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# Critical Mathematical Competence for Active Citizenship within the Modern World

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*In this paper, I aim to contribute, through a state-of-the-art literature review, to exploration of critical features that mathematics as a tool offers for reading and writing the world. Our world is crowded by scientific and technological cultural practices, among which mathematics constitutes an essential and integral part. In this review, I look at interactions between developments within mathematics as a discipline (especially mathematics as applied in various fields such as statistics, economics, finance, engineering) and mathematics as a subject taught in schools, specifically the secondary and higher secondary levels. The product of this critical review is to formulate a set of proposals meant to bring a critical eye to bear on mathematical structures taking away citizens' critical capacity to read and write the world. These structures render citizens docile, in-active, and un-able to make their input into the authoritative characteristics that these mathematical structures achieve through the processes of abstraction and objectifications within the context of the constitution of the modern world through actions of techno-science and technology.*

## Context of the Research Project

Modern societies are built around complex mechanisms to regulate matters such as trade among different countries and regions, through negotiation and dialogues in different dimensions such as political, economic, cultural, and other related domains. Within a framework of nation states, peoples compete, hopefully to co-operate and to create opportunities for mutual co-existence in an increasingly globalized world. Capitalism in one form or other is holding sway in governing societies around the world. Under the strong influence of the capitalist economies, the ways of living of people are getting affected as

well. For example, people develop calculated rationalities to organize their daily living. This process could start from organizing a monthly budget, to organizing the education of their children—in general, planning how to use resources such as time, money, and human effort to achieve different objectives of their lives.

Governing patterns have also changed greatly in modern societies. Societies have developed different kinds of strategies to govern the population within a frame of the state (Baber, 2007; Foucault, 2003; Hacking, 1999, 2001, 2002; Neocleous, 2003; Prewit, 1987; Rose, 1999; Rose & Miller, 1992). For instance, Foucault (2003) detected a shift in unit of government from family to governing population.

Furthermore, statistics presupposes the “... emergence of the calculating rationality of the bourgeoisie class” (Neocleous, 2003, pp. 52-53). Specialized techniques of statistics have been utilized to study the social phenomena. In this way, the complexity of social phenomena has been reduced to some manageable units or variables, and constant attempts have been made to posit some causal connections among the phenomena. Therefore, complex phenomena have been put into the machine of generating quantified generalized knowledge wherein some numbers appear on the social planes with their significance embedded in the socio-political space within society. The practice of standardization can be one form of generating a condition of interaction among diverse interests.

...standardization is not just a matter of the imposition of a system of bureaucratic regulation. Rather, it is a condition for interaction in diversified societies with an expanded division of labour, requiring common means of “trading” between different sectors—that is to say, requiring something that will provide a certain “translatability”. Stable standards thus enable the coordination of commercial activities across wide time-space zones, producing a means by which widely dispersed activities can be made commensurable one with another (Rose, 1999, 206-207).

It has also been argued that quantification created room for democratic public spaces where people were not judged according to status but judged through numbers (Alonso & Starr, 1987). This process of quantification has generated standardization which has led to objective exchange of goods and services without dependence on

personalities. The significant point is that the officials who use the statistical calculations are also constrained by the calculative apparatus they use.

Quantification is significant because it standardizes both its object and its subject—the act of exchange is no longer dependent on the personalities or statuses of those involved. ... Hence, while quantification is certainly bound up with the emergence of a specialist elite who calculate in terms of numbers, this is not simply a matter of the rise of technocracy. The officials who use these statistical and calculative methods are themselves constrained by the calculative apparatus they use. And this means that quantification produces a certain type of objectivity (Rose, 1999, 206-207).

Baber (2007) has demonstrated that numbers and functioning of liberal democracy are linked together; that is, the extensive uses of numbers have made possible for liberal democracy to function the way it functions in the current political landscape. Furthermore, he has shown how numbers are being used in making subtle government of citizens within the liberal democratic tradition possible, and how this governmentalization process conceals its own governing strategies. This double nature of relationship between governmentalization and the numbers raises the importance of developing a critical approach, mathemacy, needed for reflective judgement of citizens within democratic societies in today's increasingly globalized world. Under these conditions, literacy and numeracy become two important aspects that prepare citizens to become effective in handling varied demands of their lives in complex modern societies.

Moreover, in order to face a fast changing-world and become actively engaged, citizens require both critical literacy and critical competence in mathematics, and both can play important roles. For example, Morgan (1997) describes critical literacy as follows:

Critical literacy encourages students to challenge taken-for-granted meanings and “truth” about a way of thinking, reading and writing the world. It works against the notion that meaning is transparent, neutral, and unproblematic. Critical literacy also questions the neutrality of power relations within the discourses.

In pedagogic terms, students should be encouraged to develop enquiring minds that question the cultural and ideological assumptions underwriting any text. They also learn to investigate the politics of representation in the discourse, interrogate the unequal power relations embedded in texts, and become astute readers of the ways texts position speakers and readers within discourse (Morgan, 1997, p. 259).

Similarly, critical mathematical competence can be looked at in terms of empowerment of citizens as individuals and citizens as part of society. This empowerment can be achieved by developing mathematical power in terms of overcoming the barriers to higher education and employment and creating critical competence among citizens via mathematics (Ernest, 1996, p. 1). In this way, critical literacy and critical mathematical literacy can go hand in hand to develop the power of citizens to challenge the taken-for-grantedness of the text, or any claim made through it. Through the tools of critical literacy and critical mathematical literacy we can uncover the power relations that are responsible for the creation of the text. In this way, focus will be brought to the cultural and ideological assumptions behind the text production. The same holds for the ways in which messages are created by different media technologies.

Moreover, recent economic crises (or financial crises) in Europe and the USA have raised the importance of bringing a critical eye to bear on the mathematical models that banks or insurance companies are/were selling in order to make profits. On the other hand, citizens simply become/became passive actors in the crises as, due to their lack of knowledge or competence, they were unable to make informed decisions on important matters such as mortgages for homes. By implication, they become dependent on expertise/advice of financial counsellors who guided/misguided them (intentionally or unintentionally), and ultimately this lack of critical competence among citizens led them to suffer greater losses (financially, socially, and psychologically). This brings us to the need to create an active and agentive citizenship that would afford citizens access to their entitlements, in significant part by gaining competence in mathematics while becoming critical towards the mathematical structures and models which are formatting the modern world we inhabit. Here citizens exercise their rights via entitlement to “mathemacy” for reading

and writing their lifeworld critically, and ultimately to shape their lifeworld with informed decision-making.

There follow three examples that illustrate a need for citizens to understand socio-mathematical situations within their lives that are formatted through mathematical structures.

## **Example 1: Payment of Taxes as an Obligation on Part of Citizens**

Over time, different societies and cultures have evolved varied sets of mechanisms in order to regulate themselves. Forms and strategies of governance/regulation of societies are evolving/changing constantly. One of the important aspects of governance has been economic sustenance of a society. Here imposing/collecting taxes has been instrumental for economic viability of any society. The state as an instrument for the economic sustenance of society has created different formulae and structures to provide a constant flow of resources in order ensure good economic health. The state uses taxation as an important instrument to take out a portion of the income (personal income or income of a company) to generate financial resources for running the affairs of a society. The fixing of a particular level of taxation by any state has been an expression of political compromise that a particular polity of the particular society has agreed upon. Historically, the regime of taxation (include evolution of particular percentages within particular levels of taxation as a whole) have evolved. Often the determination of a particular level of taxation has also been an act of struggle. Many precious human lives have been compromised because of this struggle to achieve an agreement on a particular degree of taxes within a society. One can learn about these fierce economic and political struggles in societies such as UK, France, Germany and USA. Correct payment of taxes has been conceived of as an important obligation on the part of citizens in meriting citizenship within a particular polity.

A related realization is that citizens should be able to get a good education whereby they have possibilities to develop set of interpretations about taxation principles and the ways these principles are formulated and agreed upon. The ways different groups or actors

make their claims inform getting discounts on their taxation structures and their systematic or unsystematic struggles and strategies to achieve their goals. That is, it is an right of citizens to achieve good understanding of the processes involved in the formulation of principles and structures behind the taxation structures in a society. In this way, citizens would participate actively, not only in understanding the principles or logic behind the taxation structures, but also in acquiring sufficient knowledge to enable them to have an active input in making processes of formulating taxation more democratic in a society. Here various questions arise: Are practices of mathematics education at different levels of schooling in a society making citizens aware of their entitlements of knowing principles/structures through which a taxation system in a particular society operates? Can we find examples that can show us such educational practices in action? How can one characterize these examples from the point of view of their effectiveness? What gaps can we find in the effectiveness of these exemplary practices? What should we do so that we can improve entitlements of citizens to become able to evaluate critically these exemplary practices?

## **Example 2: Buying a House while Understanding the Market, and Motives and Models of Decision-making of the Significant Factors**

Housing is one of the basic human needs, for which one wants to find a good solution. That requires one to take into consideration factors such as earning power of a person or family, the locality where the person lives or wants to live, housing market (buying and selling values of houses), the seasons for which houses are sold or bought, interest rates on housing loans, accessibility or factors determining the availability of a housing loan, general banking policies and government policies concerning housing in a particular society, size of the family, and so on. In other words, finding a reasonable house to rent or own is a complex matter to handle. If one is not knowledgeable about the factors that determine the conditions of the housing market, then there are multiple possibilities that citizens can make decisions that can waste their valuable income resources. The negative effects of the

housing market have been clearly demonstrated by recent economic crises in countries such as Spain. The property boom burst, and it destroyed not only the citizens who were buying the houses, but also many companies who were engaged in selling the housing products based on certain trends and models. These mathematical trends and greedy profit motives created conditions for speculations which inflated the prices of housing fictitiously, and subsequently buyers of the houses were trapped by the ramifications of these speculations. In other words, speculation on the housing market brought resulted in economic catastrophes for the companies as well as for the citizens who were buying the houses, all on the basis of spurious mathematical models. Many families were destroyed because of not having the capacity to read the housing trends critically. This outcome clearly raises the importance of citizens having an entitlement to an education that supports them in exercising their critical capacities to make informed decisions such as buying or not buying a house and how the housing market is organized.

### **Example 3: Taking Health Insurance for Life and the Politics of Body Mass Index**

Societies are increasingly operating in insecure environments. The nature of the problems facing us requires us to cope with uncertainty. Here, tools with deterministic calculations might not help us much to deal with situations of uncertainty and risks. For example, securing health in a modern society is receiving increasing attention. There are different insurance companies that offer a variety of products to provide health coverage for a person. Often these companies operate on models devised through statistical methods or knowledge derived through empirical methods. The companies use several indices to inform their decision-making processes in formulating packages suitable for securing health coverage of people within different age groups. One of the common indices the health insurance companies use is Body Mass Index (BMI). This is defined as ratio between mass in kilograms divided by the square of the height in square meters. This index is typically used to quantify the obesity of the population of a country. Usually this norm of obesity in an individual case is used as

a reference point to compare the body mass index of the particular person in order to estimate chances of longevity or early or later death of the person. For example, in the USA, there are companies that require a person who seeks their insurance product to monitor their BMI on a regular basis. If this measure is not within an acceptable limit, then they should make decision on changing their lifestyle or eating habits so that they bring down their BMI to an agreed level. If not, then they have to either pay an expensive premium or leave the company health coverage. In other words, socio-mathematical models bring implications for the securing of health coverage. Hence the question arises: how can one support citizens so that they can develop their entitlements to read and interpret their world in a critical way? How they find opportunities to give an active input to decision-making processes of companies and the state concerning security of their health or minimizing risks to their healthy life?

## **Critical Mathematics Competence and Democracy**

Democratic society requires that its state, government, and legal framework should provide conditions for equitable distribution of resources within and among states, regions, groups, and individuals, for the increase/regeneration of economic resources. In this regard, mathematics is conceived of as important in creating conditions of democratic functioning while potentiating citizens/regions to settle issues such as resource allocation through logic based on rationality. Mathematics is thought of as important in providing objectivity, whereby everything is measured in one way or other. The intensive pressure of scientific and technological advances has led to foregrounding the act of measurement so that one can quantify current resources (human, time, financial, and material) and their utility in future through planning processes. Through mathematics, one can formulate conceptual objects namely categories (through codings/identifying variables) and relationships (in the form of models).

This process of formulating mathematical objects or mathematical structures in forms of models is not a neutral process. It brings a host of ethical issues in modern society. The intentions of modellers,



and the social and technological contexts, shape the very purposes for which mathematical objects and structures are applied or used. This is very much a political process, therefore it requires all citizens to not only get an access to this process of objectification of mathematical objects and structures but to acquire knowledge/skills in order to have the possibility of an active understanding of, and control over, these mathematical processes. Often mathematical structures act as action tools but these structures hide their own principles on which they operate. Technical experts and machines usually hold control on the formation and implementation of these processes. Experts and machines do the calculations for us, but normally do not tell us about the underlying principles on which these mathematical models are based. These underlying principles are normally “black-boxed”. It requires active engagement of citizens not only to understand these black-boxed principles but also to see them in the social contexts that create conditions for existence and possible uses/misuses of these underlying mathematical principles by various social actors who invoke these mathematical structures in order to promote their own proposals/projects. Through bringing a critical eye to bear on these black-boxed principles, citizens would add to the quality of democracy of the societies they live in. This could generate possibilities of dialogues between citizens, states, and other important actors in society for working together for the greater promotion of democracy in all walks of life.

One finds a gap in Mathematics Education, wherein there has not been many serious attempts made to prepare citizens to become critical of the world colonized by numbers and models with increasing intensity, controlled by experts encrypting their claims into language that is inaccessible to people. In this situation, it becomes imperative that there are opportunities available for citizens whereby they can develop their competency in giving input to authorities making claims embodied in mathematical structures. This also raises the importance of combining literacy and numeracy together to form a mathemacy (Baber, 2007) or to bring attention to critical mathematics education (Skovsmose, 1993, 1994, 2005). Against this background, we want to investigate the following research questions:

- In what ways do mathematical structures, through the process of objectification, constitute the lifeworld of citizens in societies under conditions of modernity and globalization?

- How can one develop educational processes that can facilitate citizens to become critical towards the formatting processes of mathematical structures as part of their entitlement to critical mathematical competence (namely mathemacy)?
- What are the implications for preparation of future mathematics teachers in making them critical on these formative mathematical structures?

This research can open up more opportunities to develop new lines of enquiry for curriculum development for better understanding the relationship between the self and the other (human and non-human) for creating sustainable conditions for living and the quality of living in the world. This critical consciousness can also develop organizations that would be more responsive to the needs of the users of the services of these organizations. In this way, the quality of service provisions can also be enhanced to a greater extent, and the connection between learning and organization can be brought to bear on the quality of services for the people and for the overall enhancement of the quality of provisions for society. This frame of learning can be geared to meet the needs of learners under the regime of globalization, wherein bringing a critical eye to technologically formatted structures is essential.

## **Significance of this Project**

This project will bring genealogical insights: how mathematical knowledge has been constructed historically and socially and is used as a part of power technology. This understanding of the relation between mathematical knowledge as historically and socially constructed and power technology would further open up new investigative fields in mathematics education, especially keeping in view the relationship between governmentality and mathematics in formatting lifeworlds of citizens in modern societies such as Norway.

This project will help citizens to link mathematical knowledge with society and its power relationships. This, in turn, will help citizens/learners to become conscious of their lives being constructed through numbers and mathematical models.

## Methodological Considerations

Here I want to pursue the following theoretical and empirical investigations (with considerations of sociological, historical, comparative perspectives):

- Conceptual history of accountability and audit society— investigations on objects such as evidence, objectivity, validity, trustworthiness, justification, research (Foucault, 1995)
- Balancing qualitative features with quantitative patterns (i.e. politics of large numbers)
- Sociology of money and taxation
- Learning and teaching of Mathematics with focus on development of active citizenship through development of critical competence in mathematics (through development of pre-service and in-service mathematics teachers)
- Mathematics and decision making in the context of ICT

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