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Science education against the rise of fascist and authoritarian movements: towards the development of a *pedagogy for democracy*

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Abstract
In the twenty-first century, the rise and support of fascism-related views threaten freedom of speech, freedom of sexual orientation, religious tolerance and progressive agendas that advocate equity. We argue that mainstream science education generally does not, but should, educate students against fascism-related views—such as racism, sexism, homophobia and religious intolerance—with a view to strengthening mutual respect and the common good. We argue some science teaching practices are found to be suitable to fascism-like ideologies (e.g. race in genetics teaching), and that the use of the concept of 'scientific literacy' has focused on neoliberal possessive individualism. As a consequence, mainstream science education overlooks the development of sympathy, altruism and interpersonal skills. We also discuss the activity of science education in authoritarian, undemocratic regimes in history, showing that fascist regimes have long used 'apolitical' scientists' achievements to establish and expand regimes' intolerant and violent ideologies. We use that historical relationship to argue fascism is science education's business. Given the fear that current political discourses in many countries are again swinging towards fascism, we outline potential pathways for science education which focus on the social and emotional development of students. We argue that to develop a *pedagogy for democracy*, that attends to equity and social justice, it is imperative it enables pupils to develop at a psychological level with diverse others, including through their own agency. This pedagogy builds on critical pedagogies.

Keywords Scientific literacy · Fascism · Critical thinking · Emotions · Social justice · Critical Pedagogy · Othering · Equity

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Should science education deliberately and clearly stand against authoritarian, intolerant, oppressive, misogynist, and racist views, promoted and valued by fascist ideologies? In this article, we contend that developing tolerant and empathetic views, the values of democracy, freedom of speech, freedom of gender identity, freedom of religion and of an inclusive society must be built collaboratively across all school subjects. And with this principle in mind, we will argue that mainstream science education (and more broadly STEM education) currently does not, but should, develop a socio-political agenda (Santos 2009) that challenges oppression of minorities and other fascism-related traits.

Fascism is an overloaded term, with little consensus in the literature about what defines its forms of government. In twentieth-century Europe, for instance, Mussolini's, Hitler's, Franco's and Salazar's regimes have all been described as fascist, authoritarian, nationalistic and violent, led by a charismatic leader, but they had clear different expansionist and militarist aims (Jacoby 2016). But in relation to values and feelings that feed into the fascist ideology, these invariably include hatred, xenophobia, misogyny, homophobia and racism, which nurture intolerance and bigotry (Albright 2017). In everyday language, the term fascism has been used to mean "something cruel, unscrupulous, arrogant, obscurantist, anti-liberal and anti-working-class", often used as a "bully" or "swearword" (Gottfried 2017, p. 316). Such connotations are not only detrimental to interpersonal relations in inclusive democratic societies, they are also used to strengthen authoritarian views in democracies that lead to fascist regimes (ibid.). In the modern literature, fascism-related ideological supporters are sometimes referred to as the far-Right. In particular, the Alt-Right (a term that is used to refer to white nationalist movements based in the USA) pursue ethno-national 'purity', hold reactionary gender roles, value top-down policies, are violent, advocate white male entitlement, and display a racist will to power intending to eradicate weakness and opposition from all quarters (May and Feldman 2018).

Neo-fascist movements tend to emerge under fragile political-economic crises (Renton 1999), and such political forces can gain momentum either to maintain or change the political status quo (Davies and Lynch 2002), i.e. fascism can be associated with conservative or revolutionary movements. Dave Renton (1999) has documented that in the twenty-year period after the end of WWII there was strong opposition to fascist political movements in Europe but, from the seventies, pockets of fascism resurged on the continent, including within countries severely adversely affected by the ideologies of the war, such as Italy, France and the UK.

Our particular interest in countering fascism and authoritarianism is in direct response to the widely reported news that the twenty-first century is seeing the new rise and support of fascist views in Europe, and the North and South Americas. To give only a few examples, the *New York Times* has suggested that Donald Trump fulfils the fascist agenda of racism, exclusion and intolerance (Beinart 2018)—an assessment of a president who proposed to build a wall with the Mexican border and publicly dubbed Latin Americans "bad hombres" (Dopp 2019). In a typical move of authoritarian regimes, ignoring freedom of speech and of assembly, Trump threated to use military force against anti-racism protesters after the death of George Floyd (ITV 2020). One month later, federal law enforcement officers of the so-called leading country of free world scarily used "unmarked vehicles to drive around downtown Portland and detain protesters" and drove up "to people, detaining individuals with no explanation of why they are being arrested, and driving off" (Grave 2020, para. 3 and 4). *The Guardian*, echoing the Brazilian press, has reported that Jair Bolsonaro has expressed support for torturers and called for political opponents to be shot, earning him the label of "the most misogynistic, hateful elected official in the democratic world" (The Guardian 2018a, para. 2). After he openly bullied homosexuals several

times during 2018 presidential campaign, it has been reported "LGBTQ Brazilians [are] on edge after self-described 'homophobic' lawmaker [was] elected president" (Sullivan 2018). And, shockingly, during the deadly pandemic that killed many thousands of Brazilians, Bolsonaro has used "homophobic slurs to mock masks" (Phillips 2020). In the UK, meanwhile, the new British Prime Minister, Boris Johnson, has been linked to islamophobia, saying "Muslim women wearing burkas 'look like letter boxes'" (BBC 2018a) and has been accused of "moral emptiness, casual racism and courting fascism" by a Conservative Party peer (The Guardian 2018b). Evidence similar to the above is abundant in the media, also from other European countries such as Italy and Hungary and beyond, which shows fascism-related views did not disappear after WWII. In fact, fascist-related politics are continuing to gain considerable currency and political advocates in many countries across the world (Albright 2017).

This is, as we know, just the tip of the iceberg of a cross-nation moral crisis in the twenty-first century. Fascist-related policies and deeds are context-dependent; they vary from country to country, and therefore must be tackled taking that into consideration. Whilst necessary, looking in detail into such variability, however, goes beyond the scope of this article. We are looking at creating an argument as to why fascism is science educators' business, what we have been doing (implicitly or not) to tackle it and what else we can do to strengthen democracy.

Central to the authors' concern, fascist regimes have historically benefited from and been strengthened by the achievements of scientific work (Gaspar, do Mar Gago, and Simões 2009) and such divisive ideology which ignores and explores issues sensitive to people's identities and feelings continues to shape actual science teaching today. Indeed, empirical research shows substantial evidence that STEM students and professionals demonstrate less social and civic values, less social concern, less commitment to understand racial issues, downplay altruism and the civic engagement of individuals for social change than students and professionals from other areas (Garibay 2015). In addition, empirical research has shown that textbooks in recent decades in the USA have rekindled the issue of race in genetics teaching with vigour, raising concerns about the consolidation of distorted understanding of the roots of social inequalities through biology education (Morning 2008). Although only implicitly, some current biology science textbooks and curricula still suggest a correlation between race, gender, behaviour and intelligence which portraits groups of individuals in society as essentially inferior (Donavan 2014, 2015, 2017, 2019). Clearly, those 'essentialists' correlations are suitable to fascist ideologies and have probably been deliberately used to undermine social equality movements (Donavan 2017). In the same vein, research has shown a high percentage of teachers across the world believe Eastern Europeans are genetically superior to other populations (Castéra and Clément 2014). Furthermore, sex education (in the UK this mostly takes place in biology lessons) has encountered a number of obstacles and is generally focused on reproduction, leaving issues of homosexuality not recognised (Reiss 1998). Some studies have shown biology textbooks tend to accommodate binary-gendered political views, associating homosexuality with diseases (Snyder and Broadway 2004), while other studies have concluded that schools are homophobic and heterosexist institutions, thereby creating a hostile and tense environment for teachers and students who do not fall within the binary gender classification (Gunckel 2009). Many schools and families have failed to understand the thinking and feelings of LGBTQ + students and teachers properly, tragically causing many of them to attempt suicide (Smith and Drake 2001). In the light of evidence such as this, Steve Fifield and Will Letts (2014) have rightly questioned whether humanistic movements such as 'science for all' are really for all.

Taken separately, the social roots of misogyny, xenophobia, homophobia and racism cannot be accounted for by fascist ideologies only. But the high degree of concern that the rise of fascism in Europe and in the Americas deserves in education is because the term encapsulates and even advocates all those forms of violence together. Problematically, fascism or fascist-like ideologies are a political power that is built upon a conglomerate of feelings that generate intolerance and exclusion, which have been strategically used by politicians to get elected. It is not only a matter of cultures of structured oppression (Freire 1970) that is passed on from generation to generation and which the colonial-capitalist model takes advantage of Bajaj (2015). It is a matter of how a worldview built on individualism, selfishness and indifference to fellow humans' rights and dignity has been cunningly manipulated to grab power and obliterate progressive and sustainable agendas. Therefore, we are not only interested in understanding and tackling the roots of detrimental thinking and behaviours that can be found in individuals, but also in tackling a political view which can concretely manage a huge amount of government assets to target people and remove from them their right to live a safe, free, fulfilling and flourishing life.

Educators could realise that both democracy and fascist/authoritarian ideologies are built on social and emotional issues, but they are based on fundamentally different policies and views. According to Peter Bazalgette (2017), one of the fundamental elements of a civil society is the development of *empathy* which enables people to engage in deliberative dialogues with others. Richard Sennett (2012) points out the importance of the politics of co-operation and how people need to work together with compassion. He argues, like Bazalgette, that togetherness is essential for a civil society. Drawing on many international studies, Richard Wilkinson and Kate Pickett (2018) have studied inequality and society and have shown how inequality is related to ill-health, stress, anxiety and lack of well-being. They argue that highlighting difference inevitably invites ideas of inferiority, and that inequalities heighten feelings of social anxiety and can lead to a belief in the importance of things over co-operation.

It is noteworthy that democracy recognises all kinds of views, fascist and authoritarian views included. Therefore, we contend that democracy should be continuously developed and strengthened so that, at its heart, it values mutual respect, tolerance and understanding of others in order to further a society that is open and transformative. Nurturing and protecting those values is a way to counter the growth of fascist-related views. As Jesse Bazzul and Sara Tolbert (2019) have put it, "Science education, in its conservative formulations, may simply be a distraction from much more important educational priorities" (p. 304). It seems, as they add, "there is a serious reluctance, as a field, to come to terms with this reality" (p. 306). We argue that not recognising the rise of fascism as a socio-scientific issue which must be openly addressed in classrooms leaves mainstream science education not recognising such a threat to democracy and inclusive societies.

Later in this article, we will show that several scholars from the critical pedagogy field have made substantial contributions to develop a 'pedagogy for democracy' which in many ways counter fascism-related views. We argue that those contributions will gain further currency if they are recognised and understood as a workforce against the longstanding cultural and political forces of fascism. We will also suggest alternative ways to move forward with the aim of tackling fascism.

Why fascism is science education's business

We teach and learn science not only for the sake of scientific knowledge and practice, but also for the sake of building a better world for everyone. Science education needs to create an alternative curriculum that will engage the youth in some sort of ethics and social responsibility activism: a curriculum for "people who will fight for what is right, good and just; people who will work to re-fashion society along more socially-just lines; people who will work vigorously in the best interests of the biosphere" (Hodson 2003, p. 645).

In addition, we should recognise that there is a destructive historical alignment between the work of 'apolitical' scientists and fascist/authoritarian regimes' ideologies. Scientists were persuaded and succumbed to feelings of hatred disseminated by fascist propaganda (Renneberg and Walker 1994). Fascist regimes have threated free academic work and scientists who rejected authoritarianism. Science development during Germany's Nazi regime was severely reduced due to poor administration, reduced funding, hostility towards scientists and an exodus of high-ranking Jews scientists (Deichmann and Muller-Hill 1994).

Similar behaviour is observed in twenty-first-century governments. Trump has denied the scientific community by accusing "climate change scientists of having a political agenda", saying he was unconvinced that humans were responsible for the Earth's rising temperatures (BBC 2018b). And Bolsonaro has shown "strong support for development in the Amazon" which has nearly doubled the rate of deforestation (The Guardian 2019). More recently, *Scientific American* has called Bolsonaro a "Populist President" who has sparked an "Unprecedented Crisis for Brazilian Science" (Tollefson 2019). Bolsonaro has questioned the work of Brazilian scientists, debilitating institutions and cutting research funding (ibid), similar to what happen to scientists in Portugal during the salazarist regime (Galamba 2013). Science is a social, cultural *and political* activity—it is not a value-free, purely rationalistic activity—so that scientists can and will make decisions and build arguments taking into account their political views, worldviews and emotions which may backlash or embrace fascist-like politics such as the examples above.

We are considering here a science education that is also concerned with its technological and social implications. Looking more broadly at STEM education, educators should also be concerned about the threat to democracy caused by the use of technology to undermine democratic structures. For instance, it was widely reported that analytics firm Cambridge Analytica harvested 50 million Facebook profiles and used algorithms to predict and influence how people should vote in the Brexit and the last US presidential election (The Guardian 2018c). Cambridge Analytica favoured populist nationalist candidates, using a "psychographic-profiling method (…) to develop unique voter-targeting models", raising serious concerns about the trustfulness of the democratic rite in countries affected (Persily 2017, p. 66). Here, as in the past, there are STEM-related professionals contributing to a process which appears to be a direct stab at democracy. And yet, countries concerned with international competition have been investing in the teaching of 'hard STEM' subjects in the hope of prospering economically (Mansfield and Reiss 2020). Of course, we agree countries need competent STEM professionals. But if we are to challenge fascism-related views, we must take into consideration the relationship between the development of science, technology and politics, creating a state of mind in students that fosters emotional development such as inclusion, tolerance, collaboration, empathy—aiming for the common good. In order to achieve this and counter authoritarianism and neo-liberalism, science education should include discussions about ideology and subjectivity (Bazzul 2012).

Racism (Morning 2008) and, more broadly, fascism (Jenkins 2006) has been science education's business for at least a century, but educational initiatives to counter fascist ideology have been short-lived. We know that articulating a teaching practice that clearly raises students' awareness of the threats of fascist ideologies is not an easy task. For instance, in the USA during the interwar period, educators sought to combat fascist indoctrination by teaching students to identify traits of fascist propaganda such as name-calling and glittering generalities (Fallace 2017). But feedback from teachers about students' critical thinking did not suggest this was a promising approach. It was recognised that there was a "need for a more comprehensive approach to critical thinking, beyond "a study of 'tricks' of the propagandist" (Fallace 2017, p. 50). In the meantime, in the UK, the motivations to develop political understanding in science education in the 1930s included a broader political agenda of combating the rise of Nazism, Fascism and Bolshevism (Jenkins 2004, 2006). The *Association for Education in Citizenship* argued that biology could be a vehicle to mitigate health and social problems. But its recommendations were rather vague. Members of the Science Masters' Association indicated students should "acquire a sense of fact and a sense of law", whilst "Marxist" educators advocated "relevance to personal and social needs" (Jenkins 2006, p. 200). After WWII, citizenship education within science lost motivation to supporting democracy against authoritarian views. Rather, it sought to making science more relevant to everyday life through programmes such as Science Technology and Society (ibid.). Today, because of fears that political bias would 'indoctrinate' students to think in certain ways and thus threaten freedom of thought, countries like Australia, the Netherlands and the UK have done little to promote political education in schools (Hahn 1999). To circumnavigate criticism, and to bypass its complex political system, political education in the UK takes place in *citizenship education*, a subject commonly taught separately from core subjects such as English, Science and Maths (Perry 2018). The isolation of citizenship education reinforces the idea that subject learning is non-political.

In the light of the above, as we will elaborate in this article, students need to be supported to reflect about those values in social contexts as a way to critically humanise science. Or science could be used again and again as an element of power that leads to bigotry and possibly to human obliteration.

Does mainstream science literacy seek to stand against fascism-related views?

We seek to show that the widely made argument that a scientifically literate person is able to think 'critically' in a democratic society presents limited contribution to political thinking and engagement. It also presents very limited contribution to developing interpersonal skills or raising historical awareness of the relationship between science and authoritarianism, thus not building a critical mind about fascism-related views.

The concept of scientific literacy that we take in our study encompasses knowledge and skills somewhat related to four strands: (a) the understanding and use of scientific facts and concepts in a content-orientated approach; (b) the learning of how to 'do science', i.e. learn about its methods, how to measure, collect and present data, and build evidence-based arguments through a process-approach (Millar and Driver 1987); (c) the learning of the applications of science and its relationship with technology and society through a Science, Technology and Society (STS) approach (Mansour 2009); and (d) the learning of

what science is through a historical-philosophical-sociological (HPS) approach (Matthews 1994).

At least since the 1920s, depending on the political climate of the time, curricula across the world have sought to emulate key features of the humanities by introducing strands c and d of science literacy with a view to make it more meaningful to students' everyday life, giving proper attention to human purposes and values, setting a 'noble' end for science education, and seeking to extend and enrich its purposes and objectives (Donnelly 2002, 2004). Thus, a humanised, useful and accessible science education would contribute to democracy, enabling *all* students and citizens to use scientific knowledge in their everyday affairs. After WWI and WWII educators, politicians and other stakeholders were shaken by the destructive power of military high-technology—developed and backed by prominent scientists across the world—and reassessed the general aims of education, in particular of science education. They concluded that science education should not only focus on the education of good professionals, but on the education of citizens who value democracy and peace (Jenkins 2006). However, despite attempts to humanise science, particularly through curricula that valued STS approaches, science education has aimed almost exclusively at enculturating youngsters in the forms of understanding and practices (strands a and b) valued and accepted by the scientific community (Jenkins 2004). The teaching of science for the sake only of scientific knowledge simply ignores social-political aspects of science (Hodson 1998, 2003).

Emblematic of the narrow contribution of scientific literacy to a tolerant and inclusive society, science education typically has clear neoliberal possessive individualistic aims that suit the economically privileged class, as deftly explained elsewhere (Bencze and Carter 2011; Bencze and Alsop 2009). In a nutshell, the focus on the teaching of the products of science (e.g. abstract laws and theories) serves the aims of 'knowledge economies', which, instead of valuing the production of physical things or attitudes and skills that benefit communities, value symbolic analytic services (jobs that require abstract thinking, manipulation of symbols, graphs, models, designing, creativity etc., with a view to serve the market and thus be employable). In this context of learning the abstract, science teaching is a "selection camp" of those who can do abstractions: "Relatively few students, mostly those from advantaged homes, seem able to more easily discover particular, pre-specified, abstractions from inquiries" (Bencze and Carter 2011, p. 652). The science curriculum, therefore, is suitable to the interests of the economic elite which seeks to keep its privileges of accessing the knowledge that will lead to the kinds of jobs that are of interest to them. Students are extrinsically motivated to learn science because they will *possess* the kind of *knowledge* that benefits the *individual* (themselves) professionally/economically, not the common good. This model does not question the established structures of power, marginalisation and oppression. It perpetuates them and requires an inspection of neo-liberalism and subjectivity to make visible alternatives (Bazzul 2012).

There are several examples in the literature and in government documents that fulfil the neoliberal possessive individualistic aims. For instance, it has been argued that students must be *scientifically literate* in order to gain a sense of empowerment, social agency and agency in the material world (Anderson 2007). By agency in the material world is meant someone who is able to use scientific knowledge and skills to understand, explain and predict phenomena in the surrounding world. Social agency refers to the *marketisation* of one's knowledge and skills, on how useful science knowledge can help one to be absorbed by the job market and to progress professionally. In Anderson's (2007) words, "Successful learners of science can gain respect for their knowledge, skills that enable

them to do useful work, and access to jobs and to communities that would otherwise be closed to them" (p. 5).

In views such as those advocated by Anderson (2007), youngsters are taught to look for opportunities that build their educational portfolio that will place them in privileged social positions. Arguably, the selection camp model for science education is exclusive. It will implicitly force students from low socio-economic backgrounds to accept being educationally 'defeated' and placed in an unprivileged position in society (Freire 1970).

There is the argument that mainstream science literacy also promotes 'critical thinking' in everyday contexts—i.e. it looks for teaching strategies that encourage students to think for themselves, independently, based on evidence and logical reasoning, who would not be easily manipulated by charlatans and deceived by pseudo-sciences (AAAS 1993). Critical thinking has often been described as a form of rational, impartial, nonarbitrary thinking, based on evidence and on solid principles (Siegel 1980). And a scientifically literate person has been described as one who thinks critically when accessing scientific material in the media, such as newspaper and magazines, and can read graphs, tables and the like to make critical judgements and take informed decisions in everyday life (Hodson 2009). Critical thinking is believed to be essential to deal with problems students would encounter in their lives (Aikenhead 2006).

But, as pointed out by Margaret Mcnay (2000), this idealisation of scientific literacy will not question citizen's views of what a fairer society looks like. This is because decision-making in everyday life is not a purely rational act, which implies that one equipped with scientific knowledge will not necessarily think politically towards a fairer society (Burbules and Berk 1999). Decisions about science often involve social and emotional aspects. The science literacy movement tends to downplay the politicisation of science and largely hides the fact that decisions about science are often made largely on social and emotional factors.

In fact, in the last century, science teaching that is circumscribed by the products and processes of science has not challenged fascist ideologies—partly because science has been seen as an objective rational enterprise devoid of a social and emotional context. During the salazarist regime in Portugal (1934–1974) scientific pedagogies that promoted questioning, inquiring, and wondering about the natural world (but excluding the socio-political world) were *not* seen as a political threat by the regime (Galamba 2013). Conversely, educators who worked for the emancipation of the poor by helping them to question the social structures of fascism, were targeted by the salazarist regime (Galamba 2013). As Carlos Tabernero, Jimenez-Lucena, and Molero-Mesa (2012) suggest, what matters for fascist regimes is the way that knowledge is 'managed' and disseminated. They have shown how overtly different science knowledge was circulated when conducted by libertarian movements in Spain (e.g. anarchist trade unions) and by the Spanish fascist government, and how this affected the "inclusion–exclusion dynamic"—the previously used "strategy of questioning the social, political and cultural establishment" (p. 70).

Turning now to STS (strand c), the American *National Science Teacher Association* (NSTA) refers to informed citizenship and critical decisions that should be addressed in school science in the following way:

Basic to STS efforts is the production of an *informed citizenry* capable of making *crucial decisions* about current problems and taking personal actions as a result of these decisions. STS means focusing upon current issues and attempts at their resolution as the best way of preparing people for current and future citizenship roles. This means identifying local, regional, national and international problems with students; planning for individual and group activities which address them; and mov-

ing to actions designed to resolve the issues investigated. Students are involved in the total process; they are not recipients of whatever a pre-determined curriculum or the teacher dictates. There are no concepts and/or processes unique to STS (cited by David Ost and Robert Yager. 1993, p. 282, our emphasis)

The description above supports the view that students should be active learners who think about problems that affect their local and global communities. Juan Garibay (2015) has shown how directions from NSTA and other guidelines do include a certain "understanding of society" but explains "there is no explicit mention of developing students' understanding of inequalities or interest in rectifying structural inequities" (p. 4). This stance does not envisage, or does not make explicit, power-relations and structural forms of oppressions—NSTA seem concerned with the betterment of general wellbeing and the adverse impact of technology in a sustainable planet, but do not envisage the inclusion of traditionally excluded people from power and decision making (Calabrese Barton, Ermer, Burkett, and Osborne 2003). Moreover, in STS an uncomfortable absence of addressing emotions that lead to bigotry, intolerance and hatred—that we relate to fascism—remains.

Much of the response to combat the rise of fascism can be found in the history and philosophy of science literature and in a range of constructs made within the critical pedagogy field. The next sections will turn to them.

Contributions from history, philosophy and sociology of science

Studies on the nature of science (NOS) or, more broadly speaking, on history, philosophy and sociology of science (HPS) in science education have also ignored the historical relationship between scientists and fascist regimes. By asking the question "Does science education need the history of science?", Graeme Gooday, Lynch, Wilson, and Barsky (2008) make an eloquent case for why the history of science should be taught in schools. They argue that the greatest benefits for students to study HPS are to gain skills such as the ability to "read and interpret primary sources", "develop confidence in critical thinking", "learn to formulate, marshal, and defend a cogent argument" (p. 325). These skills are advocated in the context of learning about the human struggle to develop scientific knowledge. To be more specific, students can learn about the life and work of people like Faraday, Darwin and Marie Curie, i.e. "about the life and work that led to the creation of the canon", "they can learn about the provenance of standard techniques by way of historical study of their origins, the vivid familiarity thereby attained thus at the very least making it easier to remember what might otherwise be dull facts" and "can become acquainted with the key institutions, formative episodes, and accomplishments of their fields" (p. 326).

We do not deny the importance of learning the history of science in the terms put by Gooday and colleagues, which in fact is widely echoed by other science educations in the field of HPS (Erduran 2012). Nevertheless, the history of science will be incomplete if teachers and students ignore sociological and epistemological aspects of science such as the ideologically-driven agendas undermining of the work of some scientists, the power relations that authoritarian regimes have nurtured with science in the past, and the division of scientists who either supported or resisted fascism.

We should not ignore the reality that during the Nazi regime many scientists in Germany "fit[ted] unconditionally and smoothly into the Third Reich" and thereafter sought to develop an 'Aryan' science (Renneberg and Walker 1994, p. 16). Because of its allegedly political neutrality, scientists have been used as the instrument of fascist political systems

(Siegmund-Shultze 1994). This has long been recognised: in August 1943, four years after the breakout of the Second World War, a number of scientists from different countries met in Birmingham to discuss how scientific work was treated under fascist and democratic regimes. In an article in *Nature* (Cliff 1943), they claimed hatred of mankind was a basic feature of fascism and that science can only flourish in a free society. G. Fournier, a French scientist present in the meeting, made a note that is particularly prescient in today's rise of fascism:

> Too many men of science had said: 'I'm not interested in politics'. (…) It is his [sic] duty to see that they are used for the *betterment of mankind and not for its destruction*. In future he must continuously alert to ensure that fascism does not reappear under some other name elsewhere in the world. (Cliff 1943, p. 307, our italics)

There are claims that Hitler's vision of the ideological role of war machine technology was taken up by groups of scientists and engineers who fought against the downfall of the Third Reich with intense activity in the strengthening of Nazi's armament power (Albrecht 1994). Whilst some mathematicians sought to develop an 'Aryan Mathematics', others campaigned against and withdrew from German organisations led by the Nazi (Mehrtens 1994). These are only a few examples that belong to the fascinating, and yet dreadful and concerning, history of science and fascism, that has been intriguingly unappreciated and discouraged (Renneberg and Walker 1994). A fully-fledged HPS will not do without proper appreciation of the socio-political implications in the work of scientists in our recent history.

Clearly, being a good scientist is not necessarily conducive to being a good fellow citizen. This is because scientific universal principles and values such as those of freedom, truth and impartiality are not directly transferable to the social and interpersonal domains (Siegmund-Shultze 1994). Other historical accounts have shown how scientists have overlooked the social implications of their work and may have served, perhaps willingly, as vessels to fulfil the aims of destructive fascist regimes (Renneberg and Walker 1994). The apolitical aspect of the scientific enterprise is hazardous to democracies and plural societies which are based on mutual respect and for this reason it is urgent that science education should develop a socio-political agenda that undermines oppression of minorities and other fascism-related actions (Santos 2009). Authoritarian and fascist ideologies make use of dehumanised science, but they also dehumanise people.

The literature offers significant material to approach a history of science from a social-historical perspective with critical evaluation of the relationship between science and authoritarian regimes. This important part of history should not be ignored if we are to protect democracy from the modern emergence of fascism.

Contributions from critical pedagogy

More than educating the individual to be critical consumers, critical pedagogy seeks to build a "much more politicised and issues-based science education" (Hodson 1998, p. 2). The literature in this field questions social and moral matters that have been developed in the literature under the overarching social-political action umbrella (Roth and Desautels 2002), which calls for a more democratic participation of the population on public affairs and therefore on the directions that science entrepreneurships can take (Roth and Lee 2002). This umbrella shifts the meaning of critical thinking towards social responsibility

and accommodates views ranging from scientific colonisation (Aikenhead and Elliott 2010) and Freirean perspectives on science education to transforming the lives that youngsters lead to a culture of criticality and transformative agency (Santos 2009).

The roots of contemporary works in critical pedagogy can be traced back to the very influential works of Paulo Freire. Under the premise that education is always political, and is used to normalise and perpetuate structures of power, he developed a pedagogy to empower students to question and tackle social injustices through 'dialectics' and 'praxis'. Those social injustices are related to class, ethnicity (Freire 1970), gender and race (Freire 1994). Since Freire's Marxist pedagogy, there has been extensive development in the critical pedagogy literature that calls for democratic teaching, with a focus on social practice, that empowers and liberates students (Shor 1979) and to create 'resistance' (Jaramillo and Carreon 2014) against capitalist, white supremacist, sexist (McLaren 2010) and other forms of dominant and oppressive worldviews and social structures.

To give only a few examples in science education, Santos (2009), whilst criticising the STS approach which "corroborates an ideological model for the maintenance of the status quo", has pledged "a political agenda to science education that would include issues such as unequal access to technology around the world, the domination power of technology, and the oppressive context of scientific and modern technological society" (p. 362). Angela Calabrese Barton and colleagues' work has challenged the egalitarian aims of the 'science for all' movement (Calabrese Barton 1998) and advanced teaching approaches that aim at social action for poor/marginalised children (Calabrese Barton and Osborne 2002). She has also given new perspectives on the education of 'urban children' who live in a cross-cultural, multi-racial, high crime, polluted and socially discriminatory environment (Calabrese Barton and Tobin 2001). Calabrese Barton has developed approaches to address social justice in the classroom (Calabrese Barton, Ermer, Burkett, and Osborne 2003) that include connecting with the community and its views, finding out how pupils respond and feel about these interactions, and how to solve the problem. Part of Calabrese Barton and Edna Tan's work is to give agency to pupils and to raise awareness of how certain groups of people can be ignored in political debates, and so to give them an awareness of the need for a 'rightful presence' in policymaking (Calabrese Barton and Tan 2020). Storage and colleagues have shown how the classroom discourse conveys to students that science is for men (Storage, Horne, Cimpian, and Leslie 2016) which puts women, in particular black women, off science. Rodrigues and Morrison (2019) argue for a socio-transformative approach to education that focuses on marginalised youth and builds on the foundations of diversity, equity and social justice in order to form transformative actions. Several others have scrutinised the economic-centred purpose of science education, as revealed in official documents and curricula (Garibay 2015), and proposed curricula that call for social responsibility by meeting the basic needs of the poor, the oppressed and marginalised. Marxist-humanist Paul McLaren has deftly criticised the relationship between science, education and the dominant interests through private investments (Calabrese Barton 2001). He has argued that science education emphasises profitability whilst overlooking that "The wealth of our nation should be measured by the elimination of class exploitation, racism, sexism, homophobia, and other forms of oppression" (p. 853). To counter the 'death-dealing capitalism', Bazzul and Tolbert (2019) have claimed we must "learn to extend our love beyond love of self or extensions of self" (p. 307). And studies in critical peace education (Bajaj 2015) pledge for the end of all forms of violence (physical, structural, and cultural) that may be brought about structurally or not, organised or not, particularly in conflict and post-conflict situations.

Mainstream science education will do very little to tackle fascist-related views if it ignores developments in critical pedagogy such as those above and continues to teach science for the sake of scientific knowledge only, detached from its sociohistorical connections to social injustices. This said, current developments on social justice focus mainly on the sociological level of transformation but curricula and teaching practice in Western societies still disconnect learners from love (Bazzul and Tolbert 2019), compassion, empathy, and other bonding feelings (Magee and Pherali 2019). The emotional and psychological level also needs to be brought into focus for a deeper change to occur, and in order to do this we now turn to look at Othering and social justice in order to show why the emotional level is so important.

Considerations about othering and social justice

Iris Young, in her seminal book *Social Justice and the Politics of Difference* (1990), argues that oppression and domination are two pillars of injustices. She argues that *difference* is key and must be recognised, not hidden. Differences are to be celebrated and are key to identity so have to be acknowledged. So, for example, a trans person wants people to accept and understand their differences so they can be taken into account (Tim Adams 2016).

For the voices of any oppressed group to be taken into account their voices must be both heard and understood. Anna Yeatman (1994) argues for a politics of representation so people can be heard in freedom. People's voices of representation can be made, for example, through a politics of presence (Phillips 1993, 1995, 1999). In other words, to move towards social justice people have to be meeting with each other in a form of deliberative or participative democracy so they can discuss and jointly forge understandings and solutions. However, there is a further problem as Charles Taylor (1994) points out, that people can find it difficult to understand and accept people at a psychological level. People's differences can be Othered (Rohleder 2014). Otherling is a dynamic process that often includes expression of prejudice towards groups and creates an attitude of mind that propagates inequalities and marginality. Othering occurs all the time and can lead in the extreme to violence, for example the murder of Jews in the Holocaust (Powell and Menendian 2016). In general, though, the psychological processes that include Othering go on all time, such as through men and women trying to understand each other (Paechter 1998). Similarly, in recent US elections Trump provoked anxiety and fear of the Other with his attacks on Muslims, women from certain ethnic groups, and portrayed people of colour as posing a threat to the country (Prose 2020).

Hence, it is important to have a *politics of recognition* where people empathise and recognise how others are feeling, and come to understand them. To work towards social justice it is helpful to work at a sociological, a psychological and emotional level. For example, people can work at a political level to counter racism, and this can be quite comfortable because they do not have to confront their own personal prejudices, which can be very emotionally challenging. We will elaborate this below.

Attitudes, politics and state of mind that values and protects democracy

We want to propose some initial thoughts on the connections between how science in schools conveys the nature of science, the form of society people want to build, and the role of the social and emotional development of pupils.

Using science in a dehumanised way is supported by having a view of science that is dehumanised. This is the rational model of science, where people are likely to accept science as a non-emotional activity. In this model, it seems probable that one would be less likely to question the directions taken by research as though it was insulated from politics and worldviews. Such a model of science is also more likely, stereotypically, to appeal to men because of the lack of emotional and social content (Wyer, Barbercheck, Cookmeyer, Ozturk, and Wayne 2008). On the other hand, if one accepts the socio-cultural model then science should be seen within its cultural context with all its political overtones (Parsons and Carlone 2013). The incorporation of logic, social and emotional aspects makes it more probable that it will appeal to all genders. This is a humanised view of science. Hence, it is important that pupils understand these skills within the social context of science, and that the curriculum should change to allow this, as for example in Canada (Bencze 2017), Europe (Levinson 2018) and England (SATIS 1988, 1990).

Further, therefore, students should learn to act in social situations, form networks with many people, including those who agree and those who do not. Increasingly, scientists need to work with people across diversity—gender, sexuality, ethnic backgrounds, religion and varying abilities (Cooke and Hilton 2015). In particular, they need to be able to understand, both intellectually and emotionally, those who work in the community. Both in science and in a society we are interdependent and need to develop a network of social relationships. The key is to enable students to understand this and see the interconnections between the two; in other words, develop a personal response to science (Head 1985): a scientific state of mind/identity that involves social and emotional reactions. Crucially, the state of mind—how one perceives knowledge, whether it is to be accepted or if its values are to be critically looked at in collaboration with diverse others—marks the contrast between authoritarian/fascist minds and those of a democratic citizen (Fallace 2017).

Fascism has a set of attitudes that dehumanise people through Othering and are therefore quite different to those required by democracies. There have been studies about attitudes and politics by Theodor Adorno, Frenkel-Brunswik, Levinson, and Sandford (1982) and William Kreml (1977) that have shown that worldviews that are suitable to fascism-like governments would be unlikely to support the kind of science education depicted above—one that develops students' emotional skills (Humphrey, Kalambouka, Wigelsworth, Lendrum, Deighton, and Wolper 2011). As Adorno and Kreml have reported, in general, authoritarian people are often concerned with situating people into two groups, one weak and the other strong. Othering is one of the psychological bases that is involved in the labelling of groups in order to justify dominance. Authoritarians also tended to believe in 'natural' dominances of the "strong over the weak, smart over the dull, and the able over the incapable" (Kreml 1977, p. 52). Contact with those perceived as powerless can lead authoritarians to wish to dominate or humiliate them. When combined with a generalised hostility towards people who are different, it is easy to see that racism and sexism (and other -isms) are likely to be common outcomes. Similarly, women are often seen as either 'good' or 'bad' (Theodor Adorno, Frenkel-Brunswik, Levinson, and Sandford 1982). There can be

an anxiety over sex, which can make relationships with the other sex pervaded with rigidity. In terms of broader relationships, Theodor Adorno, Frenkel-Brunswik, Levinson, and Sandford (1982) found that those people with authoritarian attitudes could form friendships based on what they could get from people, rather than on making relationships based on mutuality.

Later studies have also considered 'Social Dominance Orientation' (SDO) theory (Duckitt and Sibley 2009) in addition to 'Right-Wing Authoritarianism' (RWA) (Pratto, Sidanius, Stallworth, and Malley 1994). Those with high SDO believe that there should be strong hierarchies, often in terms of factors such as gender and 'race'. There are robust overlaps between RWA and SDO but with differences in social attitudes (Durieza and Van Hielb 2002). It has been found that those with a high SDO score negatively correlate with empathy, tolerance, communality, and altruism (Pratto, Sidanius, Stallworth, and Malley 1994). As a result, authoritarian people can believe in power-based inequality including homophobia, misogyny and racism, which is dehumanising people by Othering them and not recognising their humanity. Othering is a significant part of prejudice and group-based inequalities.

A central point here is that there are many people who are not at the extremes discussed above who can still have a fear and anxiety over difference, which is why people who are sexist are often also racist and homophobic. Even people who recognise the importance of equity can argue for it at a political level and feel secure as it is emotionally distant, but the emotional level can evoke anxieties, which is why tackling the emotional level as well as the sociological is so essential. If people can come to terms with their anxieties and fears over difference, then difference can be seen as a resource and a source of joy. Tackling Othering is less about reducing difference than to generate understanding, to accept it and enjoy it with companionship, humour and creativity.

From these arguments about dominance, relationships and anti-diversity, we would contend that in order to counter authoritarianism/fascism requires it to be tackled at a social and emotional level which, with our aim to educate pupils, requires a change in classroom practice. Hence it becomes clear that if science education is to contribute to countering fascism and promote democracy, teachers should:

1. Ensure students understand that science is a social and emotional, as well as logical, activity;
2. Support students to empathise, and develop a respect and even value of each other across diversity; and.
3. Engage with each other socially and emotionally to gain understanding and acceptance of each other.

In light of the above we contend that science could be taught to make explicit the social context of its development. If it is not made explicit there is a danger that the view of science that it is only rational will be reinforced, which will not support open discussion with the students about such dangers to free and inclusive societies.

From this evidence science education has a responsibility to make explicit the links between science and politics and to humanise science as an activity, and recognise people in all their diversity.

Embedding the emotional, the social and the political in science education

While the science literacy movement has opened up the territory and produced some important approaches, we argue that it will benefit from encompassing the social, emotional and political undercurrents that both affect the development and use of science, which in an interwoven way, changes society. A programme to help safeguard an open-minded and tolerant democracy through science education is still waiting to be developed. Here, we offer an example of scientific pedagogy that could contribute to this aim. The science classroom would benefit from (1) having a model for students to humanise science and see it as a social activity, and (2) integrating this with students' social and emotional development through combining social responsiveness with science education.

Science as a social activity

If science is seen as objective activity it can be dehumanised as it can be claimed that its discoveries are independent of people (scientists) and so politically neutral. It is known that the processes of science do not follow the 'objective' rationalist research of planning, method, data collection and conclusion, all without emotion. Rather, it is a complex set of procedures that include discussions (Mulkay 1979), networks and play (Ziman 1984), and where the social networks are more important than the 'scientific method'. Figure 1 summarises some of the social and emotional factors involved.

In Fig. 1, the top right ellipse, indicates the complexity of who has power, and what gets funded gets done, and how those in power will be influenced by their values. This can also lead to contradictions where scientists may be working for someone whose values they do not agree with. The rest of the figure, except for the square at the bottom right hand corner, indicates that the development of science is complex, overlapping, could come in
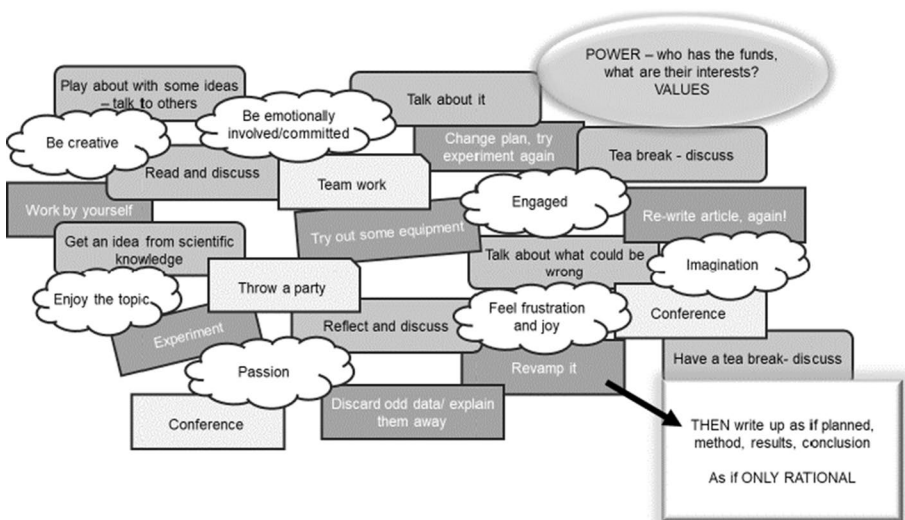

Fig. 1 How do people 'do' science? From Matthews (2015, p. 196)

any order, and involves social and emotional processes as well as logical ones. The bottom square indicates that this complex process is distilled down as if it were rational, which is essential in making the research understandable, but also hides the multifaceted development. As Bazzul (2017) points out, focussing on the minutiae of the 'scientific method' de-politicises it and so makes challenge to authoritarianism less likely.

However, in general the 'scientific method' is described as if it were linear, from planning, experiments and data collection to analysis and then conclusion. This can reinforce in pupils minds that science is objective and remote as it is not seen as a fluid and social process. To show this Fig. 1 above can be extended to make an indicative overlay of the changeable aspects of the logical development of ideas; see Fig. 2 where the social and emotional are integrated with the logical development in an irregular way.

This indicates that, for example, playing and doing an experiment may come before planning, and planning can occur many times, as may doing experiments. Data collection can occur at any time, with analysis occurring at many points. These changes can be because of social interactions and discussions which give rise to new ideas.

The social and emotional aspects of science, therefore, can be enhanced if people can understand that scientific research involves social interactions, emotional development and logic—and hence may appeal more to both boys and girls. Students could develop skills such as collaborative learning, listening, critical thinking, and accepting diversity in thinking and in people. Increasingly in the global world scientists will inevitably work and network with people of many ethnic backgrounds and sexualities (Taylor 1994), so it is ideal if people can accept difference psychologically and socially and so recognise and empathise with them (Young 1990, 1996).

The development of logical ideas can be very varied, but, and this is important for scientific development, gets written up in the accepted form of the 'scientific method' to make it easy to understand the research. Communicating science research in this way is essential; however, this hides the complexity of what actually went on and hides that science comprises social, emotional and logical aspects.
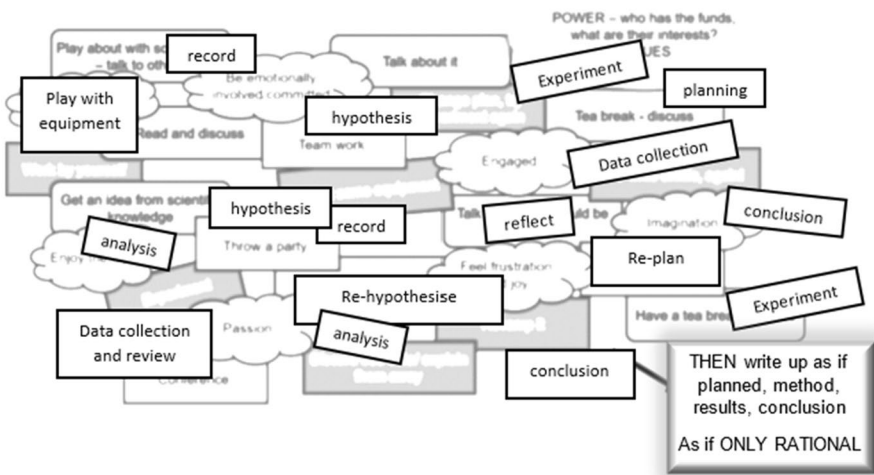
How do people 'do' science?

Fig. 2 The complexity of logic and the 'scientific method'

A crucial aspect of the development of science is that it is set within a range of values, depending upon who funds the research, and what it is selected to cover. The latter is about power, and the political power of governments and big business. If science is dehumanised and seen as neutral it is easy for an authoritarian state to fund scientific research with particular biases—for example, surveillance to control the population—and it be accepted that that was just what was discovered. In principle—though this is still rarely done—the values in any scientific research should be made explicit (Committee on Science Engineering and Public Policy 2009, pp. 96–97).

In order to be able to contribute to democracy students need to understand the complexity and the social processes of science—that is understand Fig. 1 and the importance of studying who is funding research and think about why they are making that choice rather than other options.

Combining social responsiveness with science education

We have discussed the many problems with science education and in principle how it allows a fascist/authoritarian regime to co-opt science in its controlling of people. The main point is that it is essential for a curriculum overhaul to take place to change from the current focus on learning scientific knowledge only, to one focused on learning skills within a historical (Gandolfi 2018) or social and political context (Bencze 2017) or with an emphasis on investigative science (Harrison, Howard and Matthews 2016; SAILS 2016) or a combination of all three (Levinson 2018). However, those curricula that focus on the learning of science, even with social factors, still do not acknowledge the centrality of emotional development. There are a range of courses for helping students' social and emotional development (CASEL 2003, 2016), but these are usually separated from subject learning. The courses are commonly focused on interpersonal skills, such as 'anger management'. In these lessons, commonly done in subjects such as Personal, Health, Social and Economic (PHSE) Education as a separate course, all the students address the same topic at the same time. This has benefits, but the problem is that the topic to be covered may be far away from where the pupil is socially. So, for example, a pupil may not be able to control their anger as they have not developed the stage of recognising their own feelings, and so are unaware of their internal tensions. Hence, when pupils address the same emotional topics at the same time, they are not, for example, tackling anger when angry and raising a discussion with the pupil about what was happening to them to help them recognise their internal feelings that would tell them they are getting angry. Nor do such interventions usually take place in subject lessons, let alone in science.

However, the importance of group work for learning and social interactions is recognised, and Alexis Patterson (2019) draws attention to how equity and the quality of group talk can be combined. She studies the key features of student voice, visibility and student authority and the teacher who has the power to address inequality in the group work through supporting students when inequalities occur. Similarly, Brian Fortney and Erin Atwood (2019) considered equity as a dynamic interaction between students and teachers.

Brian Matthews' (2004, 2006) work takes a different approach to social and emotional development, with a focus on gender, and is set in science lessons. While this was a small scale piece of work it is significant as it illustrates principles and strategies useful for developing a *pedagogy for democracy*. He devised a set of strategies so that pupils were

empowered to raise, discuss and address inequalities over time, as the true educator cannot shape pupils, but allow pupils to become themselves (Horton and Freire 1990). This work was based on the thesis that one cannot give power, it can only be worked through and taken. A teacher can tell a pupil that they are being, say, homophobic to another pupil, and explain why, but that will not make the pupil unprejudiced. For this to happen there has to be a change at the psychological level through a range of factors including the development of empathy and understanding, combined with gays being empowered to raise inequalities and have them discussed. The principle is that students learn cognitively while also using a strategy that makes explicit their social interaction and feelings to each other, in order to make obvious inequalities in both their social and emotional interactions, and contributions to learning. Once these are explicit it is possible for pupils to confront them. In general, the teacher's role is to keep an eye on the interactions and not to intervene unless they see no progress over time.

In brief, the students work together on a task, such as a practical, worksheet or reading task, initially with a pupil-observer, and then without one. The groups have four students and are as gender and ethnically mixed as possible. There are sheets they have to fill in with a series of questions focussing on what the teachers thinks is useful at that point. In essence the students:

1. Write down what they think went on the group.
2. Discuss how they feel about it.
3. Compare this with how others felt and see how they differ (an essential part for developing empathy and understanding across difference).
4. Discuss with each other their findings, feelings and the amount of subject learning they developed. (Matthews 2006, p. 96)

These procedures have within them the elements required for the furtherance of science education and democracy. The students learn about each other across diversity and learn to get on and help each other—both scientifically and emotionally, see Matthews (2006) where full details are given. The students are also able to develop different aspects of themselves as they feel they can; as one student put it 'You learn not to throw a wobbly'. Other quotes from the students' feedback sheets, where they write down what they thought went on in the group work and what they felt about it, show how students are beginning to empathise and understand each other: 'You just stop to think and you do understand what the others are saying, so you feel that in whatever you think that it helps you think about how you feel about girls', '[The sort of group work] we did makes me realise that working with the group is fun. It makes science more interesting because everyone helps each other'; 'They [boys] aren't the same and have different opinions, you learn about boys' (Matthews 2005, 2011; Matthews and Snowden 2007). These quotes indicate the beginning of understanding each other across gender which involves inclusion and a possibly making unconscious bias visible, part of the solutions to the problems of Othering (Powell and Menendian 2016).

The process involves collaborative group work, rather than just working in a group, because of the nature of the tasks and the structure for the reflection. Hence, the pupils are in a situation where they can develop the skills required for a simple form of deliberative democracy (Young 1996). The discussions also include an expression of how pupils have felt about each other, and how they thought others felt about them, and so involves voices of representation (Gewirtz 2006) across gender and ethnicity. Hence, interactions

and feelings are made explicit and pupils need to understand how these link to democracy. Such comparisons are also necessary for empathy to develop. Developing empathy is a vital component of developing a just and democratic society and reduces Othering (Bazalgette 2017), which in turn helps to develop a co-operative society (Sennett 2012). The more the psychological and sociological levels go together the more likely change is. Further, as Patterson (2019) points out, the pupils are engaged in a transformative social process that involves praxis. A small indication of this comes from research by Liz Morrison and Brian Matthews (2006) that followed up three years later the pupils who participated in the research described above, which focused on gender. Here are three quotes from the teachers who were interviewed:

> Certainly, from what I've seen pastorally, they emotionally support each other. When someone's having a bad day, others rally round, they are extremely caring, very concerned about the wellbeing even of people they don't normally go to or get on with. When one of the boys is upset a lot of the boys are concerned not just the girls so it crosses gender. It's also the same with showing emotions to each other and getting support from each other. (p. 14)

> They tended to try to sort out their own problems, or they would come to me and discuss it as a group with me, and then because they had this open communication and because they were used to talking to each other we could sort things out much more quickly.. .. It stopped those shouting matches that you get where they are both trying to drown each other out with their point of view because they had learnt the skill to actually listen and then get their point of view across. (p. 14)

> It got to that situation where obviously, they had friends, their special friends, but as a group we could just talk openly about things because of doing all the group work and the questionnaires helped to really focus in on what they were doing and feeling. That gave them confidence within that group of knowing that nobody was going to be laughing at them or putting them down as is usually the case. They were very confident as a group. (p. 15)

There are indications here that the pupils are becoming agents of curiosity in the quest for understanding (Freire 1994).

There are many factors at work in determining a person's outlook and psychological profile; here, one aspect has been discussed. While education is important it can have little effect when compared with the influence of parents, economic system and media, but that is not to say that schools can have no effect; they may even have a significant effect, if students are empowered and enabled to think for themselves and develop an emotional maturity (Matthews 2006). In this way we can help enable all students to live a flourishing life and develop a sense of wellbeing.

Additionally, we have argued that science education should combine social awareness and emotional development with science as a human enterprise and believe that this is a necessary, but not sufficient, aspect for change. Hence, we require a classroom that enables students to:

- learn science.
- do so, at times, in an explicit social, cultural and political context (SATIS, 1990, 1988).
- learn in diverse groups as far as is possible.
- engage with their emotions and reflect on how these affect others.
- empathise across diversity.

- develop tolerance.
- Engage with their social and emotional learning situation that also enables them to feel, experience, discuss and reflect on how they and others in the group felt in order to open up feelings and recognise each other across gender, sexuality and other diversities.

Educating with the above principle will help humanise science, if Figs. 1 and 2, or similar, are used.

Since there is a combination of cognitive and emotional learning the students can develop habits of mind (Costa and Kallick 2008) where they learn to speak to feelings and procedures along with learning. Hence, science can be seen as a social activity, where people of diversity (Matthews and Sweeney 1997) help each other learn (Matthews and Asaria 2013). This can be made explicit so students understand how networks can be built up, learning be mutually dependent and that arguments and criticism are part of moving forward.

A key aspect for students is that the processes that they are going through in the group work and social and emotional development is directly linked to science as a social activity, as illustrated in Fig. 3. The students should understand that they are, in their groups and especially if they do investigation-based enquiries, replicating to a degree what it is that scientist do; one reflects the other. This will help humanise science.

The more the features described above, of science and interactions, are made explicit the more democracy will be promoted because students will be exploring and imbibing habits that will further those elements that run counter to fascism.

In this section we have focussed on the psychological to the exclusion of the sociological level that is also essential as shown, for example by Calabrese Barton and Tan (2020). The contribution of critical theory in democracy is key, and should be
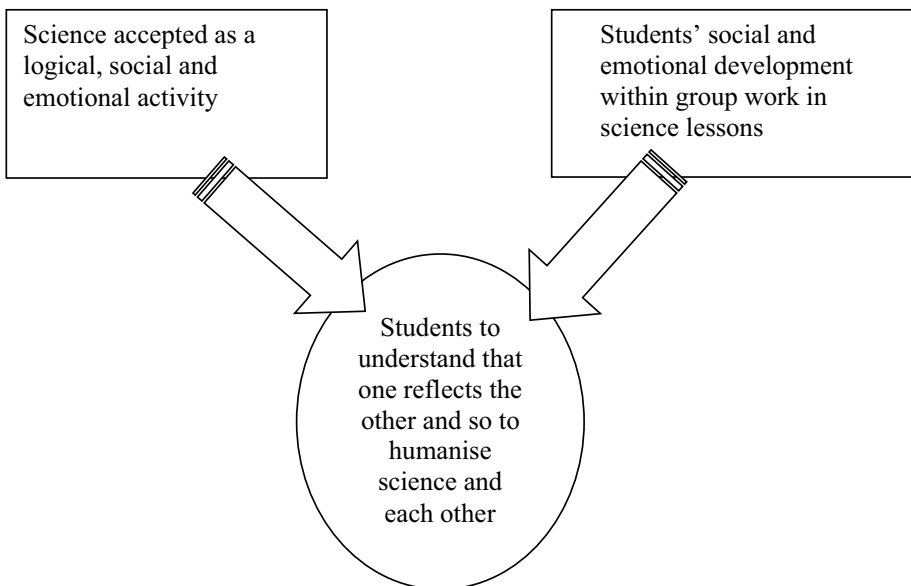
Fig. 3 Linking science and emotional development

integrated so all levels work together to engender a compassionate democratic attitude for everyone.

However, a key element of democracy is that people can choose the direction of society in conjunction with others. We can see from the phrases used, such as *pedagogy of the oppressed* and *social action for the poor* and *disadvantage*, that the focus, correctly in our view, is on those who are most oppressed. However, what can be lost here is that changes to equity and social justice are in everyone's interest. So, for example, sexual equality will benefit women more than men, but men gain as well. Tackling the unequal distribution of wealth, and social class divisions, will benefit the poor much more than the rich. However, in terms of health and well-being, as Richardson and Picket (2018) have shown, more economic equality benefits everyone, although to differing degrees. The injustices are so great that this point can be overlooked. Also, different cultures can have different emphases with regard to democracy (Bunyamin 2019). How in the education system such complexities can be tackled we do not know, but they need to be made explicit in order to put them on the agenda for change.

Conclusions

We have argued that mainstream science education can, and should, be changed so that it will contribute to the formation of democracies and against authoritarian and fascist policies. We believe that part of the answer to these problems lies in moving beyond 'science for all', STS and HPS to critically understand how culture and power influence what creating an inclusive science community might mean, and to change the aims of education (Mansfield and Reiss 2020). If the 'democratic argument' of science education is developed under the neoliberal agenda that values consumerism and individual privileges whilst overlooking empathy, humanism and the common good (Bencze and Carter 2011), it will continue to be unproblematic to intolerant, racist and homophobic views. The neoliberal possessive individualistic principle benefits those who gain the scientific knowledge, but overlooks interpersonal relationships and the importance of valuing and respecting other individuals, which are core values of democracies (Matthews 2007).

Our argument covers an overview of authoritarianism and fascism, and the social power structures through which rulers seek to impose and control others. A key element of authoritarianism is to make discrimination on the grounds of difference appear 'normal' and unquestioned, so that hierarchies become implicitly accepted. In fascist regimes both people and science are dehumanised. To counter these beliefs critical pedagogy could be brought into mainstream education while embedding emotional and social growth. Young people will be helped if they learn to listen and interact with empathy and understanding to better communicate and forge community across diversity, and to recognise the parallels with how scientists work. Science education can contribute to these processes, and in the process be able to develop a scientific community based on sharing and so, hopefully, have a set of values where scientists are committed to research to empower people, so strengthening mutual respect and the pursuit of the common good.

A *pedagogy for democracy* and against fascist/authoritarian views in science education awaits extensive development but there already exists important contributions to approaching this. The people working on critical theory and applying it, such as Calabrese Barton and Tan (2020), Fortney and Atwood (2019), and Patterson (2019) are crucial. Another significant aspect is to develop curricula such as STEPWISE and intercultural approaches

(Gandolfi 2018) that allows not only the teaching of logical science but also the complex social and emotional aspects that underpin progress, and that the 'scientific method', if it can be called that, is also complex and has no delineated procedures.

One of the main arguments of this article has been that in order to promote a *pedagogy for democracy* it is essential that not only the sociological aspects of social justice and equity need to be attended to, but also the psychological elements of education. In particular, for pupils to engage socially and emotionally in a context that makes interactions explicit, so as to develop mutual understanding and respect. It is hoped that the more the above approaches can be used the less science can be seen as an emotionless activity that has been linked to extremism.

References

AAAS. (1993). *Benchmarks for science literacy*. Oxford: Oxford University Press.

Adams, T. (2016). Trans kids. *The Guardian*. Retrieved on 18th Aug 2020 from https://www.theguardian.com/society/2016/nov/13/transgender-children-the-parents-and-doctors-on-the-frontline.

Adorno, T., Frenkel-Brunswik, E., Levinson, D., & Sandford, N. (1982). *The authoritarian personality*. London: Norton.

Aikenhead, G. (2006). *Science education for everyday life: Evidence-based practice*. London: Teachers College Press.

Aikenhead, G., & Elliott, D. (2010). An emerging decolonizing science education in Canada. *Canadian Journal of Science, Mathematics and Technology Education, 10,* 321–338.

Albrecht, U. (1994). Military technology and national Socialist Ideology. In M. Renneberg & M. Walker (Eds.), *Science technology and national socialism* (pp. 88–125). Cambridge: Cambridge University Press.

Albright, M. (2017). *Fascism: A warning*. New York: HarperCollins.

Anderson, C. (2007). Perspective on science learning. In S. Abel & N. Lederman (Eds.), *Handbook of research on science education* (pp. 3–30). London: Routledge.

Bajaj, M. (2015). 'Pedagogies of resistance' and critical peace education praxis. *Journal of Peace Education, 12*(2), 154–166. https://doi.org/10.1080/17400201.2014.991914

Bazalgette, P. (2017). *The empathy instinct. How to create a more civil society*. London: John Murray.

Bazzul, J. (2012). Neoliberal ideology, global capitalism, and science education: Engaging the question of subjectivity. *Cultural Studies of Science Education, 7,* 1001–1020. https://doi.org/10.1007/s11422-012-9413-3

Bazzul, J. (2017). Biopolitics and the 'subject' of labor in science education. *Cultural Studies of Science Education, 12*, 873–887. DOI:https://doi.org/10.1007/s11422-017-9840-2.

Bazzul, J., & Tolbert, S. (2019). Love, politics and science education on a damaged planet. *Cultural Studies of Science Education, 14*, 303–308. https://doi.org/10.1007/s11422-019-09913-2.

BBC. (2018a). Boris Johnson faces criticism over burka 'letter box' jibe. *BBC*. Retrieved on January 11th 2019 from https://www.bbc.co.uk/news/uk-politics-45083275.

BBC. (2018b). Trump on climate change report: 'I don't believe it'. *BBC*. Retrieved on July 15th 2019 from https://www.bbc.co.uk/news/world-us-canada-46351940.

Beinart, P. (2018). Is Donald Trump a Fascist? *The New York Times*. Retrieved on Jul 7th 2019 from https://www.nytimes.com/2018/09/11/books/review/jason-stanley-how-fascism-works.html.

Bencze, J. L. (Ed.). (2017). *Science and technology education promoting wellbeing for individuals, societies and enviroment stepwise*. Switzerland: Springer.

Bencze, J. L., & Alsop, S. (2009). Anti-capitalist/pro-communitarian S&T education. *Journal for Activist Science & Technology Education, 1*(1), 65–84.

Bencze, L., & Carter, L. (2011). Globalizing students acting for the common good. *Journal of Research in Science Teaching, 48*(6), 648–669.

Bunyamin, M. (2019). Morality and science teaching: Expanding the idea of giving Zakah. *Cultural Studies of Science Education, 14,* 355–360. https://doi.org/10.1007/s11422-019-09917-y

Burbules, N., & Berk, R. (1999). Critical thinking and critical pedagogy: Relations, differences, and limits. In T. Popkewitz & L. Fendler (Eds.), *Critical theories in education: Changing terrains of knowledge and politics* (pp. 45–65). New York: Routledge.

Calabrese Barton, A. (1998). Teaching science with homeless children: Pedagogy, representation, and identity. *Journal of Research in Science Teaching, 35*(4), 379–394.

Calabrese Barton, A., & Tobin, K. (2001). Urban science education. *Journal of Research in Science teaching, 38*(8), 843–846.

Calabrese Barton, A. (2001). Capitalism, critical pedagogy, and urban science education: An interview with Peter McLaren. *Journal of Research in Science Teaching, 38*(8), 847–859. DOI:https://doi.org/10.1002/tea.1035.

Calabrese Barton, A., & Osborne, M. D. (2002). Reconstructing the Harsh World: Science with/for social action. *Counterpoints, 210,* 167–184.

Calabrese Barton, A. C., Ermer, J. L., Burkett, T. A., & Osborne, M. D. (2003). *Teaching science for social justice*. New York: Teachers College Press.

Calabrese Barton, A., & Tan, E. (2020). Beyond equity as inclusion: A framework of "Rightful Presence" for guiding justice-oriented studies in teaching and learning. *Educational Researcher, 20*(10), 1–8. https://doi.org/10.3102/0013189X20927363

CASEL. (2003). *Safe and sound. An educational leader's guide to evidence-based social and emotional learning programs*. Chicago: University of Chicago Press.

CASEL. (2016). CASEL website for emotional learning. Retrieved Jan 2020 from http://www.casel.org/.

Castéra, J., & Clément, P. (2014). Teachers' conceptions about the genetic determinism of human behaviour: A survey in 23 countries. *Science & Education, 23*(2), 417–443.

Cliff, J. (1943). Science under Fascism and Democracy. *Nature, 152,* 306–307.

Committee on Science Engineering and Public Policy. (2009). *On being a Scientist: A guide to responsible conduct in research. National Academy of Sciences, National Academy of Engineering (US) and Institute of Medicine (US) Committee on Science, Engineering, and Public Policy*. Washington (DC): National Academies Press. (US) ISBN-13: 978-0-309-11970-2$4.

Cooke, N. J., & Hilton, M. L. (2015). *Enhancing the effectiveness of team science*. Washington: National Academies Press.

Costa, A. L., & Kallick, B. (2008). *Learning and leading with habits of mind: 16 essential characteristics for success Alexandria*. London: ASCD.

Davis, P., & Lynch, D. (2002). *The Routledge companion to Fascism and the far right*. London: Routledge.

Deichmann, U., & Muller-Hill, B. (1994). Biological research at Universities and Kaiser Wilhelm Institutes in Nazi Germany. In M. Renneberg (Ed.), *Science technology and national socialism* (pp. 160–183). Cambridge: Cambridge University Press.

Donovan, B. M. (2014). Playing with fire? The impact of the hidden curriculum in school genetics on essentialist conceptions of race. *Journal of Research in Science Teaching, 51*(4), 462–496. https://doi.org/10.1002/tea.21138.

Donavan, B. M. (2015). Reclaiming race as a topic of the U.S. biology textbook curriculum. *Science Education, 99*(6), 1092–1117. https://doi.org/10.1002/sce.21173.

Donovan, B. M. (2017). Learned inequality: Racial labels in the biology curriculum can affect the development of racial prejudice. *Journal of Research in Science Teaching, 54*(3), 379–411. https://doi.org/10.1002/tea.21370.

Donavan, B. M., Stuhlsatz, M., Edelson, D., & Bracey, Z. (2019). Gendered genetics: How reading about the genetic basis of sex differences in biology textbooks could affect beliefs associated with science gender disparities. *Science Education, 103*, 719–749.

Donnelly, J. (2002). Instrumentality, hermeneutics and the place of science in the school curriculum. *Science & Education, 11,* 135–153.

Donnelly, J. (2004). Humanizing science education. *Science Education, 88*(5), 762–784.

Dopp, T. (2019). Trump decries bad 'Hombres' after unveiling immigration plan. *Bloomberg*. Retrieved on Aug 30th from https://www.bloomberg.com/news/articles/2019-05-17/trump-decries-bad-hombres-after-unveiling-immigration-plan.

Duckitt, J., & Sibley, C. G. (2009). A dual-process motivational model of ideology, politics, and prejudice. *Psychological Inquiry, 20*(2–3), 98–109. https://doi.org/10.1080/10478400903028540

Durieza, B., & Van Hielb, A. (2002). The march of modern fascism. A comparison of social dominance orientation and authoritarianism. *Personality and Individual Differences, 32*(6), 1199–1213.

Erduran, S. (2012). Philosophy, chemistry and education: An introduction. *Science & Education*. https://doi.org/10.1007/s11191-012-9526-9

Fallace, T. (2017). American educators' confrontation with fascism. *Educational Researcher, 47*(1), 46–52. https://doi.org/10.3102/0013189X17743726

Fifield, S., & Letts, W. (2014). [Re]considering queer theories and science education. *Cultural Studies of Science Education, 9,* 393–407. https://doi.org/10.1007/s11422-013-9509-4

Fortney, B., & Atwood, E. (2019). Teaching with understanding while teaching for understanding. *Cultural Studies of Science Education, 14,* 465–484. https://doi.org/10.1007/s11422-019-09924-z

Freire, P. (1970). *Pedagogy of the oppressed*. New York: The Seabury Press.

Freire, P. (1994). *Pedagogy of hope: Reliving pedagogy of the oppressed*. New York: Continuum.

Galamba, A. (2013). Rómulo de Carvalho's work on the popularization of science during Salazarism. *Science & Education, 22*(10), 2659–2677.

Gandolfi, H. (2018). In defence of non-epistemic aspects of nature of science: Insights from an intercultural approach to history of science. *Cultural Studies of Science Education, 14,* 557–567.

Garibay, J. (2015). STEM students' social agency and views on working for social change: Are STEM disciplines developing socially and civically responsible students? *Journal of Research in Science Teaching*. https://doi.org/10.1002/tea.21203

Gaspar, J., do Mar Gago, M., & Simões, A. (2009). Scientific life under the Portuguese dictatorial regime (1929–1954): The communities of geneticists and physicists. *HOST*, 3.

Gewirtz, S. (2006). Towards a contextualized analysis of social justice in education. *Educational Philosophy and Theory, 38*(1), 69–81. https://doi.org/10.1111/j.1469-5812.2006.00175.x

Gooday, G., Lynch, J., Wilson, K., & Barsky, C. (2008). Does science education need the history of science? *Isis, 99*(2), 322–330.

Gottfried, P. (2017). The uses and misuses of "Fascism". *Society, 54,* 315–319. https://doi.org/10.1007/s12115-017-0144-7

Grave, J. (2020). Federal officers are using unmarked cars to arrest Portland protesters. *The Guardian*. Retrieved on Jul 27th 2020 from https://www.theguardian.com/us-news/2020/jul/17/portland-protests-federal-officers-george-floyd.

Gunckel, K. (2009). Queering science for all: Probing Queer theory in science education. *Journal of Curriculum Theorizing, 25*(2), 62–75.

Hahn, C. (1999). Citizenship education: An empirical study of policy, practices and outcomes. *Oxford Review of Education, 25*(1–2), 231–250.

Harrison, C., Howard, S., & Matthews, B. (2016). *Teacher education programme. Strategies for assessment of inquiry learning in science*. London: King's College.

Head, J. (1985). *The personal response to science*. Cambridge: Cambridge University Press.

Hodson, D. (1998). *Teaching and learning science towards a personalized approach*. Maidenhead: Open University Press.

Hodson, D. (2003). Time for action: Science education for an alternative future. *International Journal of Science Education, 25*(6), 645–670. DOI:https://doi.org/10.1080/09500690305021.

Hodson, D. (2009). Putting your money where your mouth is: Towards an action-oriented science curriculum. *Journal for Activist Science & Technology Education, 1*(1), 2.

Horton, M., & Freire, P. (1990). *We make the road by walking. Conversations on education and social change*. Philadelphia: Temple University Press.

Humphrey, N., Kalambouka, A., Wigelsworth, M., Lendrum, A., Deighton, J., & Wolper, t. (2011). Measures of social and emotional skills for children and young people: A systematic review. *Educational and Psychological Measurement, 71*(4), 617–637. https://doi.org/10.1177/0013164410382896

ITV. (2020). Donald Trump appears to back away from military threat against protesters. *ITV*. Retrieved on 27 July 2020 from https://www.itv.com/news/2020-06-03/trump-backs-away-from-military-threat/.

Jacoby, T. (2016). Global fascism: Geography, timing, support, and strategy. *Journal of Global History, 11,* 451–472.

Jaramillo, N., & Carreon, M. (2014). Pedagogies of resistance and solidarity: Towards revolutionary and decolonial praxis. *Interface: A Journal for and about Social Movements, 6*(1), 392–411.

Jenkins, E. (2004). School science, citizenship and the public understanding of science. In E. Scanlon, P. Murphy, J. Thomas & E. Whitelegg (Eds.), *Reconsidering Science Learning* (pp. 13–20). London: The Open University.

Jenkins, E. (2006). School science and citizenship: Whose science and whose citizenship? *The Curriculum Journal, 17*(3), 197–211.

Levinson, R. (2018). Introducing socio-scientific inquiry-based learning (SSIBL). *School Science Review, 100*(371), 31–35.

Kreml, W. (1977). *The anti-authoritarian personality*. London: Pergamon.

Magee, A., & Pherali, T. (2019). Paulo Freire and critical consciousness in conflict-affected contexts. *Education and Conflict Review, 2*, 44–48.

Mansfield, J., & Reiss, M. J. (2020). The place of values in the aims of school science education. In D. Corrigan, C. Buntting, A. Jones, & A. Fitzgerald (Eds.), *Values in science education: The shifting sands* (pp. 191–209). Cham: Springer.

Mansour, N. (2009). Science-technology-society (STS): A new paradigm in science education. Bulletin of Science Technology & Society. https://doi.org/10.1177/0270467609336307.

Matthews, B., & Sweeney, J. (1997). Collaboration in the science classroom to tackle racism and sexism. *Multi-cultural Teaching, 15*(3), 33–36.

Matthews, B. (2004). Promoting emotional literacy, equity and interest in KS3 science lessons for 11–14 year olds; the 'Improving Science and Emotional Development' project. *International Journal of Science Education, 26*(3), 281–308.

Matthews, B. (2005). Emotional Development, Science and Co-education. In S. Alsop (Ed.), *Beyond cartesian dualism: Encountering affect in the teaching and learning of science* (pp. 173–186). Dordrecht: Springer.

Matthews, B. (2006). *Engaging education. Developing emotional literacy, equity and co-education*. Buckingham: McGraw-Hill/Open University Press.

Matthews, B., & Snowden, E. (2007). Making science lessons more engaging, more popular and equitable through emotional literacy. *Science Education Review, 6*(3), 1–16.

Matthews, B. (2007). Science education: Preparing pupils for the future? *School Science Review, 89*(326), 77–84.

Matthews, B. (2011). Enjoying science: Combining thinking skills and emotional literacy. In M. Hollins (Ed.), *ASE Guide to Secondary Science Education*. Hatfield: Association for Science Education.

Matthews, B., & Asaria, M. (2013). Social justice, emotional literacy and inclusion in schools. In S. Harris & S. Edmonton (Eds.), *Critical social justice issues for school practitioners* (pp. 51–69). NCPEA Press: Michigan.

Matthews, B. (2015). The Elephant in the room: Emotional literacy/intelligence, science education, and gender. In D. Corrigan, J. Dillon, R. Gunstone, & A. Jones (Eds.), *The future in learning science: What's in it for the learner?* Dordrecht: Springer.

Matthews, M. (1994). *Science teaching: The role of history and philosophy of science*. London: Routledge.

May, R., & Feldman, M. (2018). Understanding the Alt-Right ideologues, 'Lulz' and hiding in plain sight. In: Fielitz, M., & Thurston, N. (Eds.), *Post-digital cultures of the far right* (pp. 25–36). Political Science, 71, 25–36.

McLaren, P. (2010). Revolutionary critical pedagogy. *Inter Actions: UCLA Journal of Education and Information Studies, 7*, 1–11.

McNay, M. (2000). The conservative political agenda in curriculum: Ontario's recent experience in science education. *Journal of Curriculum Studies, 32*(6), 749–756. DOI:https://doi.org/10.1080/00220270050167152.

Mehrtens, H. (1994). The social system of mathematics and national 291 socialism: A survey. In M. Renneberg & M. Walker (Eds.), *Science technology and national socialism* (pp. 291–311). Cambridge: Cambridge University Press.

Millar, R., & Driver, R. (1987). Beyond process. *Studies in Science Education, 14,* 33–36.

Morning, A. (2008). Reconstructing race in science and society: Biology textbooks, 1952–2002. *American Journal of Sociology, 114*, S106–S137.

Morrison, L., & Matthews, B. (2006). How pupils can be helped to develop socially and emotionally in science lessons. *Pastoral Care in Education, 24*(1), 10–19.

Mulkay, M. (1979). *Science and the sociology of knowledge*. London: Allen & Unwin.

Ost, D., & Yager, R. (1993). Biology, STS and the next steps in program design and curriculum development. *The American Biology Teacher, 55*(5), 282–287.

Paechter, C. (1998). *Educating the other. Gender, power and schooling*. London: Falmer.

Parsons, E. C., & Carlone, H. B. (2013). Culture and science education in the 21st century: Extending and making the cultural box more inclusive. *Journal of Research in Science Teaching, 50*(1), 1–11. DOI:https://doi.org/10.1002/tea.21068.

Patterson, A. (2019). Equity in groupwork: the social process of creating justice in a science classroom. *Cultural Studies of Science Education, 14*, 361–381. doi:https://doi.org/10.1007/s11422-019-09918-x.

Perry, J. (2018) *Report: The state of political education in the UK*. TalkPolitics UK.

Persily, N. (2017). The 2016 U.S. Election: Can democracy survive the internet? *Journal of Democracy, 28*(2), 63–76.

Phillips, A. (1993). *Democracy and difference*. Cambridge: Polity Press.

Phillips, A. (1995). *The politics of presence*. Oxford: Oxford University Press.

Phillips, A. (1999). *Which equalities matter?* Cambridge: Polity Press.

Phillips, T. (2020). Brazil: Bolsonaro reportedly uses homophobic slur to mock masks. *The Guardian*. Retrieved on Jul 21st 2020 from https://www.theguardian.com/world/2020/jul/08/bolsonaro-masks-slur-brazil-coronavirus.

Powell, J., & Menendian, S. (2016). The problem of othering: Towards inclusiveness and belonging. *University of California, Berkeley. Othering and Belonging Institute*. Retrieved from http://www.otheringandbelonging.org/the-problem-of-othering/.

Pratto, F., Sidanius, J., Stallworth, L. M., & Malley, B. F. (1994). Social dominance orientation: A personality variable predicting social and political attitudes. *Journal of Personality and Social Psychology, 67*(4), 741–763.

Prose, F. (2020). Watching Trump's paramilitary squads descend on Portland, it's hard not to feel doomed. *The Guardian*. Retrieved on 31 August 2020 from https://www.theguardian.com/commentisfree/2020/jul/20/trump-shock-troops-portland-doomed.

Reiss, M. (1998). The representation of human sexuality in some science textbooks for 14-16 tear olds. *Research in Science & Technological Education, 16*(2), 137–149. https://doi.org/10.1080/0263514980160204

Renneberg, M., & Walker, M. (1994). *Science technology and national socialism*. Cambridge: Cambridge University Press.

Renton, D. (1999). *Fascism: Theory and practice*. Pluto Press, *JSTOR*. www.jstor.org/stable/j.ctt18dzsj6. Accessed 10 Febraury 2020.

Rodrigues, A., & Morrison, D. (2019). Expanding and enacting transformative meanings of equity, diversity and social justice in science education. *Cultural Studies of Science Education, 14*, 265–281. https://doi.org/10.1007/s11422-019-09938-7.

Rohleder, P. (2014). Othering. In T. Teo (Ed.), *Encyclopedia of critical psychology*. New York: Springer. https://doi.org/10.1007/978-1-4614-5583-7_414.

Roth, W., & Desautels, J. (2002). *Science education as/for sociopolitical action*. New York: Peter Lang.

Roth, W., & Lee, S. (2002). Scientific literacy as collective praxis. *Public Understanding Science, 11,* 33–56.

SAILS. (2016). *SAILS project materials*: Available at http://www.sails-project.eu/portal.

Santos, W. (2009). Scientific literacy: A Freirean perspective as a radical view of humanistic science education. *Science Education, 93*(2), 361–382.

SATIS. (1988). Science and technology in society.14–16 (Units 1-100). *Association for Science Education Hatfield Herts*. This is based on the introduction to the 16–19.

SATIS. (1990). Science and technology in society. 16–19. (Units 1-100). *Association for Science Education. Hatfield Herts.*.

Sennett, R. (2012). *Together. The rituals, pleasures and politics of cooperation*. London: Allen Lane.

Shor, I. (1979). Extraordinarily re-experiencing the ordinary: An approach to critical teaching. *New Political Science, 1*(2–3), 37–56. DOI:https://doi.org/10.1080/07393147908429480.

Siegel, H. (1980). Critical thinking as an educational Ideal. *The Educational Forum, 45*(1), 7–23. https://doi.org/10.1080/00131728009336046

Siegmund-Shultze, R. (1994). The problem of anti-fascist resistance of 'Apolitical' German Scholars. In: Renneberg, M., & Walker M. *(Eds.), Science technology and national socialism* (pp. 312–323). Cambridge: Cambridge University Press.

Smith, M. U., & Drake, M. A. (2001). Suicide and homosexual teens: What can biology teachers do to help? *American Biology Teacher, 63*(3), 154–162.

Snyder, V., & Broadway, F. (2004). Queering high school biology textbooks. *Journal of Research in Science Teaching, 41*(6), 617–636.

Storage, D., Horne, Z., Cimpian, A., & Leslie, S.-J. (2016). The frequency of "Brilliant" and "Genius" in teaching evaluations predicts the representation of women and African Americans across fields. *PLoS ONE, 11*(3), e0150194. https://doi.org/10.1371/journal.pone.0150194

Sullivan, Z. (2018). LGBTQ Brazilians on edge after self-described 'homophobic' lawmaker elected president. *NBCNews*. Retrived on Jul 21st 2020 from https://www.nbcnews.com/feature/nbc-out/lgbtq-brazilians-edge-after-self-described-homophobic-lawmaker-elected-president-n925726.

Tabernero, C., Jimenez-Lucena, I., & Molero-Mesa, J. (2012). Scientific–medical knowledge management through media communication practices: A review of two opposite models in early 20th century Spain. *HOST., 6,* 64–84.

Taylor, C. (1994). The politics of recognition. In A. Gutman (Ed.), *Multiculturalism: Examining the politics of recognition* (pp. 25–74). Princeton: Princeton University Press.

The Guardian. (2018a). Who is Jair Bolsonaro? Brazil's far right president in his own words. *The Guardian*. Retrieved on July 15th 2019 from https://www.theguardian.com/world/2018/sep/06/jair-bolsonaro-brazil-tropical-trump-who-hankers-for-days-of-dictatorship.

The Guardian. (2018b). 'Morally empty' Johnson is courting fascism, says peer as Tory crisis mounts. *The Guardian*. Retrieved on July 5th 2019 from https://www.theguardian.com/politics/2018/aug/12/boris-johnson-courting-fascism-says-peer-tory-crisis.

The Guardian. (2018c). Revealed: 50 million Facebook profiles harvested for Cambridge Analytica in major data breach. *The Guardian*. Retrieved on July 10th 2019 from https://www.theguardian.com/news/2018/mar/17/cambridge-analytica-facebook-influence-us-election.

The Guardian. (2019). Brazil: Huge rise in Amazon destruction under Bolsonaro, figures show. *The Guardian*. Retrieved on July 15th 2019 from https://www.theguardian.com/world/2019/jul/03/brazil-amazon-rainforest-deforestation-environment.

Tollefson, J. (2019). Populist President sparks unprecedented crisis for Brazilian science. *Scientific American*. Retrieved on February 3rd 2020 from https://www.scientificamerican.com/article/populist-president-sparks-unprecedented-crisis-for-brazilian-science/.

Wilkinson, R., & Pickett, K. (2018). *The inner level. How more equal societies reduce stress, restore sanity and improve everyone's well-being*. London: Allen Lane/Penguin.

Wyer, M., Barbercheck, M., Cookmeyer, D., Ozturk, H., & Wayne, M. (Eds.). (2008). *Women, science, and technology: A reader in feminist science studies*. New York: Routledge.

Yeatman, A. (1994). *Postmodern revisionings of the political*. London: Routledge.

Young, I. (1990). *Justice and the politics of difference*. New Jersey: Princeton University Press.

Young, I. (1996). Communication and the other: Beyond deliberative democracy. In S. Benhabib (Ed.), *Democracy and difference. Contesting the boundaries of the political*. Princeton: Princeton University Press.

Ziman, J. (1984). *An introduction to science studies. The philosophical and social aspects of science and technology*. Cambridge: Cambridge University Press.

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