https://doi.org/10.1590/198053146644

THINKING ABOUT A POPULAR EDUCATION IN SCIENCES?

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Abstract

In this article we reflect on Education in Natural Sciences, from our educational experiences with teachers in the public system, social movements and political organizations. These experiences serve as a base from which we can glimpse new paths, in a dialogue with a diversity of theoretical references from different disciplines and areas. We intend to continue thinking about a critical pedagogy in the natural and technological worlds with the objective of strengthening processes of social transformation.

COMMUNITY EDUCATION • INTERCULTURAL EDUCATION • NATURAL SCIENCES • POPULAR EDUCATION

PENSANDO UNA EDUCACIÓN POPULAR EN ¿CIENCIAS?

Resumen

En este artículo reflexionamos sobre la Educación en Ciencias a partir de nuestras experiencias educativas junto con docentes en el sistema público, movimientos sociales y organizaciones políticas. Estas experiencias nos sirven de suelo desde donde vislumbrar nuevos caminos en diálogo con una diversidad de referencias teóricas de distintas disciplinas y espacios. Buscamos seguir pensando una pedagogía crítica sobre los mundos sociales, naturales y tecnológicos que tenga como objetivo el fortalecimiento de procesos de transformación social.

EDUCACIÓN COMUNITARIA • EDUCACIÓN INTERCULTURAL • CIENCIAS NATURALES • EDUCACIÓN POPULAR

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PENSER L'ÉDUCATION POPULAIRE EN SCIENCES?

Résumé

Cet article aborde l'Éducation en sciences à partir de nos expériences éducatives auprès des professeurs de l'enseignement public, des mouvements sociaux et d'organisations politiques. Ces expériences nous ont servi de base pour déceler, en dialogue avec une diversité de références théoriques issues de différentes disciplines et d'espaces disctincts.de nouvelles voies de travail. Nous avons essayé de penser toujours à une pédagogie critique concernant les mondes sociaux, naturels et technologiques dont l'objectif est de renforcer les processus de transformation sociale.

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PENSANDO UMA EDUCAÇÃO POPULAR EM CIÊNCIAS?

Resumo

Neste artigo refletimos sobre a Educação em Ciências a partir das nossas experiências educativas com professores do sistema público, movimentos sociais e organizações políticas. Essas experiências representam uma base da qual vislumbramos novos caminhos, ao dialogar com uma diversidade de referências teóricas de diferentes disciplinas e espaços. Tentamos continuar pensando em uma pedagogia crítica sobre os mundos sociais, naturais e tecnológicos cujo objetivo seja o fortalecimento de processos de transformação social.

EDUCAÇÃO COMUNITÁRIA • EDUCAÇÃO INTERCULTURAL • CIÊNCIAS NATURAIS • EDUCAÇÃO POPULAR

> For us there is no shadow of a doubt about the right of street children to be informed according to their age levels, and to be educated according to the progress of science. It is essential, however, that the school, becoming popular, recognizes and prestiges the knowledge of social class, "made of experience", with which the child comes to school. It is necessary for the school to respect and abide by certain popular methods of knowing things, almost always or always outside scientific patterns, but which lead to the same result. It is necessary that the school, as it becomes more competent, becomes more humble. The knowledge that is produced socially and historically has historicity. There is no new knowledge that, produced, is "presented" free to be overcome.[1]
> Paulo Freire, *La educación en la ciudad* (2010, p. 53-54, own translation)

THERE HAVE ALREADY BEEN 60 YEARS SINCE PAULO FREIRE'S (1959) FIRST BOOK, Education and present Brazil, the first of many to express his own pedagogical thinking, situated, creative, political, emancipatory, in constant movement and transformation. In this book he already discusses concepts such as dialogue, the transformation of naive forms of perception into criticism, and some of the antinomies he will use in the future. Even in this book there is already a mention of the colonial experience, which persists in the mentality of the people as habits, dispositions and ways of perceiving the world. And yet we continue today with the need to produce a ¿didactic? knowledge on Education about social, natural and technological worlds. A critical, Latin American, counterhegemonic education. Inspired and produced from the practices of struggle and organization of popular educators, practices carried out in schools, social movements, migrant organizations, indigenous peoples, women, unions, and many other that group the deprived of this world and fight for its subversion, for the creation of a just, egalitarian, diverse world. In this work we return to these constructions to, together with current productions in this field, build a pedagogical perspective

1 In the original: "Para nosotros no hay sombra de duda sobre el derecho que tienen los niños de la calle de ser informados en función de sus niveles de edad, y formarse de acuerdo con el avance de la ciencia. Es indispensable, sin embargo, que la escuela, volviéndose popular, reconozca y prestigie el saber de clase, "hecho de experiencia", con el que el niño llega a la escuela. Es necesario que la escuela respete y acate ciertos métodos populares de saber cosas, casi siempre o siempre fuera de los patrones científicos, pero que llevan al mismo resultado. Es necesario que la escuela, en la medida que se va siendo más competente, se vaya volviendo más humilde. El conocimiento que se produce social e históricamente tiene historicidad. No hay conocimiento nuevo que, producido, se "presente" libre de ser superado"

from Popular Education, of which we have fragmentedly published some sketches in the recent past (CZERNIKIER *et al.*, 2018; DEFAGO; ITHURALDE, 2018a, 2018b), performing a job here to give them greater systematicity.

METODOLOGICAL PATH

This paper comes from a work of systematization of the labour of popular educators of the Popular Movement La Dignidad (MPLD) (CZERNIKIER *et al.*, 2018; PEREIRA; ITHURALDE, 2015), from which we build a series of guiding questions (ZEMELMAN, 2001) which have ben an orientation for previous works. These questions were reworked to build the organizing principles that give order to the present work of theoretical reflection. In this paper we will focus on (re) thinking possible educational practices in spaces that have emancipatory horizons, in an area that until now has been called the Science Education (and on whose nomination we also reflect).

For the labour of theoretical reflection that this work proposes, around what is currently called the Science Education, we resort not only to the aforementioned memories, records and systematizations, but also to documents of Latin American social movements that debate on education and inquiries from critical pedagogies perspectives, what allow us to broaden our points of view and deepen the analysis. The initial words of the teacher Paulo, reflecting on his own experience as Secretary of Education of the city of San Pablo, will guide us in this way.

ORGANIZING PRINCIPLES

AN EDUCATION FOR SOCIAL JUSTICE

From theoretical perspective we can postulate concepts that help the production of social justice from educational spaces, including that of curriculum justice. According to Raenwyll Connell (2009) there are three principles that can guide the concept of curriculum justice, in order to orient curriculum designs that lead to social justice:

1. Think an education according to the interests of the least favoured. These curricula must also respond to the notion of environmental justice along with that of social justice.
2. Cultural tools for active democratic participation in decision making as the basis of a common curriculum. This requires non-hierarchical and cooperative educational practices as the basis of teaching.
3. The historical production of equality as a guide to resolve tensions between the criterion of serving the interests of the less favoured groups and that of serving the formation of active citizenship.

A primary issue is that teachers do not have a monopoly on truth and knowledge. This implies that the teaching activity needs training in listening (FREIRE; FAUNEZ, 2014). If those of us who have a role of coordination cannot show humility and open ourselves to the recognition of our own ignorance

and exercise the legitimacy of the students' knowledge and the entire learning community (TORRES, 2004), then there is no real dialogue (or democracy). A first condition of possibility for dialogue is the recognition that the Other has something to tell us, something that can transform us, that is someone from whom we can learn, thus thinking a cognitive justice (SOUSA SANTOS, 2009). If the one sof us who exercise a teaching role always have the correct answers, then we are impoverishing this dialogue, it is a staging, a "as if", but basically is constituing a banking model of education (FREIRE, 2014).

TOWARDS AN ORGANIZING CONSCIOSNESS

Subcomandante Insurgente Moisés tells us that it is "the time, it is our time to organize ourselves, to support each other, to coordinate our studies, to share data on how capitalism has exploited us. Help us" (EJÉRCITO ZAPATISTA DE LIBERACIÓN NACIONAL [ZAPATISTA ARMY OF NATIONAL LIBERATION] – EZLN, ca. 2015, p. 367). The Movimento dos Trabalhadores Rurais Sem Terra (MST) in Brazil tells us:

> We seek to prepare subjects capable of intervention and practical (material) transformation of reality. We cannot, as subjects, be pleased only with the development of the so-called "critical consciousness" that is one where people manage to denounce / discuss problems and their causes, but they fail to go beyond that. They even deceive themselves that, because they are talking about a certain problem, they are already solving it. Our education should feed the development of the so-called "organizational consciousness", which is one where people manage to move from criticism to organized action of concrete intervention in reality. At the same time, it is necessary to consider that the action itself has an educational dimension that no theoretical study can replace.[2] (1996, p. 7, own translation)

We think that an objective of Education, and in particular of Education on natural and technological worlds, should be to contribute to building tools that enable a growing reflection on the practice itself, that promote a progressively critical and autonomous reading of the world. Paulo Freire told us: "there is no real complaint without commitment to transformation, or commitment without

2 In the original: "Queremos preparar sujeitos capazes de intervenção e de transformação prática (material) da realidade. Não podemos nos contentar com o desenvolvimento apenas da chamada "conciência crítica", que é aquela onde das pessoas conseguem denunciar/discutir sobre os problemas e suas causas, mas não consiguem ir além disso e até se iludem que por estarem falando sobre um determinado problema, já o estão solucionando. Se o que pretendemos é participar dis processos de transformação social, então precisamos dar um passo adiante. Nossa educação deve alimentar o desenvolvimento da chamada "conciência organizativa", que é aquela onde as pessoas conseguem passar da crítica à ação organiada da intervenção concreta na realidade. Para isso os processos pedagógicos precisam ser organizados de modo de privilegiar esta perspectiva de ação. O que não pode ser comfundido com una visão "pragmatista" do conhecimiento que desvaloriza todo saber que não pode ser colocado imediatamente em prática. Isto é um desvio e também não leva às transformações desejadas. Às vezes é preciso estudar teorias bem abstractas e difícies para melhor entender e preparar uma ação. A questão es é ter sempre presente nas finalidades práticas destes estudos. Apo mesmo tempo, é preciso consierar que a própria ação tem uma dimensão educativa que nenhum estudo teórico pode substituir."

action"[3] (2014, p. 98, own translation). Therefore, the objectives of Education on natural and technological worlds cannot only remain about discourses and thought, but it is necessary to move towards action, a transforming action of society. The MST has thought about participation in instances of social struggle (such as taking land of landholdings, rallies, etc.) as deeply pedagogical activities (CALDART, 2000). But for this it is also necessary to promote collective reflections that allow local struggles to be related to broader historical processes in time and space. The MPLD maintains that by participating in educational spaces in instances of social struggle, they can "incarnate in the students' lives, promoting a strong appropriation of the political-pedagogical project and a great mark on collective subjectivity"[4] (PEREIRA; ITHURALDE, 2015, p. 15). The value of the struggle, of solidarity, of social organization, would be learned by practicing them authentically, that is, as part of the students' daily lives (ROTH, 2002).

A primary issue is to give value to the collective, to the bonds of solidarity between partners, with this common objective of producing a just, free, egalitarian society in this trail. This revaluation of the collective is embedded in the construction of social and political organization, based on recognizing one's experiences of oppression. It is then necessary to promote actions in these educational spaces where people organize themselves and in this process demand rights from the enemy of class, ethnicity, race, the gender oppressor, etc., while they are building a new world in this path (EZLN, ca. 2015). Actions where struggle, organization and collective action acquire value.

AN EDUCATION ABOUT THE COLLECTIVE AND THE SOCIAL ORGANIZATION

We must generate practices of democratic management of the educational spaces. A management where the voice of the student body is not only heard, but where it has an active participation in decision-making about the educational process. A participation that is consistent with the possibilities and age group of students, but where from childhood they are treated as political subjects. This implies rethinking the teaching activity in terms of coordination of the space in order to progressively increase the responsibilities of the student body in this task, seeking that the group of people who carry out coordination tasks grows, renews, expands and rotate in these functions. This issue was proposed and discussed extensively by the Soviet School of Work (PISTRAK, 2000) and resumed by Latin American social movements such as the MST in Brazil (CALDART, 2000).

Participating in democratic management also promotes learning about democratic participation and the exercise of democracy. Where even various regulations of the institution, such as coexistence agreements, are discussed and defined among all the actors of the institution. A democratic management is not only about making students real participants in decisions about the educational space, but also about them taking responsibility for these decisions, participating through collective and cooperative work. A school is democratic as long as

3 In the original: "no hay denuncia verdadera sin compromiso de transformación, ni compromiso sin acción".

4 In the original: "carne en la vida de les estudiantes, promoviendo una fuerte apropiación del proyecto político-pedagógico y una gran marca en la subjetividad colectiva."

democracy is experienced, recreated and learned in it. Alejandro Burgos (2014) shows us in an analysis of the School of Agroecology of the Peasant Movement of Santiago del Estero-Peasant Way (MoCaSE-VC), that as teachers we must create in each educational situation the conditions for the students to feel heard just for being subjects, political subjects, with the ability to intervene in definitions about the management of the educational space: the use and distribution of pedagogical time, the selection of contents and problems to work in pedagogical time, in the way of organizing decision-making. Teachers must make visible the diversity of existing positions within the teaching staff and also guarantee the possibility that in a variety of situations the decisions to be taken to be more similar to the positions of the student body than to those of the teachers.

It is necessary to recreate a multiplicity of situations that put the students in the need to organize as a group, finding ways of their own and allow greater freedom. This could be called a didactic of organizational practice, where whoever performs the coordination function has an active task in the construction of these situations, moving away from the center of them while continuing to lead. It is necessary to allow and encourage students to create new ways of organizing themselves, new ways of analyzing and thinking about reality, new ways of intervening in reality in a sense of transformation towards justice and equality. For this to be possible, whoever exercises the teaching function must habilitate himself/herself to surprise and that this organizational construction advances many times even against the beliefs of the coordinating group itself. In terms of queer pedagogy, we have to generate that didactic conditions that allow a collective production of the "unthinkable" to emerge in the group (BRITZMAN, 1995). In this sense, Hugo Zemelman in an interview tells us that "the thought of the human being must be freed from its bonds, it must be opened to the unpublished, to the unknown"[5] (RIVAS DÍAZ, 2005, p. 122, own translation). This need to promote collective creativity is at the base of the Latin American perspective of Popular Education (DI MATTEO; MICHI; VILA, 2012; FREIRE, 2014). And it implies a hard work, very active and not at all passive, by the coordination group, in the planning of these situations (deeply pedagogical in the Gramscian sense) that allow to accompany and push the growth of these collective subjects while also gradually delegating responsibilities in them.

A SITUATED AND TERRITORIALIZED PEDAGOGY

It is necessary to transcend the strictly school space, the logic of the school and go beyond schools or other scholar institutions, partnering with different neighbourhood organizations to carry out educational tasks. It is about both: going out with the school to the neighbourhoods and bringing the neighbourhoods to school.

Building bridges with these organizations is probably not an easy task but it is essential to build broad learning communities (TORRES, 2004). Learning

5 In the original: "el pensamiento del ser humano tiene que liberarse de sus ataduras, tiene que abrirse a lo inédito, a lo desconocido".

communities that appropriate the task of educating. As the MoCaSE-VC indicates, Popular Education occurs largely in grassroots work in communities, "it is something that is born from the people themselves, say, the felt need that is not something that is imposed"[6] (MOCASE-VC, 2017, p. 14, own translation). Including families in these labours, so that they allocate time and work in the education of their members, is very valuable. Not only then does the work of the educational spaces reach more and more people, resignifying their past experiences in these fields, but also, by giving them educational tasks, they revalue their knowledge, which many times have been delegitimized by these institutions. It also allows novel approaches that break the hegemonic logic of the use of time in schools (all doing the same at the same time, in the same rhythms) (ROGOFF *et al*., 2001). This way, the knowledges of families, neighbors, acquaintances can go into the school, circulate in it, are put into debate to reconstruct new, deepening the dialogues of knowledges and livings (MERÇON *et al*., 2014), producing in the process more wide and diverse epistemic communities. These dialogues of knowledges and livings allow us to show that other options are possible in our daily tasks (to the student body and the teaching staff) in the various areas in which our life takes place (work, recreation, domestic, labor, emotional, sexual, etc.) and to collectively create novel options from this sharing of experiences.

The participation of families and social and political organizations in school life allows us to build ties towards institutions that do not work on education but on other aspects of people's lives: labour, health, housing, etc. This allows to work in an integral way with the subjects integrating the critical pedagogies to approaches thought from other fields, such as, for example, an articulation with the Education and Work fields in the decolonizing sense (GUELMAN; PALUMBO, 2017), with the Collective Health (BREIHL, 2013), with environmental struggles (MICHI; DI MATTEO, 2009).

It is then necessary to develop an Education on the natural and technological worlds that includes the realization of authentic, authentic actions "not because they resemble everyday practice, but because they are part of everyday practice" (ROTH, 2002, p. 198). We think then an apprenticeship from the intentional participation in legitimate activities (ROGOFF, 1993; ROGOFF *et al.*, 2001). These must imply that each student embarks on a collective process of selecting an object of their actions and the means by which they will represent them, developing group activities within the framework of a problem that is a social and collective concern beyond the school community (ROTH, 2002; TORRES, 2004). We seek that this educational process integrates processes of teaching, learning, research and socio-community transformation processes (GUELMAN; PALUMBO, 2017), thus breaking the boundaries (which sometimes seem insurmountable) between school and community, as Latin American movements have proposed as the MST and the MoCaSE-VC (MICHI, 2010).

6 es algo que nace del propio pueblo, digamos, la necesidad sentida que no es algo que se impone

THINKING TEACHING ABOUT NATURAL AND TECHNOLOGICAL WORLDS

NATURES AND TECHNOLOGIES IN EDUCATIONAL SPACES

Reflection and thinking about natural and technological worlds are part of an exercise carried out regularly in everyday life, a cultural practice in which everyone can participate in the creation and development processes of the person. This is contrary to the hegemonic position that presents the Natural Sciences as the only activity capable of realizing that reflection and reaching truths, Natural Sciences that are assumed as a human action of difficult access, attainable by a few individuals of society, "priviliged minds", "intelligent" – and, in general, men –, excluding then, by action or omission, the rest of the student body from high-density work in these spaces.

From the Science, Technology, Society and Environment (CTSA) movement, the concept of School Science has been proposed in partial opposition to this hegemonic position (IZQUIERDO, 2005). The School Science in these proposals is different from the Science of the scientists, as it is a body designed for work in the classroom, between students and teachers at different levels of the education system. It is also not a direct didactic transposition of the Science of the Scientists because, although it has a reference to be built in the latter, it can cover contents not worked by the Academic Science and in turn not cover many contents yes worked by the Academic Science. It is a science designed to form integral and non-scientific people, not for that reason losing its rigor. School science serves as a bridge between students' daily knowledge and scientific knowledge, opens doors for students to access information from a variety of sources and make decisions based on these dialogues.

In the same way that the teacher Paulo Freire (2010) maintains in the quotation that initiates these reflections on the forms of language, people have the right to know the hegemonic forms with which the worlds are named, represented and recreated - in our case, natural and technological - while having the right to respect their own ways of thinking and analysis (something that School Science does not mention). They have the right to know other options besides their own and hegemonic ones, those produced in other places, near and far. And even more, and above all things, to participate in spaces, situations, where they feel empowered to create new ways of seeing these worlds, collectively. To these concepts help to distance themselves from their own realities, to theorize about it to think of novel ways to transform it (EZLN, ca. 2015). To feel as subjects (RIVAS DÍAZ, 2005), producing their own life projects in these exchanges (QUINTAR, 2018). For this, as educators that we are, we must feel subjects and feel the Others as subjects.

A CONTEXTUALIZED EDUCATION ABOUT NATURAL AND TECHNOLOGICAL WORLDS: SOCIOCOMMUNITARY PROBLEMS AS TEMATIC WORKLINES

Contextualization has been largely worked as a tool in critical pedagogy, from the Soviet School of Work onwards. The generating themes appear already

in the writings of the Soviet School of Work at the beginning of the Russian Revolution (PISTRAK, 2000). These are worked in a different sense by Paulo Freire, in his extensive work on Popular Education, also for whom the worldviews of students are

> Impregnated with yearnings, doubts, hopes or despair that imply significant [generating] issues, based on which the programmatic content of education will be constituted. [...] In this way, the recquirment that the emancipation action, that is historic, also in a historical context, to be in a relationship of correspondence, not only with the generationg themes, but also with the perception that people have of them. This requirement necessarily implies a second: the investigation of the significant theme. The generating themes can be located in concentric circles that start from the most general to the most particular.[7] (FREIRE, 2014, p. 105, 117-118, own translation)

From the role of coordinators we must promote a reaserch on what is the "thematic universe" of the group of students and the neighborhood, and the themes that can lead to develop those "limit situations" in the Freirean perspective. These are situations that appear as insurmountable for men and women, but with dialogue, reflection and analysis, we seek to find those unperceived solutions to transform them into possible ones, which constitutes the untested feasibility.[8] It requires a creative process, not mechanical, that investigates the interpenetration of problems of the most universal to the most concrete that give rise to this work.

Returning to the dialectical methodological conception of Popular Education, that action-reflection-action, or practice-theory-practice (JARA HOLLIDAY, 1995), can be thought of in three defined moments in the development of a problem:

1. Construction of the socio-community problem, which will act as thematic workline or generating theme.
2. Promote the need for learning, based on the analysis of socio-community problems, of the most abstract concepts that we have chosen as the learning goal and construction of these cultural tools
3. New analysis of the problem using the knowledge constructed in the above process, that allows us to look at it from new and broader perspectives.

7 In the original: "Impregnadas de anhelos, de dudas, de esperanzas o desesperanzas que implican temas significativos [generadores], en base a los cuales se constituirá el contenido programático de la educación. [...] De este modo, se impone a la acción liberadora, que es histórica, sobre un contexto también histórico, la exigencia de que esté en relación de correspondencia, no sólo con los temas generadores, sino con la percepción que de ellos estén teniendo los hombres. Esta exigencia necesariamente implica una segunda: la investigación de la temática significativa. Los temas generadores pueden ser localizados en círculos concéntricos que parten de lo más general a lo más particular."

8 Inédito viable.

The methodology, its rationale and the objectives of each phase must be explicitly worked with the students, so that this "way of doing", of analyzing reality, can be internalized by the them. The socio-community problems (as generating themes) should serve to problematize the social reality of the subjects and to establish the need for the construction of these conceptual (abstract) tools, in relation to the possibility of providing new and deeper analysis of these problems, and thus sustain the effort of the students in its construction.

Educational work should encourage the collective production of new analysis perspectives on these problems and, when possible, new proposals to solve or mitigate them. It also provides real situations for the use of these more abstract concepts and then allows them to be given significance. At the same time, it allows us to analyze the existence of mismatches between concepts and reality and the need for new concepts for things not named even in worlds that are constantly changing and require new ways of thinking (EZLN, ca. 2015). This constitutes an epistemic thinking, distancing oneself from the constructs of the past and historicalizing them (ZEMELMAN, 2001). The construction of a practical sense is also encouraged (BOURDIEU, 2015) around the work with these cultural tools and cultural practices, through a distancing from reality, in that situated reflexivity that constitutes the praxis of which Paulo Freire speaks to us:

> Reflexivity is the root of objectification. If consciousness distances itself from the world and the objective, it is because its transcendental intentionality makes it reflective. From the first moment of its constitution, when objectifying its original world, it is already virtually reflective. It is presence and distance from the world: distance is the condition of presence. When distancing itself from the world, constituting itself in objectivity, consciousness surprises itsself in its subjectivity. In that line of understanding, reflection and world, subjectivity and objectivity do not separate: they oppose, being dialectically implicated. True critical reflection originates and is dialectized in the interiority of the constitutive "praxis" of the human world; reflection that is also "praxis".[9] (FREIRE, 2014, p. 18, own translation)

As Frei Betto shows us in "Paulo Freire: a reading of the world" (w/t), by contextualizing these cognitive efforts in their territories and in their struggles and social memories abstract conceptualizations are constructed and reconstructed, they are imbricated with processes of reidentification and

9 In the original: "La reflexividad es la raíz de la objetivación. Si la conciencia se distancia del mundo y lo objetiva, es porque su intencionalidad trascendental la hace reflexiva. Desde el primer momento de su constitución, al objetivar su mundo originario, ya es virtualmente reflexiva. Es presencia y distancia del mundo: la distancia es la condición de la presencia. Al distanciarse del mundo, constituyéndose en la objetividad, se sorprende ella misma en su subjetividad. En esa línea de entendimiento, reflexión y mundo, subjetividad y objetividad no se separan: se oponen, implicándose dialécticamente. La verdadera reflexión crítica se origina y se dialectiza en la interioridad de la 'praxis' constitutiva del mundo humano; reflexión que también es "praxis"."

resubjectivation where, individually and collectively, they are subject to produce their own organizational consciousness and critically reappropriate their history.

This work makes more complex the knowledge objects normally approached in a disciplinary way, showing the heterogeneities of the problems studied and the need to address them in an integral and non-fragmentary way (not even fragmenting the social and natural worlds). This implies not seeking new answers to old questions that have already been asked, but essentially producing new questions that may interrogate what we ignore about the integrality of that problem (GARCÍA, 1999), generating a new epistemic framework in the process, and not only finding new knowledge to each sector. In order to being able to think about the complexity of socio-community problems, we must build new objects of study, teaching and learning that do not fragment them. Addressing socio-community problems from a pedagogy of complexity does not imply teaching more content, but means creating didactic conditions for the exercise of other types of thinking in the classroom from these contents, social practices that can be internalized as cultural tools and cultural practices to analyze and operate on the world. These contents become others, they are transformed, when recreated in some other social practices and reaching other objectives.

AN INTERCULTURAL, FEMINIST AND INTERSECTIONAL EDUCATION ON NATURAL AND TECHNOLOGICAL WORLDS

We understand that social spaces are, in themselves, diverse. An education for a social justice, from the curricular and cognitive justice, that is coherent between its discourse and practices, then must work on this diversity, make it visible, put the differences and equalities in dialogue, and that this dialogue be a vehicle of learning. In this process it is necessary to highlight the articulations between differences (socially, politically and culturally constructed) and social inequalities (THISTED *et al.*, 2007). Many times from the dominant pole of the social space identity discourses are built about different social groups that put their knowledge, practices, culture in inferior conditions. Other times these speeches make entire social groups invisible, as is the case with whitening discourse in Argentina (BRIONES, 2005).

Distancing ourselves from an essentializing position of the different sociocultural groups (and a multiculturalist vision promoted by neoliberalism), we seek an education that provides tools for communication between these groups, fostering their interrelation. We understand identities as multiple identifications, dynamic and always in the process of recreation. From an extended intercultural perspective, we propose intercultural education as an approach for all formative spaces (and not only for those where "minorities", subalternized groups participate).

The round-trip work on socio-community issues and various theoretical constructs, both cultural practices and cultural tools (ROCKWELL, 2000), concepts and heuristics that allow us to expand our analysis of the world, enable at the same time the production of a dialogue between the students' own knowledge and their experiences – both diverse –, the scientific literate culture and some bodies of knowledge others. This perspective allows to maintain an intercultural

approach in all classrooms, proposing in these activities to students a work "in the sense of knowing and valuing their own, of strengthening cultural pride, while working in the sense of knowing – that it is what the school has always done – and respecting the different"[10] (SCHMELKES, 2008, p. 655, own translation). By reexamining the socio-community problem (which is of the natural, technological and social worlds at the same time), the different knowledge put into play in this renewed school experience (those of school science and the knowledge of teachers and students) are evaluated (RODRÍGUEZ RUEDA, w/t). In this process, wider epistemic communities are recreated and new knowledge is built that combines the different perspectives that have been put into play (LEFF, 2011). In this dialogue of knowledges and livings (MERÇON *et al.*, 2014), which recovers knowledge as a practice, the teacher has a strong job in classroom management, and also seeks that this diversity present in the classroom to be a vehicle for learning, more than a weight for teaching action. The teacher also has the role of helping students to cross cultural boundaries (GIROUX, 1992): between their daily culture and the culture of some other socio-cultural groups (DUMRAUF; MENEGAZ, 2013), in particular the Western scientific culture hegemonic. This intercultural education approach needs a classroom management based on cooperative learning, understood as "a broad and heterogeneous set of structured instructional methods, in which students work together, in groups or teams, helping each other in generally academic tasks"[11] (TRAVER MARTÍ, 2003, p. w/r, own translation). That is, according to Díaz Barriga (2012), a situated education, which implies an education that proposes a high degree of social activity of its participants and in which the process is culturally relevant for them, putting the examples and phenomena that we bring to space and the objects of knowledge that we seek are apprehended with the experiences, trajectories, desires, questions of the students. This intercultural approach in all educational spaces, which uses sociocultural diversity as a vehicle for learning, is in turn consistent with the promotion of the construction of complex thinking, which also makes heterogeneities visible.

To practice an intercultural education we must first be able to recognize our own diversity, in the collective we integrate as educators (and in other spaces in which we participate). That is to say, to value the diversity of the body of educators, to make it visible in teaching and to value it towards the students and the learning community.

A situated education must recover how different dimensions intersect (CRENSHAW, 1991) in the constitution of the violations of rights and the conditions of oppression in which the groups that constitute the student body are immersed. This issue is of vital importance to address each student's own experiences as pedagogical facts to work in the classroom, especially as we recognize "the fundamental importance of racism and sexism as organizing principles of the

10 In the original: "En el sentido de conocer y valorar lo propio, de fortalecer el orgullo cultural, al mismo tiempo que se trabaja en el sentido de conocer –que es lo que siempre ha hecho la escuela– y de respetar lo diferente".

11 In the original: "un amplio y heterogéneo conjunto de métodos de instrucción estructurados, en los que los estudiantes trabajan juntos, en grupos o equipos, ayudándose mutuamente en tareas generalmente académicas".

system [capitalist world]" (WALLERSTEIN 1990, p. 289). Experiences that cannot be understood as the sum of exclusions due to gender, class, race, ethnicity, sexual orientation, etc., but an effort must be made to envision the ways in which these dimensions intersect in social experience (THOMPSON, 1989), social experience that is located historically and in the social space. We need then to build a pedagogy that is at the same time classist, feminist and interculturally extended and critical and practices in educational spaces that show us that some other ways of thinking, thinking and relating to the Others and acting, opposed to those of the capitalist-racist-patriarchal system.

A RECOVERY OF HISTORIC MEMORY

It is important to revalue the students' own knowledge (LÓPEZ CARDONA, 2014). In Natural Sciences, much has been written about previous ideas, which are knowledges that are thought to be constructed from common sense, unreflected knowledge, which are also contradictory to the knowledge produced by academic science. Knowledge that should be abandoned and changed by that produced by science, in a process that has been called conceptual change.

Here we rethink many of those knowledge built in the daily (or authentic) practices of the students as their own knowledges, which are real and strong knowledges, often not recognized by the community – and less by educational institutions – (LÓPEZ CARDONA, 2014), in opposition to the extensive literature of previous ideas, which disregard all those that are not consistent with academic science. These knowledges, historically produced by the communities, are housed in their collective memory. It is the knowledge that constitutes the "nuclei of good sense" (GRAMSCI, 2014), class knowledge and practices that in certain situations (especially in times of crisis) guide the social struggle against their class enemies that oppress them, by allowing a distinction between an "Them" oppressors and an "Us" opressed. This does not mean that every practice or knowledge of the student body is their own knowledge. Many of these were built and internalized through historical processes of physical and symbolic violence, pedagogical processes (GRAMSCI, 2014) of social production of habitus (BOURDIEU, 2012), in many cases as practical, unthinking knowledge that helps the reproduction of relations of domination (BOURDIEU, 2015) (reproduction that constantly recreates and reinvents them).

We seek to recover the practices of care towards the Others and the territories, food production, cooperative work, solidarity values, knowledge about the organization and collective production of knowledge, among others, that are in the antipodes of the exploiters and dispossession formats of capitalism, which promote individualism, competition and excessive profit. We seek to begin to deconstruct in practice the pedagogies of cruelty (SEGATO, 2018), promoting new and lasting empathy between subjects. What implies first knowing the groups of students, working with community memories to identify these nuclei of good sense and differentiate them from other practices and schemes of perception and classification that would be called "common sense" (DI MATTEO *et al.*, 2012). It is then about recovering and recreating these practices and knowledge and putting

them in dialogue with each other and with the theoretical constructs produced in the educational space, so as to evaluate in the specific cases provided by the socio-community problems chosen the adaptation of each conceptual body to the reality (RODRÍGUEZ RUEDA, s/f), or the need to build new ones that allow us to read it better (EZLN, ca. 2015).

A work about the nature of production of knowledge

An education designed from a point of view of cognitive justice (SOUSA SANTOS, 2018) implies questioning scientific knowledge as the only pattern of truth. Knowledge built based on personal and social interests of certain groups in relation to their positions in the social space and class struggle and budgets that constitute serious epistemological obstacles. This has long been exposed by Latin American thinking in science and technology, showing how local scientific activity in Latin America has historically been colonized (VARSAVSKY, 1969; FALS BORDA, 1971), process which continues in the present days. Colonization that is part of the coloniality of power and knowledge (GROSFOGUEL, 2016). Organized communities have shown great examples in the history of producing knowledge closer to empirical data than science, especially in problems that involve interests of important power groups. Examples are the practices of popular epidemiology carried out around fumigation with agrotoxics or the oil industry (CARNEIRO *et al.*, 2015) that demonstrate their serious health effects that confront reports coming from hegemonic places claiming the safety of these products – or, at least, the lack of data that prove otherwise – (ARGENTINA, 2009). We must move towards educational experiences that practice epistemic diversity (GROSFOGUEL, 2016), which will lead us to, as the Zapatistas teach us, "a world where many worlds fit"[12]. Where popular methods and approaches that lead to results radically opposed to science are valued, debated and analyzed.

It is necessary then a work that feminizes the task of producing knowledge in educational spaces, which breaks with the whitening of it (BRIONES, 2005) and with a narrative not only Eurocentric, but also focused on the great centers of internal colonialism (GONZÁLEZ CASANOVA, 1965/2006) of the semiperiphery and the periphery of the world-system (WALLERSTEIN, 1990). The foregoing implies not only incorporating new narratives on the production of knowledge, but also care and emotional relationships towards others as part of the daily practice in these spaces.

Critical social studies owe much to theoretical productions developed from outside the academy or on its margins, in cooperative relationships with political organizations, social movements, etc. Natural Sciences have been constituted in part based on the dispossession of the knowledge of communities and peoples, the inheritance of knowledge of the Arab and Muslim worlds, among others (GROSFOGUEL, 2016). Recovering those voices is part of an alternative work that demystifies who are those Others who perform tasks of knowledge production, that shows us how we are all intellectuals even if we do not fulfill this social

12 In the original: "un mundo donde quepan muchos mundos".

function in society (GRAMSCI, 2014), which breaks with the imaginary of the mad, disheveled, antisocial, male, white scientist, who works in a laboratory with expensive devices and is the one who primarily produces knowledge in an individual activity. A representation of this Other scientist (and sole producer of authorized knowledge) that leaves the social activity to inquire, think, reflect and theorize about natural and technological worlds as an activity for the few who meet these classifications and not as an activity open to all people who wish to develop it, then producing, through a political work of social differentiation, new relations of inequality (BOURDIEU, 1990).

In particular, when working on the sciences it is necessary to dialogue with them, making visible that they are a type of European thought, that is, that it has a localized and non-universal spatial origin, which is a hegemonic and colonizing production, impregnated since the second modernity of a sense of liberation, and that they are also culturally and politically heterogeneous (PORTO GONÇALVES, 2009). And at the same time, denaturalize certain assumptions about the scientific activity itself. Many times an image of science of the empirical-inductive type is held in educational spaces, which manifests itself in beliefs such as the linear progress of science, the neutral nature of scientific work, the infallibility of the experimental method and the superiority of the bodies of scientific knowledge about other bodies of knowledge. There is very stereotyped representation about people who are dedicated to doing science. It would seem even in these beliefs that there is a single scientific method, as a series of steps to follow sequentially, that would lead to the production of objective, neutral and universal knowledge, when research and epistemological reflection from the sciences themselves have shown the invalidity of the previous statement (BOURDIEU, 2003).

One way to avoid this accumulation of prejudices on science as a human activity is to use stories that are based on the history of science, narrating and debating in the classes different moments of knowledge production, the different epistemological obstacles with which They have found scientists in the past, and the methodological diversity that has been used to produce knowledge in scientific disciplines and their articulations with other bodies of knowledge. The narratives allow to circulate the interests, desires and affections that have moved science as a social and cultural activity (GARELLI; CORDERO; DUMRAUF, 2016). This work should provide narratives where "low voices" appear (GUHA, 2002), those people who, because they belong to different subalternizing classifications, are invisible in the hegemonic accounts of science. Scientists who work outside the centers of power of capitalism (and outside academic institutions), women, political dissidents, are some of the scientific experiences (and other knowledge productions) that it is necessary to recover to break the imaginary about who they are that develop this human and social activity that we call science. Science that, in addition, hegemonically is represented only by the so-called Natural Sciences and Technological activity, which is why it is necessary to revalue and equalize the so-called Social Sciences.

But just as work on the nature of science is necessary, so is work on the nature of the production of other bodies of knowledge. Knowing their places of

origin, their values, their colors and genres, as Catherine Walsh (2007) would say, that allows us to feel about this knowledge, as Estela Quintar tells us, what we think about them, what it means in our existence and in our practice (RIVAS DÍAZ, 2005), as an exercise where we become subjects again. That allows us to recover these bodies of knowledge, revalue them and apply them, but in a critical, situated and reflexive way (WALSH, 2007), so that they can be recreated.

Above all, it is proposed to practice the production of knowledge in educational spaces. Efforts should be made to put into practice specific practices in the classroom, shared and organized with all students through the realization of projects that involve sustained practices of (self) questioning, interrogation, inquiry, analysis. These projects allow enriching teaching strategies by linking: principles and methodologies of inquiry in the production of socio-community school knowledge, recognizing the role of various bodies of knowledge in understanding the world and creating public spaces for communication and exchange of educational experiences. Therefore, we need to create the conditions of an educational experience in which research and interventions can be built and practiced, in which all members of the learning community can participate. They recreate then, in an authentic way, ways of doing with Others, in intersubjective relationships, where you hold them reemerge by dialoguing with their experiences, experiences and theories. The socio-community issues, as organizing thematic axes, provide an excellent framework for the development of these projects. Projects that become true authentic practices of collective production of knowledge from educational spaces, which retake and recover many bodies of knowledge as living bodies, thus recreating them day by day, and not as dead bodies forced to remain immutable for centuries the centuries (WALSH, 2007).

It is also necessary to produce educational situations where reflections on the work carried out are promoted, which enable debates and conceptualizations of their own, confronting with previous experiences and with the hegemonic "common sense" on, among other issues, what it is to produce knowledge, where it is done, who do it, for what purposes it is done, how its results are disseminated. Articulating these reflections to the work with narratives and stories, in first and third persons, of different groups of knowledge production and members of the community that recover their collective memory and the realization of authentic knowledge production practices.

LANGUAGES IN THE EDUCATION ABOUT NATURAL AND TECHNOLOGICAL WORLDS

We consider that language "is rather an instrument to test ideas, to imagine what will happen and to interpret situations" (SUTTON, 1997, p. 12), while being a cultural tool and a cultural practice (ROCKWELL, 2000). We seek to initiate students as listeners, readers and authors of speeches around problems of the natural and technological world.s We aim to build communication tools on the natural and technological worlds at the school level necessary to provide autonomy to the subjects, while offering bridges between their own language and the languages of the different bodies of knowledge worked in space (LEMKE, 1997). Teachers must generate the didactic conditions that allow students to have

varied opportunities to understand and express themselves using the different bodies of knowledge, in their school version and in their communicative format. This implies promoting diversity of situations where students must defend opinions, dialogue with Otres, legitimize positions. Jay Lemke expressed about working with the Natural Sciences:

> Teachers should actively expose the scientific enterprise as an activity open to people of all genders, races, technical and social media, as well as potentially compatible with any cultural and social values that students can hold [...]. The methods of evaluation and accreditation in science should not penalize students for the use of dialects or alternative forms of organization and argumentation, except when there are good reasons to demand the use of formal scientific language.[13] (1997, p. 190, own translation)

The students' right to know other forms of expression and knowledge production, in particular the dominant forms (which is also important for their ability to negotiate with different sectors of the State and dominant groups), must be made compatible with their right to that their own forms be respected and valued, as Paulo Freire points out:

> It is necessary that the popular school, especially the one that is located in the deepest of the peripheral areas of the city, think seriously about the question of language, of popular syntax, of which I speak and write so long ago. For so long and often misunderstood or distorted. [...] It is not possible to think about language without thinking about the concrete social world in which we are constituted. It is not possible to think in language without thinking of power, in ideology.
> What seems unfair and undemocratic is that the school, based on the so-called "cult pattern" of the Portuguese language, continues, on the one hand, stigmatizing the language of the child of the popular class, and on the other, in doing so, introject into it a feeling of incapacity from which it is hardly released. However, I never said or wrote that children in popular sectors should not learn the "cult pattern." For that, however, it is necessary that they feel respected in their identity, that they do not feel that they are seen inferior because they speak differently. It is necessary, finally, that when they learn in their own right the cult pattern, they perceive that they must do so not because their language is ugly or inferior, but because,

13 In the original: "Los profesores deben exponer activamente la empresa científica como una actividad abierta a gente de todos los géneros, razas, medios técnicos y sociales, así como potencialmente compatible con cualesquiera valores culturales y sociales que los alumnos puedan detentar [...]. Los métodos de evaluación y acreditación en ciencia no deberían penalizar a los alumnos por el empleo de dialectos o de formas de organización y argumentación alternativas, salvo cuando hay buenas razones para exigir el uso del lenguaje científico formal."

> dominating the so-called cult pattern, they are instructed to fight for the necessary reinvention of the world.[14] (FREIRE, 2010, p. 53-54, own translation)

At the same time, as Ana Dumrauf and others (2019) propose, it is also important to work with other forms of expression, such as image, an issue in which Bolivian thinker Silvia Rivera Cusicanqui is recovered. The images, the work from the body (and expressing oneself with the body), provide rich spaces for the emergence of forgotten experiences, feelings, knowledge and analysis of reality, not said in other ways, that challenge the knowledge and epistemes worked In the educational space.

FINAL REFLECTIONS

When thinking about a work of inquiry in relation to the natural and technological worlds in constant and interdependent crosses with the social world and the practices of language and communication, from an anti-systemic, feminist, intercultural extended and intersectional perspective that is based on the Epistemic diversity, in pursuit of social justice and social transformation, we should question whether this activity continues to be about natural sciences. Continuing to call her in this way implies always putting the hegemonic and colonizing form of modernity to study and talk about natural and technological worlds at the center. In the same way that there has been a movement from the Didactics of Natural Sciences towards Science Education[15] (which makes clear its political-pedagogical nature and not just technical issues), we can think of an Education about natures and technologies. An Education about natures and technologies that does not ignore Natural Sciences as a body of knowledge, but as one more body of knowing among others (taking into account its hegemonic character, recovering its history and spatiality of production and its colonizing social trajectory). A comprehensive proposal to think about how to retrace modern epistemicide in our educational spaces, taking a decolonizing path and towards an ecology of knowledge.

We understand that the old tension between the particular and the common continues today and crosses our entire field of analysis. The accumulated experience of policies that have fragmented educational systems, enhancing inequalities, leads us to wonder what could be common in schools, always

14 In the original: "Es necesario que la escuela popular, sobre todo la que se sitúa en lo más hondo de las áreas periféricas de la ciudad, piense seriamente en la cuestión del lenguaje, de la sintaxis popular, de la que hablo y escribo hace tanto tiempo. Hace tanto tiempo y muchas veces malentendida o distorsionada. (...) No es posible pensar en el lenguaje sin pensar en el mundo social concreto en que nos constituimos. No es posible pensar en el lenguaje sin pensar en el poder, en ideología.
Lo que me parece injusto y antidemocrático es que la escuela, fundamentándose en el llamado "patrón culto" de la lengua portuguesa, continúe, por un lado, estigmatizando el lenguaje del niño de clase popular, y por otro, al hacerlo, introyecte en él un sentimiento de incapacidad del que difícilmente se libera. Sin embargo, yo nunca dije o escribí que los niños de sectores populares no deberían aprender el "patrón culto". Para eso, no obstante, es necesario que se sientan respetados en su identidad, que no sientan que se los ve inferiores porque hablan diferente. Es necesario, finalmente, que al aprender por derecho propio el patrón culto, perciban que deben hacerlo no porque su lenguaje sea feo o inferior, sino porque, dominando el llamado patrón culto, se instrumentan para su lucha por la necesario reinvención del mundo."

15 "Didáctica de las Ciencias Naturales" and "Educación en Ciencias Naturales" in Spanish.

diverse. How do we think of a school for everyone, an educational system not fragmented by social classes, gender, ethnic identifications, etc. and that does not impose particularities of certain social sectors as universal? Gabriela Diker (2008) argued that the claim to be shown as complete universals is at the base of school exclusion mechanisms. And then maybe we have to open before closing what is common, think open, porous sets. Returning to the classics, in this case the teachers Paulo Freire and Antonio Faundez (2014) and their *Pedagogy of the question*, we could postulate that the common, rather than a list of closed contents (concepts, practices, etc.) could be great questions to be discussed in classrooms, questions that can be analyzed from different points of view located in a variety of positions in the social space and territories, proposing a wide range of teaching strategies. Broad questions, such as: How do writing systems work? How can we count? How food is produced? What do we value from other people and why? What are the lights we see in the sky at night and how were they formed? What is society? Big questions that can guide the construction of cultural tools and similar cultural practices in terms of their ability to contribute to the understanding of certain realities, which allow entering new and open worlds, without closing in certain universals defined centrally, but on the contrary, opening the range of possibilities, strengthening diversity. As Andrade (2019) shows, this leads educators to rethink their own place, from the knowledge-power point of view, where the question does not have a mere place of intellectual exercise, but the question need to be "lived"and the possibility of expressing with freedom the own relationships of students and educators in the world and with the world. In these dialogues and tasks, located, territorialized, loaded with the experiences and livings of the participants themselves, new pedagogical practices could be built in pursuit of social justice without generating ghettos or exclusions.

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HOW TO CITY THIS ARTICLE

ITHURALDE, Raúl Esteban. Thinking about a popular education in sciences? *Cadernos de Pesquisa*, São Paulo, v. 50, n. 175, p. 186-208, jan./mar. 2020. https://doi.org/10.1590/198053146644

Received on: 20 JUNE 2019 | **Approved for para publication on:** 22 JANUARY 2020