IDEOLOGY AND MATHEMATICS EDUCATION: A REBOUND

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> I don't think we have any alternative other than remaining optimistic. Optimism is an absolute necessity, even if it's only optimism of the will, as Gramsci said, and pessimism of the intellect. —Angela Davis [1]

Ideology seems to be *passée*. The word itself appears to be surrounded by a patina of dust and, when employed in political discourse, it is usually articulated in a pejorative sense, as an insult to discredit intellectual enemies. In the public sphere, societal problems are often narrated to be fundamentally non-ideological: as quantifiable and mathematizable problems that eager and well-intended technicians would be able to solve, if given enough data and if enough computational power is put at their disposal. While it is not difficult to recognize this as a manifest ideological fantasy, its hegemony appears hard to dispel.

In 1997 Borba and Skovsmose discussed in this journal what they called the *ideology of certainty* concerning mathematics. In a nutshell, this involves the belief that mathematics is a perfect and pure form of knowledge and, furthermore, that mathematics is applicable to all (or almost all) sorts of real-world problems. More recently, Skovsmose (2020) introduced in this journal the parallel notion of the narrative of the sublime depicting mathematics as a sublime object in view of its aesthetic and utilitarian features, in turn responsible for bringing about various advantages and benefits to individuals and society. As Borba and Skovsmose noticed, the ideology of certainty (or, in the later formulation, the belief in the *narrative of the sublime*) has deep consequences on the way in which mathematics is (mis)used as a tool and language of power [2].

Interestingly, this ideology is not (only) the product of the misuse of mathematical jargon by politicians or journalists in bad faith or not having had a sufficiently deep education in mathematics. As Borba and Skovsmose suggested, the ideology of certainty is in part a consequence of the way in which mathematics is taught and learnt in school. This potentially troublesome link between mathematics education and ideology has been explored in different forms by theoretical and empirical research with converging conclusions (Borba & Skovsmose, 1997; Lundin, 2012; Pais, 2013; Ernest, 2016; Beccuti, 2024; Beccuti, Valero & Robutti, 2024), but has mainly remained under the radar of mainstream mathematics education research. A first aim of this article is thus to bring these convergences under new light, by framing them into a materialist understanding of the working of educational institutions conceived as places of labor and of ideological (re)production.

In connection to this, a second aim of this article is to contribute to a more comprehensive understanding of the challenges and opportunities entailed in opposing the hegemonic status of the ideology of certainty. As we will see, Borba and Skovsmose proposed to counter this ideology by changing the way in which mathematics is taught as an important element of their more general project of critical mathematics education (recently re-proposed by Skovsmose, 2023). The overall emancipatory aims of this project were disputed by Pais, Fernandes, Matos and Alves (2012) who deemed it fundamentally superstructural*, i.e.,* involving ideological changes not directly affecting (and, in their opinion, ultimately reinforcing) the structural working of schooling (*i.e.,* the material power relations and mechanisms underlying directly its functioning). Assessing this objection is important since it does not only pertain to Borba and Skovsmose's proposal, but also potentially applies to any mathematics education program with radical emancipatory objectives. Pais and colleagues' argument was partially anticipated by Skovsmose (2011) and generally acknowledged in his later writings. However, no attempt has been made to assess this objection in theoretical terms focusing specifically on the ideology of certainty and its role in educational reproduction. While Pais and colleagues' argument should not be downplayed, I will nonetheless maintain that they ultimately overlooked the dialectic potential of Borba and Skovsmose's proposal. As we will see, the latter in particular includes a kernel which is fundamentally at odds with the current mode of reproduction of mathematics as a discipline in schooling. However, for this very reason, inherent systemic difficulties arise in countering the ideology of certainty which must be taken seriously into account by mathematics educators interested in attempting to dispel the hegemony of this way of thinking and the perpetuation of its formatting power in society.

Ideology and schooling

The influential essay *Ideology and Ideological State Apparatuses* by philosopher Louis Althusser (2014) contains important hints on the working of educational institutions. These are inscribed within a general theory of ideology depending on an understanding of society based on the structure-superstructure dualism. Indeed, Althusser, following Marx and Gramsci, fundamentally emphasized that, in order for a society to function, it is necessary that, generally speaking, the conditions of production are reproduced. The reproduction of the conditions of production requires not only that the material subsistence of labor power itself is

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replicated (*e.g.,* that workers can survive and reproduce) but that the competences employed in labor are reproduced, too. Such competences are nowadays provided outside the workplace and mostly delegated to educational institutions where their teaching is inextricably coupled with the teaching of generic good behavior as well as with hidden or overt ideological messages. Importantly, for Althusser, the school is the dominant ideological apparatus ensuring the reproduction of the superstructural conditions of production.

> What do children learn at school? […] they learn 'know-how'. But besides these techniques and knowledges, and in learning them, children at school also learn the 'rules' of good behaviour […] the rules of morality, civic and professional conscience […] In other words, the school […] teaches 'know-how', but in forms which ensure subjection to ruling ideology or the mastery of its 'practice'. (pp. 235–236)

For instance, in order for a nation to sustain its demand of menial white-collar jobs, it is not sufficient that an adequately copious cohort of people is taught arithmetic and spelling/grammar or that it is trained in computer typing, as well as in basic good behavior, but also that the ideologies which sustain the system of production have penetrated them sufficiently deep as to render their situation bearable or even desirable.

In general, for Althusser, "ideology represents the imaginary relationships of individuals to their real conditions of existence" (p. 256). Thus, ideology does not merely represent reality (perhaps distorted, as Marx argued), but represents the relationships of individuals to reality. In particular, it represents to individuals their own imaginary recognition of themselves as free subjects who freely subjects to a higher authority, being, truth, or necessity. This representation develops, according to Althusser, through a process of identification or subjectification by which individuals experience themselves as the cause of their actions, as a consequence of their material participation in institution such as families, armies, factories, and schools. Indeed, "ideology has a material existence" (p. 258) in the sense that it exists only in institutions and within their practices. Adopting a Pascalian theoretical reversal, Althusser's argument provocatively flips the causal relation between idea and act. Indeed, it is not, as Pascal said, that we pray because we believe, but we believe because we pray. Analogously, for Althusser, it is not that we believe in an ideology and hence we materially participate in the practices of some institution, but it is the very material participation in the practices of the institution which retroactively (re)produces the representation of the necessity of our participation. Ideological beliefs and worldviews thus come to be interiorized via the material participation of people in institutions and via the performance of the practices demanded from them within these.

Resonances and findings in mathematics education research

Althusser's account of the material functioning of ideology may be paralleled to more specific theoretical arguments advanced within mathematics education research. For instance, Ernest (2016) argued that belief in the certainty of mathematics is a result of the engagement with mathematical practices in educational institutions. This belief

> is not arrived at overnight but is the end point of a process of engagement with mathematics […] in school […] and associated cultural presuppositions. Belief in the certainty of mathematics is constructed by the individual as a response to an extended and highly directed and shaped experience of learning and doing mathematics (p. 388).

Notice that with "certainty" Ernest meant mainly the view that mathematical knowledge is known with certainty, *i.e.,* beyond any doubt. Already in 1997, Borba and Skovsmose argued that the way in which mathematics is presented in school produces an ideology of certainty concerning mathematics, meaning that

> (1) Mathematics is perfect, pure and general in the sense that the truth of a mathematical statement does not rely on any empirical investigation. The truth of mathematics cannot be influenced by any social, political or ideological interest.
>
> (2) Mathematics is relevant and reliable because it can be applied to all sorts of real problems. The applications of mathematics have no limit, since it is always possible to mathematise a problem. (p. 18)

If we employ here the aforementioned argument by Ernest, then the first component of Borba and Skovsmose's ideology of certainty would be arrived via material engagement with exercises and procedures enacted within mathematics classrooms. The second component of this ideology can also be argued to be a product of school mathematics itself. Indeed, Lundin (2012), building on Althusser, argued that engagement with realistic problem solving is an activity delivering to its spectators and performers an ideological message concerning the relationship between mathematics and the world. On the one hand, individuals engage with mathematics within a system of production of knowledge which, according to Lundin, is mostly self-referential and whose relevance is largely determined by the relevance of the schooling system itself. On the other hand, this engagement is represented to individuals as a necessity stemming from the imaginary fact that mathematics is useful primarily in the 'real' world outside the system itself (see the Althusserian definition of ideology in the previous section). Therefore, the very engagement with mathematical practice (and particularly with realistic problem solving) progressively constitutes as a reality the utility and relevance of mathematics' in the mind of the engager (see also Pais, 2013).

In my own work, I have carried out preliminary studies in two complementary directions partly with the objective to empirically explore the conclusions of the aforementioned theoretical arguments. On the one hand, I studied the mathematics frameworks of the influential Programme for International Student Assessment (PISA) in order to nuance how they characterize mathematics and how they articulate why students should engage with it (Beccuti, 2024). In particular, I argued that the articulation of mathematics' sublime features (and especially its extra-institutional utility) is

deeply connected to the type of mathematical instruction that PISA seeks to promote. The latter can be characterized as an explicit program of formation of subjectivities which includes agreement on the utility of mathematics in almost all domains. On the other hand, Ornella Robutti, Paola Valero, and I detailed how master's students in mathematics preparing to become teachers in Italy characterize mathematics itself, in connection to how they articulate their own mathematical identity (Beccuti, Valero & Robutti, 2024). This was described by the participants as a bond with an ideal community of like-minded individuals revolving around the agreement on mathematics' unique and positive features, variously articulated (among which the utility of mathematics had a fundamental place). These views were narrated by the participants as having been progressively consolidated over the years via engagement with mathematical exercises and problem-solving in school. Furthermore, these views were employed by the participants in order to discursively justify both their past engagement with mathematics and their aim to make other people engaged (in their future role as teachers).

Overall, the sublime characterization of mathematics (and the connected ideology of certainty) emerges as central in the reproduction of the educational system (with respect to mathematics). On the one hand, it is inscribed in the project of formation of subjectivity articulated by the main regulatory documents which guide and sustain global curriculum evolution (see Beccuti & Robutti, 2022). On the other hand, at least in one nationally-situated case, it appears to be crucial to the identity of those who will have the direct duty to enforce the curriculum inside the educational apparatus, *i.e.,* future teachers of mathematics.

Countering the ideology of certainty?

Borba and Skovsmose (1997) conjectured that it would be possible to counter the ideology of certainty by means of a different mode of teaching mathematics. In short, they proposed that

> Mathematics educators with a critical perspective should try to teach mathematics in a way which shows:
>
> (a) that this 'body of knowledge' is just one among others;
>
> (b) the short-cuts made in the process of mathematising.
>
> Students should therefore be talked out of ideas such as: a mathematical argument is the end of the story; a mathematical argument is superior by its very nature; or arguments such as 'the numbers said such and such'. (p. 18)

These suggestions—which resound in many proposals meant to counter the myths connected to the perfection and faultlessness of mathematics—could be enacted in the classroom. For instance, this could be done by means of metamathematical reflection on the inherent limits of formalization coupled with historical Lakatosian-inspired reflection stressing on the imperfection of the practices of mathematicians (see Ernest, 2016) and on the limits of mathematization in modeling natural and social phenomena (Borba & Skovsmose, 1997). Similarly, it would be promising in this direction to emphasize the cultural relativity of mathematical knowledge (as is usual, *e.g.,* in ethnomathematics), and to downplay the traditional notion of rigor, also by simultaneously valuing approximate 'good-enough' mathematical arguments (as in Zack & Reid, 2003). Borba and Skovsmose, in particular, inscribed their suggestions within their general project of critical mathematics education. This is a form of mathematics education aimed at emancipatory social justice based on the critical investigation of non-standard open problems of a societal and political nature, also importantly including the critique of the role of mathematics itself in schooling (Skovsmose, 2020, 2023; see also Larnell, Bullock & Jett, 2016).

Pais, Fernandes, Matos and Alves (2012), moving from a perspective informed by the Althusserian theory of ideology, criticized the emancipatory aims of critical mathematics educators. Indeed, Pais and colleagues contended that the very claims concerning the liberatory power of critical mathematics education may come to constitute an ideological screen which would ultimately be functional to the reproduction of capitalist schooling itself. This is because, they argued, if the emancipatory strategy of critical mathematics education is carried out only at superstructural level, while the structural working of schooling (and the overall system of capitalist production) remains the same, then only superficial changes can occur and these will ultimately work in the direction of consolidating the primary ideological role of the educational system itself. Moreover, the potential for social justice predicated of critical mathematics education would run the risk of substituting or adjoining one type of legitimation of school mathematics to another, *i.e.,* of propping up the old fantasy of a sublime mathematics with a new kind of sublimity, this time tied to social justice themes. This would ultimately end up reinforcing "the belief that mathematics is precious knowledge, a keystone of modern society, and an inescapable tool of citizenship" (Pais, 2013, p. 30). As a consequence, according to Pais and colleagues (2012), critical mathematics education generally "exemplifies the power of Capital in co-opting what is officially presented as an emancipatory enterprise" (p. 31). Skovsmose himself appeared to have been aware of this as he observed that, if we accept a strictly structuralist reading of Althusser's theory, then "any educational 'improvement' simply facilitates a further submission of educational practices to the capitalist order of things" (2011, p. 22).

While this critique cannot be downplayed, a finer-grained reading of the Althusserian theory of ideology and of its Gramscian premises is in order here. It is true that people's participation in some apparatus depends largely on the practices and discourses which are produced (or perhaps selected) by their material engagement within such apparatus. However, it is not true that such system of practices and discourses is completely dependent solely on the structural working of the apparatus itself reduced to its day-to-day self-preservation, as perhaps a too mechanistic reading of Althusser's account would suggest. In such a picture individuals and groups would be simply puppets of an entirely deterministic machine, which in turn would be completely incapable of transforming itself. In contrast, there is a dialectic relationship between ideas and structures which cannot be accounted solely by means of a unidirectional interpretation of the

Pascalian inversion of the causal relationship between belief and act discussed by Althusser. Indeed, while ideology in a sense rationalizes people's behavior by constituting them as subjects, at the same time the form and content of ideology are always re-interpreted by individuals and groups and even by institutions themselves (which are in turn composed of people and groups), thus potentially producing new discourses, new practices, and new (or changed) institutions.

Therefore, in general, ideological struggle (especially when involving change in vital material practices of institutions) is not necessarily superficial struggle but can significantly influence and change institutions themselves. In this case, the proposed focus of critical mathematics education on altering the material practices of mathematics towards critical encounter with open social and political problems takes its full significance in view of the material mode of existence of ideology maintained by Althusser. Furthermore, countering the ideology of certainty may also be instrumental in undermining the very ideological legitimation of mathematics and of its centrality within the current system of schooling. This is best exemplified simply by noticing, again in Althusserian terms, that the school is not only an ideological apparatus, but also a place of labor and production. The school has thus to produce its own conditions of production, *i.e.,* it has to produce the ideologies which sustain its continuous functioning. Since schools are organized around disciplines, specific ideologies sustain and rationalize the existence and justify the prosperity of each particular discipline, in turn justifying why people should engage with them. With respect to mathematics, as seen, not only the ideology of certainty is produced by participation in school mathematics, but also this very ideology fundamentally sustains people's engagement and forms of identity-constitution in relation to it. Therefore, disrupting and criticizing the discourses articulated around mathematics entails fundamentally disrupting the modes in which subjects are (or should be) constituted in relation to mathematics as a discipline. Thus, Borba and Skovsmose's proposal contains a kernel which renders it fundamentally unacceptable by mainstream institutional mathematics education as it entails questioning the legitimacy of mathematics education itself in schools and universities.

Of course, as said, it remains a possibility that critical mathematics education will eventually turn into just one of the many educational proposals which comes to be co-opted by the capitalist system of schooling. However, much will depend on whether critical mathematics educators are prepared to struggle for educational hegemony and on what forms this struggle will take in the future. A helpful analogy could be that of trade unions understood within the history of the international workers' movement. Indeed, it can be argued that, given that their way of operation is constrained by inherent legal and bureaucratic limitations, unions essentially function as a subsidiary factor of capitalist reproduction which is eventually doomed to be co-opted by the long-term interests of the ruling class. Nonetheless, unions ultimately serve not only the localized purpose of defending workers' wages but also historically have had a key fundamental role in creating the ideological conditions for more radical fights. Marx and Gramsci discussed extensively this from a theoretical viewpoint and indeed part of their direct political work in their times was occupied in trying to leverage the contradictions widened by the unions' struggles in the attempt to hegemonize them (see Annunziato, 1988).

In our case, it could be true that the most radical emancipatory aims of critical mathematics education may be directly out of reach. Nonetheless, leveraging the contradictions instilled in school mathematics from the inside by critical mathematics educators could have potentially far-reaching consequences in view of the importance of the educational apparatus and of the central place which mathematics has historically assumed in it [3]. This could serve to go in the direction of creating the superstructural conditions for general structural change (at least at the educational level and at least with respect to mathematics) as well as to oppose the most disruptive consequences of how mathematics is employed as a language of power in the public sphere.

Conclusion

The proposal advanced within critical mathematics education of materially changing the way in which school mathematics is taught in order to counter the ideology of certainty appears to be of foremost importance. This is primarily due to the fact that this ideology is constituted through people's material participation in the practices of school mathematics, as seen. Furthermore, this can have important far-reaching systemic consequences, given the significance of this ideology in legitimizing the role that mathematics has in school and in society.

Several proposals going in this direction were discussed in the literature. Skovsmose's own work is of course rich in suggestions involving reflection on the political nature of mathematization and in classroom examples focused on deconstructing (and hence, in a sense, reconstructing) notions such as democracy, equity, fairness, and merit (*e.g.,* Skovsmose, 2020, 2023). Other related proposals can be seen as going in this direction by promisingly working at the intersection of issues of race, gender, class, and (dis)ability, also by reconsidering the role that mathematics has in framing problems and formatting identities (see, *e.g.,* the review of Larnell, Bullock & Jett, 2016). Other recent interesting classroom proposals concern for instance engaging with so-called 'wicked' problems, *i.e.,* societal problems inherently vaguely characterized and intrinsically not having a definite right or wrong solution (see, *e.g.,* Steffensen, Herheim & Rangnes, 2018).

What many of these suggestions share, besides their concern with the socio-political, is their attempt to turn critical reflection on mathematics and mathematization into a legitimate component of school mathematics itself. Favorable allies in this direction could be found among the mathematics educators aligning with the aforementioned Lakatosian-inspired paradigm of fallibilism and of course among ethnomatematicians. Other potential dialectical openings could also be found among those (seriously) concerned with the teaching and learning of mathematical modelling and even among those adhering in good faith to the premises of PISA's own general ideology. Indeed, in my experience, even the most conservative-minded mathematics educators, when confronted, would admit that unquestioned and unbridled

mathematization can seriously lead astray when studying social and political phenomena. Therefore, they would agree that, very simply put, a competent student of mathematics should also be competent enough to understand when mathematics is *not* usable for describing the phenomenon at hand. A significant inconsistency could then be made apparent between PISA's promoted sublime vision of mathematics and its overall asserted stress on the extra-institutional utility of mathematics. Insisting on these and related contradictions (both in research, in classroom practices, and in discussions with other scholars) could serve to create a space for turning reflections and work on the status and the applicability of mathematical knowledge into allowable components of school mathematics itself, so that they are not "perceived as time away from mathematics" (Esmonde, cited in Larnell, Bullock & Jett, 2016, p. 26). This could ultimately bring into being "a legitimate space for students to completely reject the demand to solve problems of social significance by means of mathematics" alone (Straehler-Pohl, 2017, p. 49, emphasis removed). In view of the above argument on the materiality of the functioning of ideology and on the centrality of the ideology of certainty, the significance of this apparently simple, yet crucial, change within curricular mathematical instruction should not be underestimated.

Finally, notice that taking full consciousness of the centrality of the ideology of certainty in the overall reproduction of school mathematics nonetheless entails recognizing the fact that the problem is deeper than simply one of making people 'see through' this ideology. Indeed, the ideology of certainty is not just a cluster of contingent beliefs that one can hope to systemically counter solely by ad hoc didactic adjustments or by rational discussion on the epistemological nature of mathematics and mathematization. The ideology of certainty (or the twofold sublime characterization of mathematics) fundamentally sustains mathematics as a discipline within the educational system itself. It is, in a sense, inscribed in its produced subjectivities and hence it is, to all appearances, a vital component of the general way through which mathematics education reproduces its own conditions of production. These crucially also include the reproduction of the legitimacy of the intellectual work of mathematics educators themselves, by providing "a paradigmatic umbrella for mathematics education practices and for mathematics education research" (Skovsmose, 2020, p. 48). The ideology of certainty is thus a fully systemic phenomenon inextricably tied to the institutional functioning of mathematics education.

Therefore, it appears difficult to challenge this ideology only by means of local interventions framed within the current system of schooling, as Pais and colleagues argued. There is always the risk that our critical aims will be ultimately anesthetized, if well-intentioned educational efforts are not concomitantly accompanied by the explicit recognition of the school as the dominant ideological apparatus. Indeed, this very fact is too fundamental for it to be acknowledged as a somewhat esoteric old truth, possibly agreed upon, but not emphasized, perhaps in fear that it should inspire nothing but pessimism. Instead, I contend that it should be put at the center of our efforts towards opening legitimate spaces within school mathematics for leveraging its inherent contradictions (also crucially by developing natural as well as possibly unexpected alliances with other scholars and traditions, as sketched above). This endeavor cannot disregard the theoretical tools developed around the concept of ideology in general and the ideology of certainty in particular, specifically by taking advantage of the dialectical openings entailed by a materialist understanding of their functioning. Until we frame the discussion in these terms, we cannot hope to fundamentally disturb, let alone reverse, the influence of the typical discourses and practices of mathematics education connected to the perpetuation of the ideology of certainty and its consequences on society at large. If we are to wake up from this (bad) dream, the notion of ideology must be regained.

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Notes

[1] From p. 49 of Davis, A.Y. (2016) *Freedom is a Constant Struggle: Ferguson, Palestine, and the Foundations of a Movement.* Haymarket Books.

[2] Outside schools, for instance, this is evident in the aforementioned public framing of societal and political problems as unilaterally solvable by means of quantitatively-informed expert management (see Straehler-Pohl, 2017), whereas, within schools, it is apparent in the connected centrality of mathematics as a discipline and in its consequent role as a gatekeeper to other disciplines, societal roles, and professions (see Pais, 2013).

[3] It could be true that outright belief in direct structural change by means of critical mathematics education requires on last analysis "a leap of faith" (Pais *et al.,* 2012, p. 32), but this is also no solid reason to concede to a self-demoralizing pessimism. Pais and colleagues claimed to be, following a Pascalian maxim, optimistic in practice but pessimistic in theory. This position can be paralleled (but is not exactly equivalent) to Gramsci's pessimism of the intellect and optimism of the will endorsed by philosopher Angela Davis (quoted in epigraph). Indeed, outright pessimism here entails generally overlooking the potential of superstructural struggle to be dialectically reflected onto the structure. While this position can be accused of idealism, affirming its opposite would make us fall back into a purely mechanistic and untenable reading of the functioning of ideology.

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