their social development.

Jesús still has a long way to go. He is participating in ESL classes, which are helping him improve his academic skills in English. At the same time, he is taking preparatory science courses that are helping him build the background knowledge he will need. When he leaves these classes in approximately one year, he might qualify for a scholarship in the MBRS program.

Ana did not have to take preparatory science courses at Rutgers but is finding it hard to cope with isolation and cultural alienation. She seems to need a way of integrating her studies, her work, and her life so that she can find the strength necessary to pursue graduate studies.

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### **Contextualizing Policies to Increase the Participation of Latino Students in Science**

The low representation of Latinos in higher education science programs documented at the beginning of this article indicates that there is a need to increase the enrollment of Latino students in science programs while improving the retention rate of those already

enrolled. To achieve this dual goal, we have to establish a clear policy for the design of appropriate curricula and support services, which requires the following: (1) a careful assessment of student needs; (2) an accurate definition of academic literacy; (3) an integration or coordination of language and content instruction; and (4) an evaluation of approaches to teaching language and science that permit us to achieve realistic goals.

1. An effective assessment of Latino students should take into consideration their language proficiency and education in their first and second languages. Assessment of the language and knowledge of Latino students is usually conducted only in English. Research in second language acquisition has shown that the knowledge acquired in one language can be transferred to another. Likewise, the literacy acquisition process in a second language by those who have reading and writing skills in their native language usually speeds up once they reach a level of English proficiency at which they can transfer their academic skills from their first to their second language.

2. We need to specify the contexts in which students are going to use the acquired literacy. We need to define better specifically what students must know and design curricula accordingly. This, in combination with accurate assessment, can help us bridge the gap between the knowledge and skills of students and the academic standards of universities. Interpretations of the literacy of linguistic minorities that view literacy only as a set of skills that students must command, ignoring socioeconomic, cultural, and circumstantial components, often simplify the complex social issues and hide the social inequalities at the root of their illiteracy.

We need to envision academic literacy beyond its skill-oriented focus and include the social, cultural, and economic dimensions of students' lives as the framework for literacy. To the degree that we are able to integrate such an orientation, we will either continue to disable students with limited English proficiency, as Cummins contends, or empower them through their own processes.<sup>21</sup>

3. An educational approach that considers language alone and ignores content is inadequate to the needs of LEP students. Mohan believes that the task of devising a policy for the integration of language and subject calls for the development of a more integrated model of learning.<sup>22</sup> Such a model should provide a theoretical background and guidelines for educational policy.

To improve the retention of Latino students who are limited English proficient, we must pay closer attention to the role that language plays in teaching and learning in evaluating students' academic performance, in the social interactions that take place in school settings, and in the way schools and classrooms are organized. Not every school has set itself the task of devising a policy adequate for integrating language instruction and curriculum.<sup>23</sup>

Language and subject matter are usually considered in isolation from each other, and many educators treat them separately. Some bilingual programs integrate language instruction and content in elementary and secondary education. But these programs are becoming rare because of a national tendency to equate bilingual education and English as a second language. Bilingual programs in higher education are exceptional. I know of two: Keàn College of New Jersey and Erie Community College address the needs of LEP students by offering science instruction in Spanish. At La Guardia Community College, ESL instruction has been coordinated with courses offered by the Nursing Department.

4. The way science is taught may be one of the factors contributing to the decrease in the number of science majors at a time when college enrollments are climbing.<sup>24</sup> Kessler

says that for English to serve as a medium of science learning for nonnative English students, language and science content should be integrated.<sup>25</sup>

This requires organizing science experiences in ways that foster development of both language and cognitive processes. The authors of *Undergraduate Science Education* conclude that if science instructors are more preoccupied with covering the syllabus than with how much the students understand and learn, many students will do poorly and drop out of these courses or switch to other majors. According to this report, science professors tend to teach the way they were taught, regardless of the heritage of those they instruct.<sup>26</sup> In other words, the lecture remains the primary form of instruction. Compared to their colleagues in the humanities, education, and the social sciences, science faculty are much less likely to employ student-centered pedagogy such as cooperative learning and class discussions.<sup>27</sup>

When one works with limited-English-proficient students, particularly with nonnative English-speaking students, awareness of how much time it takes for them to acquire academic skills and perform in a second language is crucial. In science courses, it may be desirable to dedicate more time to developing academic literacy. This would give teachers more time to focus on helping students acquire scientific terminology to learn to use computers, the library, tables, and graphs in ways in which learning is interactive. To address the specific needs of native and nonnative English-speaking students among different socioeconomic groups, we have to grasp the differences in their needs. Underestimating their differences leads us to set quixotic goals that can result in frustration for both students and teachers. The multiple factors that affect the literacy acquisition process of Latino students in science programs point to their need for supportive communities such as the ones I have described. These communities can integrate them into the mainstream science programs by both encouraging them to use their learning sources and exposing them to the scientific dialogue and knowledge expected from them in the field of science. My four recommendations seek to promote their integration into mainstream science programs. First, a holistic and accurate assessment of Latino students permits us to learn about these students' complex realities. This knowledge is necessary to understand the differences between the standards of the university and the students' academic skills and background knowledge. Then, a realistic examination of literacy acquisition processes and the ways language is used in science gives us the extra information we need to design curricula that meet students' needs. Finally the integration of language and content and the selection of appropriate approaches help us ensure that science programs can address students' linguistic and educational needs beyond entry-level courses. ■

## **Appendix A Sources of Aid**

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### **Educational Opportunity Fund (EOF)**

The Educational Opportunity Fund was established by the New Jersey legislature in 1968 to increase access to higher education by providing financial assistance and support services for “needy” New Jersey residents attending the state’s colleges and universities. The program is the most comprehensive of state-funded efforts to eradicate inequality in higher education. The EOF program, which is administered by the New Jersey Commission of Higher Education under the guidance of a board of directors, serves more than twelve thousand students at fifty-eight colleges and universities. Since its inception, EOF has been a major access route to higher education for minority students, twenty-five thousand of them having graduated. Approximately 70 percent of the students enrolled through EOF are black and Hispanic, groups underrepresented in New Jersey’s colleges and universities.

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### **Minority Biomedical Research Support (MBRS) Program**

This program, funded by a grant from the National Institutes of Health, was designed to encourage minorities to enter biomedical research careers by offering a hands-on learning experience. Both undergraduate and graduate students are assigned as research assistants to professors and are encouraged to coauthor scientific reports and present their findings at the Conference of the National Institute of General Medical Sciences and other scientific meetings. Eligibility for the program is determined by ethnic origin (African-American, Latin American, Native American, and Pacific Islander), legal status (U.S. citizen or legal alien), and grade-point average (3.0 or better). The retention rate is estimated at 85 percent, and there have been eighty graduates since the 1984 inauguration of the program at the Rutgers-Newark campus.

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### **Academic Foundations Center (AFC)**

The Academic Foundations Center of Rutgers University in Newark admits underprepared students who have the potential to succeed in college but do not meet traditional academic criteria to enter Rutgers. Most of its students enroll through the EOF program, which provides funding for scholarships and for a good part of the AFC infrastructure. The AFC, which provides a summer college-readiness program for incoming freshmen, also offers developmental courses in English, mathematics, and science. Advisement, counseling, tutoring, and student activities round out the services this center offers throughout the four years of study. Additional services available to nonnative English students include ESL courses during the summer and academic year, bilingual counseling, and bilingual tutoring. This center creates a sense of community among its participants, which eliminates some of the alienation Latino students experience in college.

## Notes

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