puntos adicionales. Esta estrategia logró un triple objetivo: mejorar el rendimiento del grupo para obtener bajos índices de reprobación e, implícitamente, crear la motivación suficiente en los alumnos para realizar estudios posteriores en esta área y fomentar el trabajo de conjunto entre los estudiantes.

Según MASLOW, el máximo nivel de su teoría de las necesidades es la autorrealización, mismo que se ve reflejado en los estudiantes al querer aprobar dicha materia, y si analizar que se trató de un solo grupo en una facultad de ingeniería en particular, se puede concluir que los resultados fueron muy satisfactorios, se logró que los mejores elementos de este grupo mostraran mayor interés por esta especialidad debido a la gran satisfacción y retos que experimentó cada uno de ellos. Esta motivación favorecerá, muy posiblemente, los ingresos a nivel maestría y doctorado, situación que mejora enormemente la calidad del área y de sus egresados.

En cuanto a los demás estudiantes, se logró que cambiaran favorablemente su opinión inicialmente negativa respecto a la Mecánica de Suelos, que igual pudo tratarse de alguna otra, y consideraran cierta posibilidad de estudios posteriores sobre esta área. Además que el rendimiento de los alumnos, en general, aumentó teniendo bajos niveles de reprobación respecto a los comunes presentados en esta materia.

Por todo lo anterior, si esta estrategia fuera llevada a cabo en todos los grupos y en todos los cursos, de todas las escuelas y facultades de educación superior, se aseguraría mayor número de estudiantes interesados y motivados en terminar satisfactoriamente la licenciatura y se fomentaría el deseo de realizar estudios posteriores de especialización y de investigación; lo mismo se aplica para cualquier otra licenciatura.

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Received: 26.02.2004 / Approved: 8.05.2005

Students' worldviews and school science: a David and Goliath confrontation?

Las perspectivas del estudiante y la ciencia escolar: ¿una confrontación entre David y Goliat?

WILLIAM MEDINA JEREZ

Science Education Center. The University of Iowa, Iowa City, Iowa. P.O. Box 769. 52244-769. USA
william-medina@uiowa.edu

Abstract

In the last decade, the field of science education has given special attention to cultural issues in its research agenda. The core of one such orientation in research is to consider both the culture of the official science, in the classroom, and that of personal worldviews held by the students. Since a confluence of these ways of "knowing" is inevitable, investigators today worry about the role of traditional worldviews in an age of school science that presents only dominant and conventional agendas. This perspective will be examined, along with other possible measures of significance for the interest of science educators in multicultural classrooms.

Key words: culture, subculture, worldviews, science education.

Resumen

En la década anterior se observó que los aspectos culturales ganaron prevalencia en los estudios realizados en el campo de la educación en la ciencia. Dentro de esta linea investigativa llama la atención la consideración que se ha otorgado a la cultura de la ciencia oficial en el aula y de otra parte, las perspectivas o saberes del estudiante. Sin embargo, el rol hegemónico de la ciencia oficial frente a las perspectivas culturales del estudiante aparece como el aspecto que causa preocupación en la comunidad de investigadores en esta área. El presente artículo hace una presentación de esta confluencia de saberes al tiempo que propone acciones importantes para la educación en la ciencia desde una perspectiva multicultural.

Palabras clave: cultura, subcultura, perspectivas, educación en ciencias.

INTRODUCTION

The field of science instruction has evolved throughout its history. COBERN and AIKENHEAD (1997) observe that the initial research was done based on psychological theory to examine personal constructivism and the abilities of individual learners in their early years. Later, the goals aimed at exploring learning implications in social settings (social constructivism, science for specific social purposes, and situated cognition). Currently, the studies by COBERN (1993); COSTA (1995); PHELAN *et al*. (1995); AIKENHEAD and JEGEDE (1999); and GEORGE and GLASGOW (1999), have moved research notably towards an anthropological orientation which contextualizes science education with regard to culture. A significant amount of research has addressed the role of so-called children's science or alternative conceptions (MCKINLEY *et al*., 1992); traditional knowledge (GEORGE, 1999); the sub-cultures of every day life (AIKENHEAD and JEGEDE, 1999); micro-cultures (MADDOCK, 1981; OGAWA, 1995); and folk knowledge (POMEROY, 1994).

The science education community generally acknowledges the urgent need to practice more culturally sound instruction that helps students to expand beyond the frontiers of their science classrooms to where the two sub-cultures converge and find mutual meaning and application. According to this perspective, some authors (AIKENHEAD, and JEGEDE, 1999) advise that learning science should allow students to travel comfortably from their everyday life-worlds into the world of science found in their classrooms - and why not, back to their personal views of the world? Others, such as MCKINLEY *et al*. (1992); KROMA (2003); and PALMER (1999), contend that childhood mindsets in science, although not scientific, influence what learning may or may not occur. Nevertheless, with an ever-dominant dependence on the western educational model, these perspectives face a resistance that demands an automated and defined educational style that promotes a globalization of western science. It should be clarified that the term 'western' in this manuscript has a solely historical connotation. The term 'western' refers first to the organization of the Roman Empire. Today, the attribute indicates the relationship between Europe, the United States of America and Canada, which share a linguistic and cultural past. 'Western" will thus serve as an expression to distinguish a cultural and geographic separation between the two traditions, and also implies different levels of modernity.

STUDENTS' WORLDVIEWS

It is widely accepted that learners carry everyday ideas, conceptions, beliefs and understandings from local communities into the school environment. This set of images and understandings is rooted in the child's direct interaction with phenomena ocurring in vast cultural surroundings, that, as noted by HAWKINS and PEA (1987), are shaped by objects, people, media, informal learning situations and practices of institutions such as schools. Nevertheless, the invisible presence of students' cultural backgrounds seems often to be openly marginalized in the science classroom, which provokes students to develop dual attitudes; one of them, the apparent acceptance of westernized science instruction within the schoool environment; and the other, an acknowledgement and practice of their personal and cultural ways of knowing in the spaces where every day experiences actually occur. Interestingly, students have demonstrated how well they perform this task in both settings. To prove this, if a student were to engage in an informal conversation and he or/she were allowed to talk at length about nature, it would be expected that his or/her views might lack connections between science and dialy world experiences. Surprisingly, academic success does not necessarily mirror an accpetable level of scientific literacy; science-oriented and personal views about nature are kept separately and available to serve different needs. That compartmentalization of knowing and behavior leads students to, as pointed out by COSTA (1995), "leave their personal life at the door of the classroom and take it up again like a backpack when they leave (p. 331)".

Western science in the classroom therefore fails in many regards, especially when the incompatible science taught within local cultures is deemed within the same setting to be unworthy, perhaps because of non-scientific foundations, and also because the "image of scientific knowledge often differs from the knowledge used in life world experiences (KYLE, 1999)". The prevalence of this form of instruction over the so-called folk knowledge, which remained ignored in the school science context, produced an underground generation of students who are imperceptible in the school landscape, but are vividly rejecting a journey for which they do not have a map. According to BAKER and TAYLOR (1995), even the same traditional educational system seems to accept, implicitly, the superiority of the (western) scientific view of the world and the concomitant inferiority of the learner's worldview. It also has been admitted (TORRES GARAY, 2004) that students are taught that there is a huge gap between the two forms of knowledge. The disparity between school science and the worldviews of students has been attributed to a conflict between sub-cultures, the subculture of science in the school and the particular life worldviews of students (COSTA, 1995; AIKENHEAD, 1996; OKEBUKOLA and JEGEDE, 1990; BAKER and TAYLOR, 1995). OGAWA (2002) goes one step further and proposes not two, but three domains; western modern science, indigenous science, and personal science. In his descriptions, the author regards the first as "a collective, rational perceiving of reality, which is shared and authorized by the scientific community", indigenous science as "a culture-dependent collective perceiving of reality", and personal science as "a rational perceiving of reality, which is unique to each individual. (p. 1)" The term 'indigenous', in these definitions, is meant to represent the constructs underlying the assumptions people make about every-day world life situations, and not necessarily the manisfestation of practices traditional in tribal groups around the world.

In developing countries, students have declared that their schooling experience often makes them feel as though they were dwelling in a foreign country. According to AIKENHEAD (1996) and JEGEDE (1994), this feeling is grounded in recognizable mismatches between the culture of western science and their indigenous cultures. In many of these nations the official school view is the result of western culture (GRAY, 1999). SIMILARLY, INGLE and TURNER (1981), and OWAGA (1995) contend that science programs in these nations often are taken directly, with little or no adaptation from the science programs in truly western nations. As a consequence, WALDRIP and TAYLOR (1999) observe that "in developing countries the process of enculturation into western school views implies a devaluation of the students' traditional worldviews which govern their lifestyles (p.281)" In his view, KROMA (2003) points out that as a result of the prevailing and yet often inappropriate western view of the world, science education in developing nations has become impoverished, and he goes on to say that "children in many third world communities are not exposed to the indigenous knowledge of their communities, and what is more, they are exposed to formal school subjects without mediation with their local contexts" (p.1). BOTH, KYLE and GRAY (1999) note that the emulation of foreign educational approaches in developing countries has proven to be ineffective. In their view, the hegemonic image of the first world scientific model that is implanted in non-western classrooms via formal science instruction, limits the desicion-making process of those heading educational systems in these nations.

Consequently, it would not be extreme to say that if this trend continues to invade non-western science classrooms in such a pervasive way, so these nations will lose an exceptional opportunity to create science curricula relevant to their national cultures, a valuable investment needed to enhance and sustain vital cultural and socio-economic improvements with a more participatory and committeed citizenry. Preventing this disappointment would require that developing countries be more critical of policies, practices and curricular materials that emanate from the developed world. Instead, their educational efforts should be driven by nationally and autonomously contextualized thought.

GEORGE (1999) delineates the process of learning western science by non-western pupils as a journey that extends beyond the boundaries of family and culture into the grounds of a distant body of concepts. In so doing, students are inducted into activities of a larger dominant community (a sub-culture of school science). Although this induction begins in science classroom settings, it has powerful and perhaps damaging effects on traditional culture and identity in the student's home and community. In this regard, it has been documented (WALDRIP and TYLOR, 1999) that students may find themselves negating, disguising or simply ignoring aspects of their own cultural heritage that are discussed. The uneasiness with which students face school science is not necessarily an aspect found soley in the classrooms of developing nations, but also in some western school communties (AIKENHEAD, 1996). A large portion of this puzzle has to do with the negotiation made by students as they attempt to transit from one sub-culture to another. Moving in and out of the sub-culture of school science makes the students employ a number of strategies for survival in the foreign sub-culture of school science. In an effort to explain this behavior, JEGEDE (1994) presents the theory of collateral learning which accounts for the avoiding tools students use when reacting to the stress embedded in unfamiliar systems of knowledge. These students, according to this theory, "construct side-by-side and with minimal interference and interaction western and traditional meanings of a concept (p. 67)", pretending to absorb foreign sets of knowledge in their personal schemata. This phenomenon is certainly not news for teachers and administrators. In fact, they admit that their pupils are 'gaming the system' and that actions need to be taken to re-conquer the genuine interest and curiosity that abound in elementary school classrooms.

CULTURES AND SUBCULTURES

"In an African study authors concluded that the rural participants in the project were irrational because they used traditional ideas to explain phenomena in nature (COBERN, 1994) (p. 10)". In a series of manuscripts, OGAWA (2002) contends that every culture has its own science, that is, knowledge about nature, knowledge in informal learning environments, and knowledge about the means on how to approach the natural world. Some researchers (GEORGE, 1999; AIKENHEAD, 1996) argue that learning science is by itself an exercise of migration between sub-cultures. It has also been observed (BAKER and TAYLOR, 1995; JEGEDE, 1994; POMEROY, 1994) for instance, that the transition from one subculture to another is almost always a frustrating and slow process because students with 'traditional backgrounds' are forced to learn a subject matter grounded in western culture. Others admit that education in science should adopt a pluralistic perspective. In this concern, OGAWA (2002) suggests a multiscience approach in teaching and learning science. KYLE (1999), asserts "there is no a singular or universal knowledge, rather there are multiple knowledges" (p. 257). In other words, science education practices should create dynamic and plural scenarios where everyone's practical experiences, as well as his/her way of participation in the real world, are taken into consideration.

In education, some investigators prefer to talk of multiethnic or cross-cultural education (ATWATER and RILEY, 1993), but the term multiculture came on to the scene in the middle of the last century. Since then, 'multiculture' has gone through redefinitions while being advocated by numerous educational researchers. BANKS & BANKS (1989), for instance, defend this perspective by pointing out that this effort should enable schools to allow students from different ethnic origins, gender and academic competencies to excel while in the schooling process. In turn, ATWATER and RILEY (1993) contend that the main goal of a multicultural education should be set at emphasizing the development of communicagtion skills for cross-cultural and interethnic group interaction. The term culture is extensively used in the daily language spoken by almost all people, in different contexts, and within their particular worlds. Yet the word implies a range of different connotations depending on its environment; one can refer to an African culture of music and dance, or to the culture of the highlands indigenous people in the Andes of Bolivia, or to that of Oriental cuisine or fashion. Even the culture of consumerism, religion, sport and leisure, or any other particular lifestyle practiced by a community should be considered cultural in nature.

Different researchers define this concept according to varying terms. PHELAN, DAVIDSON and CAO (1996) delineate culture as the combination of norms, values, beliefs, expectations, and conventional actions of a group. In turn, GREETZ (1973) talks about culture as a system of meaning and symbols shared by the members of certain groups as they interact, such as the members of the scientific community who establish the standardized norms that govern their procedures. In this document the term culture will align with the above definition that was employed by COSTA (1995) and AIKENHEAD (1996) who in turn, elaborate upon PHELAN, DAVIDSON and CAO (1996). The selected cultural framework leads to the consideration of sub-cultures within cultures. That is to say those immersed in each culture include groups of individuals who share common attributes (language, race, ethnicity, social class, beliefs) which prescribe the activities and the roles they assume. Therefore, it is predictable that each individual, depending on the diversity of his/her eco-culture, belongs to multiple sub-groups or sub-cultures. In everyday life, people move among settings and are enmeshed in the differing sub-webs of meaning that provide the cultural context to their activities (MEDVITZ, 1996).

In the context of science education, it has been observed (COSTA, 1995) that 'powerful sub-groups' influence students' participation in the class-room world. Factors such as the media, physical and economic environments, and, as COSTA (1995) points out, family, peers, and school, influence the student's participation in this particular world (western science). It is important to recognize that science itself is a subculture of western or Euro-American culture (BAKER and TAYLOR, 1995; COBERN, 1994; JEGEDE, 1994) and that consequently western-based science can be thought of as a sub-culture of science. (AIKENHEAD, 1996). But evern within western (developed) cultures there is a huge problem linking science education to the real worlds of the student outside the classroom. Many of them 'learn' science as a set of dissociated or meaningless ideas or words for the purpose of gaining a qualification or 'satisfying' the teachers requirements. Stemming from this standpoint, modern reforms in science education have proposed that efforts should be oriented at making a high quality science experience affordable for various student populations, that is, allowing different mindsets to come together into the teaching and learning of science (ATWATER, 1993). In OGAWA'S (2002) terms, a multiscience movement should recognize that different forms of knowing are possible in the classroom and that each of them should be respected.

THE SUBCULTURE OF SCHOOL SCIENCE

It is known in one way or another, that students in science classrooms experience a disenchantment when dealing with the demands of this 'foreign world' and the disillusionment that their teachers blame on a lack of commitment on the part of their pupils, especially those in the higher grades. If one asks students about their perceptions of science, it woud not be surprising to hear them associate its image with webs of non-sense facts that must be mastered at any cost, to maintain the status of an inductee into the canonical world of science, and its practitioners, the scientists, as a "slightly scatty egghead who is a male, with white coat and receding hairline, engaged in dangerous chemistry experiments with flasks of fuming liquids (SOLOMON *et al*., 1994) (p. 342)".

GEORGE and GLASGOW (1999) recognize "the gate-keeping role" (p. 2) played by traditional science teaching instructional approaches, which for the most part, function under the premise of delivering sets of contents within a timeframe, hoping that students learn science with increasing levels of difficulty and abstraction. Unfortunately, this view seems to be accepted as the only qualified method for teaching and learning science, and very few efforts have been made to advance this field towards instances in which learners find, in their daily life experiences, an image of science supported by all possible worldviews about natural phenomena. Customary models of science teaching have the tendency to obscure and avoid students' idiosyncratic backgrounds, presenting science as the exclusive passage to reach to the understanding of science in the fashion proclaimed by the scientific community. Aikenhead (1996) suggests that students should be given opportunities to transit comfortably between the worlds of conventional science and the ones encountered in traditional contexts. In order to achieve this goal, COSTA (1995) suggests metaphorically, that educators should play the role of 'tourism guides' freeing and advising students while engaged in exploring and making the move from one domain to the other, or in Aikenhead's (1996) terms, educators as 'cultural brokers'.

SOLOMON (1994) points out that an explanation for the cultural mistmatch can be found when examining how knowledge is built by both the members of a scientific community and those outside the scientific arena, for instance, teachers, students and the general population. Epistemologically, the scaffolding upon which knowledge is constructed and embraced by the two, involves notable divergences. Some arguments claim that the kind of science praticed in school does not look like that one conducted by scientists (Millar, 1989), due to the absence of coherence and other epistemological qualities. Others (COSTA, 1995) firmly believe that a meaningful education in science is possible when providing students with worthwhile experiences and when they have ownership in self-oriented inquiry tasks, when they and their educators, discover that the connections and extentions of science into socio-cultural contexts are highly profitable. Yet for others such as FENSHAN (2000) the divergences between the two domains result because the sub-culture of science continues to transmit an incomplete image of the dominant sub-culture, "school science has some characteristics of science but certainly not all of them (p. 9)".

BRIDGING THE GAP

Issues of fairness and equity have been identified as the most imminent aspects that need to be tackled in education (KYKE, 1999). Adapting HARGREAVES'S (1996) views about equaility in the school setting, it would be reasonable to think of education in science as a practice grounded on principles of (1) humanity, where "all voices are worth listening" (p. 16); (2) democracy, in that the voices of those whose lives are part of the educational community are heard with attentivienss and sincerity, and (3) professionalism, which avoids demeaning or dismissing the cultural contribution that students offer in science.

Acting in line with these issues requires that school administrators, policy makers and science educators pay special attention to a variety of possibilities that could make science education a more culturally sound practice. It is not a simple task when the set of demands from the socio-economic context of the school are considered. Nevertheless, valuing the science-related thinking that students bring to the classroom, which requires understanding the nature of traditional science, and being aware of how these views suit and best serve the construction of knowledge, could guarantee a good start. As noted before, it has been recognized that various forms of knowledge are ordinarily used and plausible in the sense-making of reality. In this regard, BANKS (1993) suggests that when students are presented with different types of knowledge, they are then capable of developing their own interpretations about nature. In his review, school knowledge appears as the organizing piece, comprising personal/cultural knowledge, popular knowledge, and academic knowledge. In sum, the knowledge offered in school lessons should reflect and represent "the concepts, explanations, and interpretations that students derive from personal experiences in their homes, families and communties" (p. 6).

Considering knowledge from a plural perspective, then leads us to a stance where all possible ways of knowing and voices are to be central in the education in science, and most importantly, where connections with the real world experiences of the learner, and with other academic disciplines in school, are to be found highly enriching. From this standpoint, science educators need to play a significant role. They are the ones who, as expressed by COSTA (1995) and AIKENHEAD (1996) should serve as 'tourism guides' or 'cultural brokers', administrating teaching and learning scenarios in a way that the scientific view of the world is presented from the outsider's perspective, and not merely centered in scientism as the only valid instructional approach available.

In most cases, teachers are under the demands and constraints of national and local educational goals, which include the competition of standardized formal testing. For education to be more concerned for its multidimensional role, the scientism of the teachers must be deconstructed. While teachers must keep their positions and stay within national and local guidelines, they must also pioneer elements of creativity and individualized curricula. There are still opportunities to make science education meaningful and relevant for both educators and students, while also perserving traditional cultures.

CONCLUSIONS

Currently, educational practices are viewed from a broader perspective, and a multicultural approach is emerging, particularly in science teaching. Consequently, science education has gained a status that makes it accountable for the achievement of such a goal. In one of his manuscripts, OGAWA (1995) points out that "science is a way, not the way of understanding phenomena" (p. 585), and ATWATER and RILEY (1993) contend that "the world consists of different cultural groups" (p. 667). Therefore the role that is expected to be played by the science education community now and in the forecoming years is to act in a concomitant fashion with these premises. The goal of this article was to offer a brief description of two differing postures about nature. Both the scientific view of the world enacted in the classroom, and the various modes of understanding the world held by each learner, are to be respected as meaningful approaches in science teaching. These postures are summerized in the question posed in the title of this article, is the confortation a David and Goliath situation? If the mission of education in science is viewed through pluralistic, dynamic, and fair lenses, then the answer to that questions is yes. As stated before, students in science classrooms should be offered and allowed to explore different views of the world, and science educators must accept daily activities as possible opportunities to accomplish the task of making science classrooms pleasant and inspiring spaces where various standpoints reconcile for the needed equality that must be present in the school atmosphere.

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Received: 26.10.2004 / Approved: 11.04.2005

La influencia de las secuencias didácticas sobre la construcción de narraciones de los estudiantes de enseñanza básica: un ejemplo sobre el tema electricidad

Effect of didactic sequences on narrative constructions about electricity of primary school students

DANIELA KOGA, MARÍA ELENA INFANTE-MALACHIAS, JOSÉ MARIANO AMABIS, SILVANA SANTOS

Departamento de Biologia, Instituto de Biociências, Universidade de São Paulo, Rua do Matão, Brasil
danielakoga@yahoo.com.br, marilen@usp.br, amabis@usp.br, silvana@ib.usp.br

Resumen

Este trabajo, relata la aplicación de secuencias didácticas sobre el tema electricidad, obtenidas de dos libros texto con enfoques diferentes, en cuatro cursos del octavo año de enseñanza básica, incluyendo cerca de 140 alumnos con edades entre 13 y 17 años. Son descritos: el diagnóstico de los conocimientos previos de los alumnos, las características de los materiales educacionales utilizados, la secuencia didáctica, el proceso de aplicación de los materiales, y la utilización de las narraciones de los estudiantes como evaluación. Con este trabajo se obtuvieron evidencias que indican la elaboración de distintas narraciones cuando los estudiantes utilizan libros basados en diferentes visiones de aprendizaje, en lo que se refiere a la fragmentación/cohesión de la narración del estudiante sobre lo que él aprendió durante el período de la utilización de un mismo concepto como eje central de su narración, la relación entre los conceptos, hasta su aplicación en nuevas situaciones.

Palabras clave: *Proceso de enseñanza-aprendizaje, libro del texto, conocimiento cotidiano, electricidad.*

Abstract

This paper describes didactic sequences based on different science textbooks about dealing with the topic of theme electricity. This study involved four middle school groupsof primary, with 140 students with ages from 13 to 17 years old. In this communication paper, there are descriptions about the of the diagnosis collection of of the students´ previous ideas knowledge, the characteristics of the science collections educational materials used, the instructional sequence, the process of applying using different textbooks in different classrooms, and the students´ narrative accounts were used to compare patterns of learning. Although it was hard to carry out perform the project as planned, there was were evidence showing that different materials, supported based on by different conceptions of learning, can promote different understandings about the same theme. This has been was seen when analyzing the coherence of their the students´ narrative accounts of what they learned when using the same concept as the focus for their ideas; about how they thought the concepts were interrelated; as well as how to apply them in new situations. if students use the same