

Challenges to Science Education in Troubled Times

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We are experiencing moments of regression regarding democracy, human rights, social justice and the well-being of individuals, societies and the environment. A number of communities suffer politically, emotionally and physically because of a society that does not take care of all its members, ignoring those who are most vulnerable and subjecting them to deplorable living conditions and discriminatory and persecutory behaviors due to ignorance, prejudice and intolerance.

The negative effects of neoliberalism and globalization have intensified, and social and political institutions seem unable or unwilling to respond effectively to multiple instances of injustice. Social asymmetries have worsened, perpetuating a system that benefits only a small minority, at the expense of the environment, the uncontrolled and unsustainable exploitation of resources and the suffering and exclusion of the majority of the population.

Many citizens do not feel empowered to understand or make decisions about the social and environmental problems that affect their communities and – at the same time – the confidence in political representatives has diminished and political apathy has gained ground, making room for populist movements and a likely 'democratic recession'.

The ignorance among a significant portion of the population of what science is, associated with the misinformation disseminated by certain groups creates an environment that is conducive to the appearance and proliferation of distorted and erroneous views and anti-science movements.

The global political and social climate is saturated with anger, fear, misinformation, distrust and discouragement. Political polarization spreads around the globe and has repercussions on divisions and conflicts between countries and within communities and families.

How can we counter this situation from the perspective of science education? What challenges does science education face in tackling the causes of such problems and injustices?

Challenge 1 – Science Education for Social Transformation

The social and environmental problems that different communities face and the population's difficulty being actively involved in the development of solutions



to these problems make it urgent to shift the focus of science education from the transmission of knowledge to the promotion of skills that ensures not only the training of scientists and specialists, but also a scientific education to reach all citizens. That is, not a science education that focuses on promoting the adaptation and conformity of citizens to the current rules and conditions of our society and our communities, but – instead – a science education that is concerned with the training and empowerment of citizens for a democratic, collaborative and grounded-in-science society (SCHUTZ, 2019). That implies a participatory transformation in which teachers and students actually act as agents of change committed to a vision for society in the future, breaking with a set of bureaucratic / suffocating practices that seem intended to keep individuals tired, numb and without the capacity for (re)action.

Science education for social transformation is seen as a democratizing force and a catalyst for individual development and social change. In this way, the school is a living forum for liberating dialogue instead of an institution destined to teach to exams, for social conformity or competition between individuals and societies (KELLNER; KIM, 2010).

Challenge 2 – A View of Science as an Attitude of Critical, Questioning and Intellectual Autonomy

Currently, a considerable number of citizens still share an outdated view of science, as a definitive and unquestionable body of knowledge, built by scientists through a neutral and objective process. This idea of science: (a) seriously distorts the nature of science and scientific practices; (b) deters citizens from critical scrutiny by presenting scientific knowledge as a collection of fixed and non-questionable statements made by experts; (c) contributes to the internalization of an intellectual dependence on specialists by citizens in general; and, (d) promotes a feeling of lack of power among citizens (BENCZE; CARTER, 2011; BENCZE; SPERLING, 2012).

The troubled nature of today's society justifies a scientific education that encourages, among the population, a conception of science: (a) as a process of knowledge construction, conditioned by social, historical and cultural contexts and in constant interaction with technology, society and the environment; and (b) as an attitude of critical, questioning and intellectual autonomy in the face of the news published by the media, of the proposals of particular groups and of the events in daily life. This attitude should ideally apply to all citizens instead of consisting in a privilege of a small group of specialists (MATTHEWS, 2015; MCCAIN; KAMPOOURAKIS, 2020). A concept of science that will facilitate the collaboration and mobilization of all citizens in order to: (a) call for and guarantee participatory and well-founded citizenship on issues related to science and technology; and (b) demand social and ethical justice in the interactions between science, technology, society and the environment.

Challenge 3 – Training and Empowering Citizens for Reasoned Action

There is much to do in terms of training and empowering citizens for active and informed participation (in scientific knowledge) in decision-making and action process (individually and collectively) on the issues that affect our societies / communities, with implications for quality of life and social justice. In this process, science education

always plays a relevant (positive or negative) role, depending on the actions of educators. Traditional practices, marked by a lack of dialogism and banking education (FREIRE, 1974) that does not take into account the needs and interests of students, increase the social invisibility of citizens and reinforce their dependence on opinions, decisions and interests of restricted groups (politicians, scientists, and specialists among others) that do not always seem to act for the common good. Educational practices that acknowledge students' (regardless of their age) right of participation / involvement in identifying problems that affect their communities – and in building, discussing and making decisions about possible solutions to these problems – increase the intellectual autonomy of citizens and allow them to play the role of social protagonists who are capable of taking responsibility for the future of their lives and their communities (ALSOP; BENCZE, 2014). These practices, which promote a critical and investigative attitude, invest citizens with the skills necessary for thought, discussion, decision-making and action, thus making them socially relevant knowledge builders, rather than simple uncritical consumers of knowledge (as other practices otherwise seem to stimulate) (BENCZE; SPERLING, 2012). Through these types of emancipatory practices, any student, regardless of age, is recognized as a citizen for the extremely influential action that they can perform within their families and groups of friends.

To this end, it is necessary to: (a) ensure that children and young people have opportunities to participate significantly in their daily lives, through the provision of informal and formal spaces (at different levels, namely home, school, community, organizations and associations) in which they can articulate their own expressions of active citizenship through different forms of participation; (b) encourage children and young people to assume high levels of responsibility and action in the exercise of active citizenship; and (c) encourage adults to assume the role of facilitators and advocates – not controllers – in carrying out actions (involving children, youth and adults) that focus on common concerns and that facilitate the development of a culture of respect and mutual trust (HART, 2008; PETERSON, 2018; SCHULZ *et al.*, 2018).

Challenge 4 – A Curriculum Design Strongly Contextualized and Focused on Appropriate Skills to Promote the Well-being of Populations and Ecosystems, and Social Justice

Some limited / restricted conceptions of curriculum – for instance as an exhaustive list of contents that are decontextualized from students' lives – relegate the teacher / educator to an official role that is limited to uncritically executing the educational policy guidelines imposed by particular groups. In this type of context, teachers / educators often feel overwhelmed / tired / anesthetized by bureaucratic tasks and far removed from reflection and decision. However, the achievement of a socially relevant and empowering science education requires a different curriculum design, like the set of learning outcomes (knowledge, skills and attitudes) that are important in a given historical and social context, marked by specific requirements. According to this curriculum design, it is up to societies / communities to identify the set of knowledge that is most appropriate for successfully overcoming the challenges they face. In this context, the teacher is actually a curriculum builder (HARGREAVES, 2000): an expert and a decision maker capable of contributing to the development of a curriculum centered on

competencies that promote social justice, and the well-being of populations and ecosystems (HADJICHAMBIS *et al.*, 2020; REIS, 2020).

In the opinion of Hodson (1998, p. 4), any science curriculum should prepare students for socio-political action, through problem-based scientific education that is much more politicized and equips students with "[...] the capacity and commitment to take appropriate, responsible and effective action on matters of social, economic, environmental and moral-ethical concern". This type of curriculum should: (a) be based on local, regional, national and global issues that are considered socially relevant by the teacher and the students; (b) present science and technology as human undertakings; (c) propose politicized scientific and technological education imbued with human and environmental values; and d) consider where students, teachers and community members have the opportunity to carry out scientific investigations and to get involved in the implementation of solutions (based on scientific data) for problems that they consider relevant. The strongly contextualized science curricula – centered on real situations and problems in the communities in which students live – reinforce students' perception of the social relevance of science education and the importance of science in solving problems that affect communities.

Challenge 5 – Evaluation for Individual Development and Social Transformation

From the perspective of science education as a process that is centered on the promotion of required skills for solving current social and environmental problems, evaluation is of crucial importance. The assessment of these competencies only becomes possible if carried out in a contextualized manner, in real situations in which the competencies can be observed in action (while students identify problems, consider their causes, develop possible solutions and put these solutions into practice) (BLACK; HARRISON, 2010). Only in the context of these real actions is it possible to conclude whether students have become competent or not. In this way, evaluation is at the service of individual development and social transformation instead of at the service of examination, social conformity and competition between individuals and societies.

Challenge 6 – Continuous Training with a Greater Impact on the Professional Competence of Teachers and the Learning Outcomes for Students

The answer to the great challenges that the current school is faced with requires continuous teacher training that is both highly contextualized, i.e., centered on the specific needs of particular teachers and schools, and that uses the school and the classroom as the privileged place for the development of relevant professionals and for causing greater impact on students. Greater contextualization and the consequent reinforcement of the relevance of teacher training will allow for monitoring the development of professional skills – teacher knowledge – with the motivational factors – the will – and the means of achievement – the power – which are indispensable for the skills to be translated into effective educational practices (CAMPOS, 2011).

The development of communities of practice – involving the collaboration of different educational agents in analyzing problems and implementing and evaluating proposed solutions – has proved to be an effective way of improving teaching in specific contexts and provides support for innovation that combats feelings of isolation and discouragement, and simultaneously promotes individual and collective development and social transformation (DAVIS, 2003; REIS, 2014, 2016; REIS; GALVÃO; BAPTISTA, 2018). In communities of practice in the school context, teachers associate and interact when they are motivated by common interests and the desire to improve their educational practice by: (a) sharing knowledge, experiences, ideas and skills; and, (b) becoming involved in research-reflection-action dynamics focused on solving specific problems diagnosed by themselves, with the introduction of innovative educational approaches (WENGER, 1998, 2010).

Challenge 7 – Teacher Supervision as an Emancipatory Process

Pedagogical supervision in the school context is increasingly accepted as an adequate strategy for the training of teachers in order to exercise their profession. This is a process that aims to strengthen the capacity of schools to contribute to the education and academic success of each of their students, by promoting interaction, problem-solving capacity and the professional development of teachers (FULLAN; HILL; CRÉVOLA, 2006; REIS, 2011; SERGIOVANNI; STARRATT, 2007). That may take place in different situations, namely, within the scope of: (1) an internship in professional practice that provides contact with particularly interesting teaching practices and the development of trainees' professional skills; (2) a period of professional induction focused on the integration of teachers with an educational community and functions to be performed; or (3) a professional development initiative in the school that supports the identification and overcoming of individual and collective weaknesses. However, regardless of the situation in which supervision occurs, the challenge lies in the transition from a more controlling and inspecting perspective – centered on the evaluation of teachers and triggering negative feelings that compromise the developmental character of this process - to a perspective of emancipation and autonomy that enables the subjects involved to transform school and social practices.

The more inspecting perspective of supervision emerges as a way to “fine-tune” teaching and to control and force teachers in directions that are considered desirable by top school leaders. That is carried out hierarchically – in a top-down fashion, from the specialist to the subordinate – constituting an individualistic and hierarchical process of learning about teaching that encourages a passive, dependent and adaptive attitude among teachers. Strongly focused on maintaining rules and standards of action, these types of supervision reduce the role of teachers to that of employees who are limited to implementing curricula, practices and assessments imposed by others. Consequently, teachers are not prepared for change / transformation, but in fact end up perpetuating the *status quo* by constituting a conservative process that maintains existing practices and structures (SMYTH, 1988).

The emancipatory perspective of supervision has a collaborative and differentiated nature, and is adequate for the development needs of each teacher (ALARCÃO; ROLDÃO, 2008; GLICKMAN; GORDON; ROSS-GORDON, 2007). In this way, it is assumed as an

emancipatory process in which teachers help themselves to gain control over their professional lives and to transcend and transform their teaching and the social and cultural context in which they work, with a view to a fairer and more environmentally sustainable process (SMYTH, 1986). In this kind of supervision (among peers), teachers are active agents (a) in changing their practices, (b) in adapting curricula to what they consider to be the needs of their students and of the communities in which they live, and (c) in the transformation of society and their personal lives.

Challenge 8 – The Use of Web 2.0 to Support Action in Response to Social and Environmental Problems

Web 2.0 tools can be quite powerful in implementing collective actions on social and environmental issues (REIS, 2013). Many social movements (youth and adults) have used Web 2.0 tools to break through dominant media agendas and mobilize citizens for new forms of organization and socio-political action (CANDÓN-MENA; BENÍTEZ-EYZAGUIRRE, 2016). A number of social networks have given social prominence to groups of citizens traditionally removed from media monopolies that are dominated by states or economic groups. This helps to create and sustain access to more democratic virtual spaces that facilitate the rapid interaction and exchange of ideas between an extremely large number of individuals. However, these social networks have also facilitated the dissemination of wrong and distorted information and propaganda among the world population, manipulating public opinion and the behavior of citizens, thus promoting wrong ideas about science, hatred and fanaticism (ASHLEY, 2020; LANIER, 2018; VAIDHYANATHAN, 2018). The information disorder, triggered by facilitated access to the Internet by groups interested in manipulating public opinion, particularly affects communities with low levels of media literacy and scientific literacy (LOPES, 2019; WARDLE, 2019; WARDLE; DERAKHSHAN, 2017). Therefore, the promotion of these types of literacy assumes a key role in the fight against all problems resulting from information disorder (IRETON; POSENTTI, 2018; WARDLE, 2019).

Despite these negative aspects, however, Web 2.0 tools can have a strong impact on citizens' cultural, social and political empowerment (KELLNER; KIM, 2010; ZORAS; BENCZE, 2014). They are more effective in promoting civic participation than traditional media (KAHNE; NAM-JIN LEE; FEEZELL, 2013; SEGERBERG; BENNETT, 2011) and they allow all citizens to express their views and take a leading role in the dissemination of particular proposals for solving social and environmental problems (GARCÍA BERMÚDEZ et al., 2014, 2017; KRSTOVIC, 2014; MARQUES; REIS, 2017a, 2017b; SCHEID; REIS, 2016; ZORAS; BENCZE, 2014).

Final Considerations

The challenges to science education presented here are not new. However, the current social and environmental context make the topic an extremely urgent issue. The realization of the importance of these challenges will promote: (a) the recognition of the dignity and value inherent in all human beings; (b) critical thinking and intellectual autonomy among citizens, in an atmosphere of freedom of thought and expression; (c) the widespread empowerment of citizens for informed and active participation in the

evolution of their lives, and in solving the problems that affect them; (d) reinforcement of every individual's right to participate freely in the life of the community, and to contribute actively and in an informed way to a healthy society and environment.

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