

A critical gaze on new digital technology: Answers from mathematics education?

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An increasing concern have been expressed in both academic and public debate that new digital technology might undermine democratic values and practices. This paper explores how studies in the field of Mathematics Education could present different answers to ramifications of new digital phenomena for both individuals and society. A transdisciplinary approach under a post structural theoretical framework is suggested, and two tentative studies are presented. One study will carry out a critical text analysis of Swedish educational steering documents and one will be a classroom action research study, where discourses will be analysed.

New digital phenomena in the world of information

Digital technology is an integral part of our lives. Information flows from the Internet to us. However, scholars within different research fields have also drawn attention to the flow in the other direction, from us to the Internet (Kosinsky 2013; Zuboff 2019). Following this, the aim of this paper is to suggest possible studies in mathematics education as answers to ramifications of new digital phenomena for both individuals and society. For heuristic reasons, a distinction is made upon the direction of the information flow. Techniques that make use of the flow *from* us – our digital trace – are called *reading* techniques since they can predict attributes never explicitly stated. Techniques that make use of the flow *to* us are called *writing* techniques since they can change our behaviour, i.e. rewrite us. A full understanding of the new digital phenomena comes with the realization that they are formed by a symbiosis of reading and writing techniques, like lichen are formed by a symbiosis of algae and fungus.

Techniques reading more about us than we tell

We leave digital traces when we are online. They show our history of preferences, and are used to predict what videos, music or books we might prefer when continuing using such services. Thus, our behavior is constantly being read. The increasing size of this information flow have made it possible to see more general patterns in the data. This enables prediction of information that we might be unwilling to provide if asked. With methods from linear algebra, it is possible to predict attributes such as sexual orientation, ethnicity, religious and political views, and to some degree even personality. This is possible by merely having access

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to information of users' interaction with the 'like' function on Facebook (Kosinsky 2013). The accuracy of the predictions increases with more information, and companies that sell advertisement have access to much more information than just 'likes'.

The economic incentive to read humans through digital traces has been proposed by Zuboff (2019) to create a new form of capitalism, called surveillance capitalism, which operates with our traces as raw materials, mathematical methods as means of production and behavior predictions as products. She warns that this mostly unregulated form of capitalism is prone to exploit the lack of users' awareness for profit, no matter the human cost. In fact, she underlines that people need to be kept unaware, else the extraction of predictive value from digital traces would not work.

Techniques writing our future

Both online and offline behavior can be changed by what we see online, and we do not always select independently what will be shown. Techniques that affect the selection of content shown may therefore 'write' our behavior. One example was demonstrated by Bond et al (2010), who showed that voter turnout in the 2010 US congressional mid-term election was increased by planting a message on social media. Increasing voter turnout is beneficial for democracy, but the opposite has also been tried. In the United States 2016 presidential election, the Trump campaign used citizens' digital traces in an attempt to deter them from voting. Sponsored messages on social media are routinely distributed to people based on what is known about them. In this case though, the 3.5 million-person list destined for messages deterring them from voting, consisted *only* of individuals identified as not likely to vote for Trump (Sabbagh 2020). It is debated to what extent such measures can change the outcome of elections. Nevertheless, the fact that they are being used changes the democratic process of election campaigns to now incorporate mathematical modelling of Big Data.

Other writing techniques are the algorithms in search engines and on social media. They select what the user will be shown. However, it can easily be demonstrated that they show different content depending on historical digital traces. Reading and writing are thus intertwined here, both feeding the other. Limitation of the users' agency must therefore be understood in relation to this *interaction* of reading and writing, and not by them separately. This is also true for the attempted voter suppression.

Foucaultian theory and a transdisciplinary holistic approach

To be able to propose studies in mathematics education answering to the new roles of mathematics in society, a Foucaultian (Foucault 1995) inspired approach is one way. As an example, I appropriate the concepts *discourse*, *subjectification* and *dispositive* as tools to analyze the interaction between the new digital phenomena, the individual and society. *Discourse* will be used close to Foucault's (1995) own work, meaning not only language but also norms, habits, artifacts, institutional praxis etc. *Subjectification* as I use it, describes how the self is developed in interaction with the flow of information partly steered by algorithms.

The reading-writing algorithms would here be viewed as reinforcing the normalization process that produce subjects in relation to a milieu. By trying to resist this, the mechanics of power in the system may become confirmed and reproduced rather than refuted. One example is the usage of programs that generate random cookies to blur the digital traces. They confirm and propel the notion of a relation between the ability to read our digital traces and production of power. *Dispositive* in my adaptation, is used to envisage how the digital phenomena are linked and constitute an integrated knowledge structure that exercise power in society. This is exemplified by surveillance capitalism.

Research in mathematics education concerning the relation between mathematical techniques and democracy, should take into consideration the limits of what mathematics can achieve. Some mathematical problems are not solvable if all contemporary views on equity are to be respected. Thus, it would then be wrong to accuse algorithms that attempt the impossible to be unjust. It would rather be the expectations on what is solvable under certain combinations of societal principles of justice that would be unfair. One example is algorithms using criminological data to predict risk of recidivism. Such algorithms are used to select whom to keep in jail until trial. When optimized for public safety, they will either give more false positive in some groups (discrimination) or treat groups according to different standards (e.g., depend explicitly on ethnicity, which may be illegal) (Corbett-Davies et al. 2017).

Therefore, understanding of the general problem depends not only on contributions from several disciplines, but also on how these contributions interact. I suggest a transdisciplinary holistic approach including results from data science, sociology, mathematics and mathematics education.

Critical text analysis of steering documents

A starting point in the overall aim of exploring answers could be in the already present. In a critical text analysis it will be investigated what discourses can be construed in relation to democracy, in present steering documents for Swedish Upper Secondary School. Of special interest is mathematics role in subjectification of democratic citizenship and the dispositive of mathematical practices.

The text analysis will include both general steering documents and mathematics specific documents to see what differences exists. Inclusion of the mandatory national tests in mathematics will add the important aspect of assessment. Any discrepancies between what is to be taught and what is to be assessed is part of understanding the present. The critical aspect of the text analysis will be investigating what is present and what is *not* present in the steering documents, both in terms of current internal consistency and also when relating them to the new digital phenomena. This provides a point of departure when exploring revision of curricula.

Action research

An important aspect of the exploration of answers is what happens when teachers and students discuss the new digital phenomena in a classroom setting. For ecological validity, this will be investigated in classrooms in Swedish Upper Secondary schools together with teachers that already have an interest in teaching this content. Through negotiations with the teachers about details in objectives, methods, roles, etc, it will be attempted to achieve a milieu that augment learning for students, teachers and researchers under the framework of action research. This process will be unpredictable and the exact form of the study cannot be known beforehand. However, some general principles can still be sketched.

A concern is that the mathematical methods used from linear algebra are too different from the content of any pre-university curriculum, especially in their complexity. However, drawing on Skovsmoses (1990) three notions of knowledge, mathematical knowledge, technological knowledge, and reflective knowledge, I would suggest that the aim here is not for students to be able to use the methods themselves. The objective is rather reflective knowledge, i.e. knowledge about the methods, their limitations etc.

Data in form of observations, video, and interviews will be analysed through a discursive Foucaultian theoretical lens. Discourses can be construed from several viewpoints; (1) finding possible obstacles, what differences exist between teachers and students, before, under and after teaching (2) how is the complexity of the digital phenomena expressed, e.g., the reading-writing dialectic, (3) relating the classroom to research and public debate, (4) role of mathematics, (5) subjectification in the digital context, (6) dispositive of digital technology in a sociological context.

Which exact route the analysis will take depends on the nature of the discourses construed from the data. Nevertheless, the outcome will be relevant to the overarching aim of exploring how mathematics education can answer to new digital phenomena.

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