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Engaging Disenfranchised Urban Youth in Science Learning

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Abstract: The purpose of this work was to elicit the perceptions of science educators regarding enhancing opportunities to retain disenfranchised students in secondary schools. The article shows selective international perspectives on how teachers, university professors, and researchers in teacher education programs strive to support school completion for disenfranchised students. Interviews were conducted in Canada and Spain. Selective sampling was used in order to focus interviews on individuals with particular expertise on the topic and individuals who work in cooperation with colleagues engaged in similar work. Anecdotes, comments, and opinions from the interviews support the basic contentions in the article. The authors strive to bring insight and awareness into the importance of training science educators in the adequate pedagogy and in their engagement in high school programs that prepare students for college. The researchers conclude planning and delivering of a science program needs to start from the students' experiences with the phenomena, and from their own connections to the subject and with the laboratory material. They also stress the importance of the role that higher education professionals play not only in educating high school science teachers in the adequate pedagogy for at-risk student retention, but also in engaging themselves in programs that prepare students for college.

Keywords: Disenfranchised urban youth; youth at risk; high school completion; student retention; pedagogy; educational policy; educational theory; science education methodology; alternative science teaching

Introduction

Disenfranchised urban youth in different environments and locations are similarly disillusioned by a lack of meaningful engagement in school and by poor opportunities in the job market. Many leave school prior to completion because of difficult home environments and lack of support in schools. This work intends to contribute to a body of literature aimed at addressing ways to meet learning needs of disenfranchised students (Wishart, 2009), as well as to contribute to policy development in education in both Spain and western Canada.

The purpose of this work is to elicit the perceptions of science educators in Spain and in Alberta, Canada regarding enhancing opportunities to retain disenfranchised students in secondary schools. The authors strive to bring insight and awareness into the importance of training science educators in the adequate pedagogy and in their engagement in high school programs that prepare students for college. Note that the terms "disenfranchised urban youth" and "youth at risk" will be used interchangeably in this paper.

Educators, in this research, are based at university locations in both Western Canada and Spain. This paper explores the question: what do science educators understand regarding the

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effectiveness of pedagogical approaches designed to increase the engagement and retention of disenfranchised urban youth? Additionally, it examines the similarities and differences in pedagogical approaches in Western Canada and Spain.

Specifically, science teachers may adopt remarkable techniques and strategies that not only are prone to attract students at-risk into science courses, but also encourage students to stay and engage in some way in their class activities. However, in the authors' experience, specific pedagogic conditions ought to be considered in order to genuinely contribute to the disalienation and educational growth of those students.

Methodology

Sites chosen for this work are located in Edmonton, Alberta, Canada, and in Madrid, Barcelona, and Valencia in Spain. University faculties and departments of education were chosen based on the relevancy of their work in education with disenfranchised high school students. Selective sampling was used in order to focus interviews on individuals with particular expertise on the topic and individuals who work in cooperation with colleagues engaged in similar work.

The researchers both have prior experiences teaching in secondary school classrooms with student populations of disenfranchised youth. These experiences inform research interests and directions. The Alberta component of this current research involves work on policy and practice of early school leavers who have been re-engaged in alternative schooling.

In Canada, education is a provincial responsibility; therefore, there is no national coordination of education programs to increase high school completion of students who have left high school prior to completion. In Alberta, alternative programs are designed to meet the educational needs of these students. Alternative programs exist in the public education system as store-front and charter schools, in the private system, and as non-formal educational programs. Enrolments in these schools are increasing.

In Spain, there is a national education program relevant to at-risk youth education, the *Programa de Cualificación Profesional Inicial* (Initial Professional Qualification Program, known as PCPI by its initials in Spanish). The PCPI is an alternative program for those students who did not graduate within the Spanish educational system in the Compulsory Secondary Education (*Educación Secundaria Obligatoria* or ESO, up to the Junior level) and it offers a professional (trade) certification with the opportunity to acquire the secondary-level degree. The PCPI and its predecessor, the Social Guaranty Program (*Programa de Garantía Social* or PGS), are discussed in more detail later on in this paper.

This work looks specifically at the experiences of educators who are working in higher education contexts, reflecting on their involvement with programs that are designed for secondary students who are at-risk of not completing high school. The authors emphasize the important role played by higher education professionals in preparing specifically science teachers in the adequate pedagogy that would retain the at-risk students in their school programs. It is the authors' belief that the implementation of proper science teaching approaches would impact positively the students and the educational policy and practice. This work is also bounded by the research time-frame of the approved ethics report. All interviews were conducted between August 2010 and October 2011. Consistent with case study design, we conducted semi-structured interviews of six Spanish educators and two Canadian educators. A follow-up questionnaire was sent to the Spanish participants.

Aspects of the Spanish Context of Educating at-Risk Youth in Spain

As mentioned in the previous section, in the Spanish national system of education, there is a special national program relevant to at-risk youth education, the PCPI. The PCPI is designed to facilitate the students' employability, but also their continuation in their optional senior high school education.

For Dr. Bernardo Gargallo López, who holds the Chair of Theory of Education Department, at the Faculty of Philosophy and Educational Sciences at the University of Valencia, in Valencia, Spain, programs such as the PCPI are able to offer an effective response to those students who could end up failing or dropping out if one considers particular factors that are discussed here (personal communication, November 2, 2010). In general, noticed Gargallo López, students find the opportunity for more individualized attention without being labeled as differentiated or being special in the negative way (Gargallo López). However, for the program to work aspects of cognitive learning such as student motivation, self-esteem, self-regulation, and emotional support need to be present. Other factors include the different educational methodologies being used, which could be focused on learning or on teaching. Those methods could, in turn, include different pedagogic skills and evaluation approaches (Gargallo López). Gargallo, Sánchez, Ros, and Ferreras (2010) have categorized and described those teaching methodologies; although, the research context was on teaching done by university professors. Gargallo López concluded that, once particular factors are taken into consideration, the PCPI is an effective tool for students at risk of failing or abandoning school (personal communication, December 15, 2010).

Professor Elena Giménez Urraco agreed, in some respects, with that conclusion (personal communication, November 2, 2010). Giménez Urraco has researched the PCPI's predecessor, the Social Guaranty Program or PGS (*Programa de Garantía Social*), which, in spite of its lack of credentialization (offered no high school diploma), still provided valuable educational opportunities for those students at risk of failing or dropping out of the regular program (Elena Giménez Urraco). Moreover, Giménez Urraco considered that programs like the PGS and the PCPI intend to tackle school absenteeism by providing smaller classes with more teacher's attention going to each student and an improved environment conducive to the learning of those that could otherwise leave their schooling.

Fernando Marhuenda Fleixà argued, however, that the recent (since 2006) PCPI's higher curricular expectations on its high-school degree have affected the apparent flexibility that had been a feature of its precedingPGS, adding a third objective: The youth’s personal and maturity development (personal communication, November 2, 2010). Marhuenda Fleixà saw that the rigidity of curricular expectations on the PCIP program, besides increasing credentials, appears to sacrifice pedagogic innovation, which is important for attracting students back to complete their education. The problem is that, given a more rigid curriculum, as it is in the case of the PCPI, the teachers are constrained in their capacity to implement teaching techniques more appropriate to the needs of the students. A predictable consequence is that those students who have had difficulties in the regular program and are now being taught with traditional pedagogies are more likely to lose interest and they could end up abandoning the program. The curricular prescription in the Spanish educational system addresses objectives, content, and evaluation; the teaching methodology to be used is not prescribed in the system and it is the responsibility and the decision of the teacher. The teacher’s autonomy could be used to compensate for the inflexibility of the curriculum. Nevertheless, teachers often fold back to traditional teaching methods that may not be adequate for the at-risk students, according to Marhuenda Fleixà.

Alternatively, teachers who witness decreasing enrollment may be pushed to become more pedagogically creative just to save their employment. In this case, even though the teachers may not feel obligated to explore pedagogies that are more adequate, they may do so just to be able to continue teaching in the program (Fernando Marhuenda Fleixà, personal communication, November 2, 2010). Giménez Urraco agreed with Marhuenda Fleixà in that, if the assessment of at-risk students focuses on academic skills without taking into consideration the personal context of those students, it is likely that students who belong to disadvantaged social classes and who have social difficulties end up abandoning the high school all together given that their life experiences could prevent them from reaching the schooling objectives (Elena Giménez Urraco, (personal communication, November 2, 2010).

Recent (since 2006) PCPI's higher curricular expectations on its high-school degree have affected the apparent flexibility that had been the feature of the preceding PGS. This inflexible curriculum is designed for the mainstream student and does not necessarily address those students with schooling difficulties. However, Vicente Garrido Genovés thinks that, even though the program is better than leaving students outside the educational system, the program's lower standards and limited opportunities for the PCPI to fully develop the students' capabilities show important program's inadequacies (personal communication, November 2, 2010). Moreover, the students may feel unmotivated to take the program or they may not feel that they could succeed in it. In Garrido Genovés's metaphor, the students referred to the program may be in a situation where “for example if I were a person with no dancing abilities and someone invites me to take dancing classes at a dancing academy, in dancing I would look like a two-left-feet dancer unless I end up liking the academy” (Garrido Genovés, own interpretative translation).

In the Spanish school system there is a major problem with academic failure. As a general average, about 33% of the school students do not graduate. For Garrido Genovés, the system does not have adequate responses to that problem (personal communication, November 2, 2010). In general, the pedagogy used in the classes is traditional, with characteristic lecturing, studying from textbooks, written drills, and rote learning. In fact, there are different kinds of students that could be failing under the traditional teaching, including those who have disadvantages when entering the school, and also those who do not appear to have disadvantages but whom the school system could lose. Indeed, some students who have difficulty memorizing may not respond well to the rote learning used in traditional teaching.

Gargallo López noticed, however, that those students who have had previous discouraging and inadequate educational experiences could complete their education if a program offered them adequate experiences such as teachers who demonstrate affection to them, teach them to self-regulate, to develop their capacity to plan, as well as other aspects of the pedagogy for which we find references in Piaget, Vygotsky, and others (Bernardo Gargallo López, personal communication, November 2, 2010).

For students who experience learning difficulties, there are special needs educators, but also there is a program called Curricular Diversification (DC by its initials in Spanish), which adapts the curriculum to facilitate the learning of those students who potentially could fail or drop out of the educational system. Nevertheless, and as Gargallo López points out, if this curriculum diversification program appears in practice as if it were to decrease or to reduce the academic standards, we have to ask ourselves if by decreasing the academic expectations offered to those students a resulting so-called Pygmalion or Rosenthal effect could be expected to be the end result (Gargallo López). In the Pygmalion effect (also considered part of the self-fulfilling prophesy phenomenon), changes in teacher expectations would likely produce changes in student

achievement (Rosenthal & Jacobson, 1992). In the case of adaptation programs such as the DC, lower expectations communicated to the students through lower curricular standards, would result in lower achievement by those students who are already at risk.

Among the adaptations to the regular program, there are modifications such as flexible groups that organize the student's progress and that are based on the student's capacities and skills (Bernardo Gargallo López, personal communication, November 2, 2010). Also, the educational policies are integrative and they try to compensate for the diversity by way of specific interventions, such as the case of Spain's Educational System Welcome Program (PASE, by its initials in Spanish), which has been designed to respond to the needs of immigrants who are trying to integrate into the regular school program (Gargallo López). However, according to Gargallo López, there is a difficult balance between "equity and quality (excellence)" (personal communication, November 2, 2010).

Gargallo López showed optimism about the programs that are implemented with precise objectives and for specific reasons, such as to teach students who have academic and emotional difficulties. One of them is a program based in projects, from which Gargallo López has direct experience. Those programs tend to modify behaviors effectively (Gargallo López). As an example, it has demonstrated that students show interest, attend classes regularly, work with enthusiasm, and end up completing the program (Garfella & Gargallo, 1998). Gargallo López cautioned that, for the complete adequacy of the programs, they should be integrated into the educational system over the long term. These programs demonstrate the capacity to produce promising results for those students who tend to fail or to drop out of school (Bernardo Gargallo López, personal communication, November 2, 2010).

Garrido Genovés noted that the system does not have adequate responses yet to the problem mentioned earlier in Spanish schools that have about 33% of academic failure and dropout rates (personal communication, November 2, 2010).

International Trends in Science Teaching in Main Stream Schools and in Special Programs

Some Historical Tensions in Science Teaching in North America

Given the centrality of relevancy in the curricular development and pedagogy of science teaching for disenfranchised youth, this article reveals some of the tensions that are inherent in practice.

Relevancy in science teaching. Early on in the history of science teaching in North America, some minimal efforts were made to consider the relevancy of science-teaching curricular content and pedagogy. Those efforts were evident in the establishment of the curriculum in USA by the National Education Association (NEA), which eventually led to the adoption of a curriculum characterized by experiential opportunities to the students (NEA, 1894). Important aspects of this reform were evident in the recommendations given by the Committee of Ten on Secondary School Studies to the NEA, such as urging "that the study of simple natural phenomena be introduced into elementary schools" (NEA, 1894, p. 25), as well as emphasizing on the "necessity of a large proportion of laboratory work in the study of physics and chemistry and advocates the keeping of laboratory note-books by the pupils, and … [their] use as part of the test for admission to college (NEA, 1894, p. 26). It appears that younger, not older students could have the opportunity to discover for themselves the phenomena where they naturally occur, and that mainstream schools science teaching, specifically in North America, has been challenged with the issue of relevancy.

In the authors experience, their at-risk students consistently found difficulty accepting what they perceived as irrelevant learning and they legitimately questioned what they were asked to do in the laboratory that have no apparent application or usefulness in their lives. This experience correlates with some findings in the literature. For instance, according to Hostettler (1983) and Kumar et al. (2005), “if elementary education students do not believe that chemistry is related to everyday life, …they may not feel it is important to learn and understand” (as paraphrased by Durland, Karatas, & Bodner, 2010, p. 86). Furthermore, Fox (2010) pointed out that students who “don’t see the connection between the content and activities of the course and their future lives, they question what the teacher is asking them to do”. The authors stated that to maintain student interest and motivation, perceived relevance is a critical factor (Fox, 2010).

The problem of relevancy could be seen as a problem with teachers' difficulty in integrating multidisciplinary aspects of the science teaching. Related to this aspect, Bektaş, Çetin-Dindar, and Çelik-Yalçin (2010), stated that “pre-service chemistry teachers have some difficulties in integrating both some chemistry concepts and physics, chemistry, and biology concepts” (p. 82). According to Bektaş, Çetin-Dindar, and Çelik-Yalçin (2010), these difficulties have also been seen in the literature, such as in cases when students “encountered chemical reactions, they thought that the chemical reactions were one way. When they learn the chemical equilibrium at their chemistry sessions, then they comment about two-way reactions” (p. 82). Also, according to Taber (2008), “they do not try to integrate among chemistry, physics, and biology concepts” (as cited in Bektaş, Çetin-Dindar, and Çelik-Yalçin 2010, p. 82).

Relevancy and Disenfranchised Students. Students' perception of lack of relevancy in science learning would bear consequences for teachers and students in mainstream schools, but what about disenfranchised students? In one of the author’s experience, teaching science to at-risk students in an alternative high-school academic program in Western Canada (which included a majority of disenfranchised aboriginal and immigrant students) science classes needed to be highly relevant in order to maintain students’ attendance. Teaching plans needed to make students’ experience relevant, but also to make that experience sufficiently worthwhile so that students would resist the persistent pressure to skip classes that they frequently experience from outside school.

In this regard, a search for adequate science teaching pedagogies appropriate to at-risk youth was relatively easy. In fact, new approaches in science teaching have been adopted by schools in many countries (Adams et al., 2008; Aikenhead, 1996; Farid Alatas, 2006; Bennett, Lubben & Hogarth, 2007; Bianchini & Brenner 2010; Dennis & O'Hair, 2010; Hulleman, & Harackiewicz, 2009; Kennedy, Yezierski, & Herrington, 2008; Lam, Cheng & Ma, 2009; Llewellyn, 2005; Markic & Eilks, 2010; Marín Martínez & Cárdenas Salgado, 2011; Norris, 2006; Petrosino, Martin, & Svihla, 2007; Scott, Mortimer, & Aguiar, 2006; Walker & Wood, 2008).

Experiences from Higher Education Professionals in Catalonia

The education and training of future science teachers in one of the prestigious universities in Spain has recently created a Master’s degree in teacher education in compulsory secondary education, post-compulsory secondary education, and professional development; its candidates are mainly professionals from different fields in science who learn the pedagogy for teaching science courses in secondary education. One of the authors of this article recently visited the program and interviewed some of its professors. This Master’s degree is a program from the Educational Sciences Institute (*Instituto de Ciencias de la Educación*, known as ICE by its initials in Spanish) of the Universidad Politécnica de Catalunya (UPC) in Barcelona, Spain. ICE is

responsible, among other things, to take on the education of the teaching and research staff and for the improvement of its academic activity. At the same time the ICE offers activities on continuing professional development for Compulsory Secondary Education (ESO), Post-Compulsory Secondary Education, and Professional Development (Ignacio de Corral Manuel de Villena, personal communication, December 15, 2010; www.upc.edu/ice/lice-de-la-upc). The UPC's ICE organizes the Master's in secondary teaching education. A strong aspect in this educational program is the teaching staff. Part of the academic staff that teaches in the Master's program are high-school teachers who combine their teaching in secondary institutions with their teaching at the University.

The pivotal axis of the Master's degree is the Practicum that the students do in the fields of Mathematics, Technology, and Professional Development. The Practicum and the Final Master's Project amount to 1/3 of the Master's Program Syllabus. It is implemented in high school centers across all of Catalonia, including Compulsory Secondary Education (ESO), Post-Compulsory Secondary Education, and Professional Development. This field experience is quite complete in terms of offering a variety of opportunities for student-teachers to experience their integration in the different areas of school activities, beyond the teaching practice itself.

Within the Master's degree, the ICE offers education in Technology, Mathematics, and Professional Development; Industrial Families, and more (http://mfp.masters.upc.edu/). It is of interest that students graduates from different specific areas in science, technology, and mathematics (for instance, many hold bachelor's degrees in engineering, architecture, or mathematics) and who effectively, because of their prior experiences in their respective fields, come to contribute interesting ideas and initiatives that many times are taken up and utilized by educational centers or by the educational resource centers that provide teachers with materials and instrumentation (Ignacio de Corral Manuel de Villena, personal communication, December 15, 2010).

According to Dr. Ignacio de Corral Manuel de Villena, the pedagogy implemented in the program follows a pragmatic criterion; it is one that effectively works and, after a reflective analysis about the didactic experiences, whatever produces (effective) results is implemented (personal communication, December 15, 2010).

Experiences from Barcelona Relevant to Science Teaching at-Risk Students in Canada

This open approach to teaching prospective high-school science teachers provides a valuable opportunity for this Master's program from Barcelona, Spain, to experience and adopt novel approaches and methodologies in science teaching. However, the disadvantage could be that the strategic adoption of teaching techniques that seem to work could be missing one of the pedagogic reference framework built wisely over time by the researchers in the institution. This is a very important aspect, since, in the authors' experience, educational departments, after considering different factors and research, may recommend pedagogies more critical of, for example, the past inadequacies presented by behaviorist approaches.

This expectation does not appear to be evident in the science teachers education program at the UPC. Nevertheless, it is important that some form of pedagogic preference is identified by an educator's teaching institution based on its research and field experiences that work for all students, but especially for at-risk students. This is important since the authors know from their experience in Canada and from the literature that the lack of proper pedagogy or incentives in secondary science teaching excludes a good number of students who cannot adequately learn from that pedagogy, which is a crucial negative factor for teaching science to disenfranchised

students. In fact, in the case of some Canadian disenfranchised students, an improper pedagogy has been a crucial factor in shaping students' feelings and perceptions about what the school has to offer to them, and it has been vital in their previous decisions to drop out of school (Wishart, 2009).

Experiences in Costa Rica: Factors to Keep Students in: Relevancy & Methodology

In contrast, in the discussion of factors that will keep students *in* school, the authors have included here some conclusions that come from the participation of one of the authors of this paper in the relevant workshops offered at the II International Congress on Educational Research 2011 at the University of Costa Rica (UCR). At the Congress, Arguedas Negrini (2010) presented the results of research with students, teachers, other school staff, and parents from secondary-level institutions from an area that reported high dropout rates in Costa Rica. The research related how critical factors perceived by students, such as school competencies, concept of self and self-esteem, communication with others, coping ability, and self-control, along with familial, and institutional factors help secondary students stay in school (2010, p. 1). Arguedas Negrini concluded that one has to consider that school success not only has to be related to success in academics, but to success in the socio-emotional and behavioral domains (Arguedas Negrini & Jiménez Segura, 2007; Arguedas Negrini, 2010).

Arguedas Negrini and Jimémez Segura (2007) also discussed aspects of pedagogy that influence students' conflictive feelings toward school. Citing findings by other authors (see Espíndola & León, 2002; Partida, 2005), Arguedas Negrini and Jimémez Segura included among these aspects: The low academic performance, institutionally unresolved "discipline" problems, inadequate and un-motivating teaching approaches, students' apathy towards the courses that appear irrelevant to the students' daily life, problems in the student-teacher relationships, inadequate communication between the student community and the teaching staff, as well as the manifestation of teachers' "authoritarism" (Arguedas Negrini & Jiménez Segura, 2007, p. 7-8).

Tensions in Science-Teaching Visions

In teaching disenfranchised youth, pedagogic relevancy is one aspect that the authors of this paper have found to be indispensable in science-teaching. Of course, the educational vision and teaching methodology are other crucial aspects that need to be discussed. However, in addressing those aspects, the authors acknowledge an artificial separation of educational issues that are intrinsically interrelated in reality.

Efforts in changing teaching approaches and visions in science teaching in the last two decades have been slow in North America. It is interesting to notice the expression used in a study about change in science teaching framework: "In order to widen the scope of science education to a broader student base, some educators *have ventured away* [emphasis added] from lecture-based teaching models to one that is more 'participatory' in nature" (Adams et al., 2008, p. 221). In an insightful paper, Aikenhead (2003) summarized key concepts in the research done on science teaching in the last century and described the *failure* of the traditional *school of science to* address its serious educational problems that have been ignored thanks to *political* decisions that followed predominant ideological points of view (p. 1-2).

Scientific Epistemological Views

It is interesting to find what Tsai (2007) discovered about teachers' scientific epistemological views (SEV) and their teaching practice. His study was done on science teachers in Taiwan. Teachers were, in general, coherent in applying their SEVs in their teaching. In fact, Tsai found that teachers whose SEV were close to positivism coherently stressed expository lectures, use of drills in delivering classes which implied, in Tsai's assessment, a more passive learning of science. In contrast, those teachers with SEV in constructivist inclinations focused more on the students' understanding and application of the scientific concepts, and used more time to engage students on science research activities or in interactive debates (Tsai, 2007).

The implication of these findings to science-teaching of disenfranchised youth is that there will be an expectation in the resulting pedagogy from the teachers who hold different SEVs and this is important to consider not only because of the implications in the application of appropriate pedagogy, so important in the delicate environment of at-risk youth educational programs, but also because of the consequent teaching staff hiring criteria of the educational center.

Tensions in the Approaches and Methodology of Science Teaching

Vazquez Alonso and Manassero Mas (2007) effectively described great challenges in science teaching methodology, which can be applied to the different educational levels and acquire special relevance in the at-risk youth education:

> The propaedeutic orientation designed to educate future scientists is centered in the logic and in the transmission of the subject concepts which are predominantly cognitive, abstract and irrelevant for day-to-day life, but which are essential in the way to become a scientist. (p. 249)

In research on science teaching methodology, Bencze, Bowen, and Alsop (2006) proposed that school science students can widely benefit from their participation in appropriate open science research projects. The authors discuss how science teachers' views about science either stimulate or discourage them to encourage students to carry out open science research projects appropriate to them. Moreover, the study showed that those teachers who held a social-constructivist paradigm planned and implemented an approach that engaged the students in research activities (Bencze, Bowen, & Alsop, 2006). An important conclusion from this study that should be taken into consideration in science teaching with disenfranchised students is that those teachers that used a more firm control of the knowledge construction did not hold a social-constructivism vision (Bencze, Bowen, & Alsop, 2006).

In the context of teaching at-risk students in Alberta, the use of open projects became necessary, not only because it engaged them in the pedagogy and increased their motivation, but also because strategies like the open projects of scientific research provided more control on the hands of the students than in the hands of the teachers. This approach was supported by the alternative school administration in that province.

Positivism, Rationalization, and the Exclusion of Social, Cultural, or Affective Values

Vazquez Alonso and Manassero Mas (2007) concluded that in the curriculum, teaching materials, and learning in traditional science education there is an abuse of the empiric referent and of the logic reasoning which are the two epistemic factors of the logic positivism based on the truth and the objectivity as essential values of science (p. 248). This positivist abuse,

according to the authors, results in the exclusion of social, cultural or affective values (p. 248). This unbalance of the pedagogic factors of science teaching is not acceptable for those who seek to improve pedagogy, and least when that pedagogy has to be for the service of the youth at risk of failing or abandoning school. There is a need, in the science education of these youth, to attend to those socio-cultural and affective (emotional) factors. However, the inclusion of those factors in the pedagogy for youth at risk is not enough to protect them from inadequate pedagogies, or worse, discouraging education for their continuation in the school.

The reason for this highly demanding proposition is that the youth at risk, like the students at an alternative high-school academic program in Western Canada where the authors taught, are usually quite critical of schooling and society. In the authors experience. this is understandable since those students are coming from experiences where their feelings of inadequacy in the school system have made them critical of that system and of society in general. Moreover, that critic could marginalize them even further, which, in turn, makes them resist educational attitudes of control. In science classes this may be expressed as skepticism towards “truths” and scientific dogmas. Furthermore, in the authors' experience, students are critical of the adults who fail to recognize and acknowledge the critical-social intelligence that youth possess. The problem is that the youth sense that lack of recognition.

Youth Questioning Educators’ Dogmatic Truths

Skepticism about truths taught dogmatically is not only a characteristic of some youth in the student population, specifically the youth at risk, it is also an attribute of a number of intellectuals and educators. Recognizing that past tenets in science are vulnerable may assist us in understanding the youths’ skepticism in that regard.

In fact, Foucault (1977) and other philosophers have raised deep skepticism about the capacity of the scientific method to support truth claims. They claimed that knowledge is inseparable from power. According to Foucault, knowledge is the “result of patterns of power relations in a community” (Wallace & Louden, 2000, p. 5). Moreover, the claim of dogmatic truths in science teaching has never been so difficult to sustain. In relation to the skepticism of marginalized youth, revisionist philosophers place science in a less arrogant position and as a form of knowledge “skeptical of truth claims arising outside its own Enlightenment metanarrative of a triumphant reason” (p.5).

In teaching youth at risk, not only an adequate pedagogy and other conditions and attributes highlighted in this article is needed, but also teachers who humbly listen to the youths’ critique and concerns and acknowledge the value of their insight. Particularly in science teaching, teachers--without diminishing their professional expertise and wisdom--should participate in the search for truth with the students.

Assessing Constructivism

Observing pre-service teachers teaching science in many schools over the years, we have seen frequent planning and implementation of science classes guided by a constructivist pedagogy. Many times the use of that theoretical underpinning could be attributed to the pre-service teachers’ own education, but other times that pedagogic approach was evidently recommended and supported by their mentor teachers. One of the authors incorporated class activities whose objectives follow constructivist principles. While generally following a critical pedagogy, the authors of this article recognize that some constructivist science class activities are useful instruments that could accomplish critical pedagogy objectives as well. Notwithstanding

that, a critical revision of the pedagogy underpinned by constructivism is needed, especially when committing to doing the best to keep at-risk students in the school and preventing youth from failing in their schooling.

In a critical review of constructivism, Cato (2006) argued that the pedagogy under the paradigm of constructivism in its two forms, trivial constructivism and radical constructivism, lacks coherence (p. 57). For Cato, the theoretical basis of trivial constructivism is indistinguishable from the traditional theory it purports to supplant. At the same time, radical constructivism is inherently self-contradictory, and as a consequence of the two theoretical problems, the resulting constructivist pedagogy (trivial or radical) is incoherent (2006, p. 57). Cato's research provided evidence that the "constructivist pedagogy is theoretically incoherent" and its "claim to differ from traditional pedagogy" is "practically vacuous" (p. 73), and is highly important to ponder by educators who adopt a constructivist pedagogy, especially if they are teaching at-risk youth.

Accessibility of Experimentation, Instrumentation, and Laboratory Methodology and the Alienation of the Marginalized Youth

Science teachers who adopt techniques and strategies that attract students at-risk into science courses often engage those students in class activities leading to increased attendance. Strategies used by those teachers many times are guided by coherent and consistent theoretical foundations, that follow an educational vision sensitive to marginalized students. However, if the educational strategy has missed considering the accessibility and relevancy of experimentation, instrumentation and laboratory methodology, it could have failed to properly address the perception and actual alienation of the at-risk students. The perceived and real students' alienation will not only impact negatively their motivation to stay in the science course or in the schooling program, but also it will likely affect their perception of the sciences as an area of interest, work or career choice in their lives.

In this paper, the authors define accessibility of experimentation, instrumentation, and laboratory methodology as the capacity that the experimentation practices in the science course or program have to accomplish at least two pedagogical aspects: the pedagogy has to expose the students to experimentation that is and it is perceived by the students as relevant and meaningful to them. The observation of the phenomena and the experimentation should include, in large proportion, means (e.g., material and equipment) that are taken from daily life and that could be safely replicated by students beyond the school setting, and that are, consequently, accessible to the students beyond their economic and social situation.

Some Conclusions on Science Teaching for Youth at Risk

This work has discussed, among others, the importance of the role that higher education professionals play not only in educating high school science teachers in the adequate pedagogy for at-risk student retention, but also in engaging themselves in programs that prepare students for college.

Anecdotes, comments, and opinions from professors at different universities in Spain and Costa Rica, the review on different pedagogies used with at-risk student population drawn in the literature, and the authors' experience in teaching those youths in Western Canada provide some conclusions.

Recent literature has presented diverse science teaching approaches that are not only appealing, but also tend to increase the relevancy of the subject to the students and their participation level, modeled, in general, after the inquiry and constructivist concepts. However, more than hands-on activities and relevant, participatory techniques derived from those teaching approaches, at-risk students need to be given the confidence that they can control, interact, find meaning, and create new knowledge out of their encounter with the natural phenomena that (Western) science tries to measure and understand.

Students control of the science experimentation occurs when the teacher removes barriers to that control. The latter could find difficulties if the experimentation has to be accessed through methods and equipment that are unfamiliar, not accessible to them (e.g., not reproducible at home) and, consequently, not relevant (alienating) to the students lives. What pedagogic philosophical approach would then adequately respond to the need of students' control, especially disenfranchised students' control of their learning, and to the problematic disconnection between what is being taught, including the teaching materials, techniques, and lab experimentation, and the students everyday-life problems and events?

This is the challenge for research and teaching. Nevertheless, in the authors' experience, the lack of students' control over their own learning, the irrelevancy of science-teaching, and the inaccessibility of instrumentation used in their classes will likely alienate particular disenfranchised youth. Moreover, the insignificance to disenfranchised students of what is being lectured, demonstrated, or practiced in laboratory in some main-stream schools could be translated into an epistemological and cultural domination, as students do not appear to gain control of their learning through that approach.

Some Recommendations on Science Teaching

The scientific epistemological views, the teaching theoretical approach, and methodology with its experimentation, laboratory, and materials have to address the need of self-control and disalienation experienced by marginalized students. Consequently, the planning and delivering of a science program needs to start from the students' experiences with the phenomena, and from their own connections to the subject and with the laboratory material (e.g., materials taken from places and experiences familiar to the students). Moreover, much of the instrumentation used in science experiments has to be readily accessible to them and be (safely) reproducible by students outside the school. This is needed because the materials and science methods that connect to students' lives has been, in our own experience, increasing the students own confidence in managing their learning, and consequently, inspire and motivate those students to gain control and management of their own lives.

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