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Röj-Lindberg, Ann-Sofi

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Reflections on the Links between Innovative Practices in Mathematics Education and Democracy

Ann-Sofi Röj-Lindberg, aroj@abo.fi
Åbo Akademi University, Finland

Abstract

Mathematics education can promote democratic competences and values, but also inhibit them, and create inequalities. A basic idea behind the promotion of democratic competences and attitudes is proposed by Vithal (1999): within a mathematics classroom where it is possible for students to experience democratic life students can learn to listen to others' ideas, argue, take decisions, and critically analyse arguments made by authorities, e.g., the teacher. Aguilar and Zavaleta (2012) found three facets of mathematics education linked to democracy: a provider of critical mathematical skills, a source of values and attitudes, and a social gatekeeper. In this paper I discuss how mathematics teachers through innovative practices can foster a democratic competence in their students.

Introduction

Being a Finnish mathematics education teacher and researcher, I find it important to begin this paper on the links between mathematics education and democracy by stating that Finland is a country that is guided by a social democratic ideology which is reflected in its school system. Since the 1970s Finland has a state funded comprehensive school system without selecting, tracking, or streaming students during their common basic 9-year education. Part of the rationale that led Finland to abandoning its former two-track system is determined by Finland's sociocultural values which include a dedication to equity and collaboration. In the curriculum design process that preceded the latest curriculum reform (2016) in Finland, hundreds of professionals were involved, including mathematics teachers. The basis of the curriculum is national, municipalities do their own alignments and schools decide on the details. The aim is students' growth as human beings who strive for truth, goodness, beauty, justice, and peace, as well as to develop individuals and communities capable of making decisions based on ethical reflections, putting themselves in the place of another person, and considerations based on knowledge. Every school interprets the curriculum in their own way, but teachers are expected to implement activities that support democracy. The local curriculum is binding for the teachers but there are no sanctions or other forms of punishment if schools or teachers do not adhere to it and there is plenty of space for innovative practices. Nevertheless, there are indications that the Finnish mathematics classroom practices, like in many other

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mathematics classrooms around the globe, continue to be characterized by the habits of a mathematics education which in short can be described as teaching that proceeds by directly telling students what is true and how to perform predetermined techniques. My own research, where I followed mathematics students from grade 7 to their adult lives, showed that mathematics teaching of this type may run the risk of creating social inequalities which have long-term negative effects on how students experience their mathematical identity, their power to build their lives and, indirectly, the future society (Röj-Lindberg & Hemmi, 2019). If a student's mathematical identity has become fragile during the school years, this student hardly acts on his or her mathematical knowledge to critically analyse arguments of a mathematical origin made by authorities. Lack of deliberative acts of this type clearly display lack of a disposition linked to democratic decision-making (Biesta, 2016).

Whilst mathematics itself is regarded as ethically neutral, the ethical principles which produced both democracy and mathematics and which can be conveyed in mathematics education are highly relevant to today´s society (Hannaford, 1998). Stemhagen and Henney (2021) locate mathematics' origins in human activity and argue that the links between mathematical activity and democratic practices and values are rich, but often overlooked. Mathematics is a remarkably useful tool with the power to help realize change. Often, however, mathematics teachers are not even aware of that they are teaching any values when they teach mathematics (Aquilar & Zavaleta, 2012). Mathematics education can promote democratic competences and values, but also inhibit them by creating inequalities (Boaler & Selling, 2017; Röj-Lindberg & Hemmi, 2019), which in turn might inhibit a person´s potential to flourish individually (see Su, 2022) as well as to act in society to promote the principles of democracy. In this paper I define classroom practices as the recurrent activities and norms that develop in a classroom over time, and with 'mathematics education' I refer to the set of practices associated with the teaching and learning of mathematics.

Democracy and mathematics education

The complex link between democratic values such as justice, equality, respect for life and human rights, and education was acknowledged already by Dewey and since then by many others (e.g., Biesta, 2016; Klette et al., 2018). Dewey saw democracy as a way of life and argued that individuals in successful democracies can think for themselves, judge independently, and recognize trustworthy information. He saw schools as "embryonic societies". Others, on the other hand, argue that the school is not a society and society is not a school, and ask how democratic education at the same time can implement the principles of democracy and meet the requirements of education (Biesta, 2016, p. 93).

The link between mathematics education and democracy is not a new topic in the field of mathematics education research. The topic has appeared in discussions in the field for over 30 years (e.g., Aguilar & Zavaleta, 2012;

D'Ambrosio, 1990; Hannaford, 1998; Vithal, 1999), often in connection to different philosophies of mathematics and of mathematics education (Stemhagen & Henney, 2021). Stemhagen and Henney (2021) see democratic mathematics education as a philosophy of practice and argue that democratic mathematics education is where the nature of mathematics, its teaching and learning, and the broader purposes of schooling can and should meet. They further state that a necessary condition for democratic mathematics education to work is that the social must be recognized as part and parcel of mathematics learning (p. 135).

With the help of an extensive literature review Aguilar and Zavaleta (2012) identified multidimensional links between mathematics education and democracy. They found a variety of definitions of democracy in the texts they analysed and used the most overarching definition to be able to connect mathematics education to political, juridical, economical and socio-cultural dimensions; the last dimension being of most interest to the set of practices associated with a mathematics classroom. Aquilar and Zavaleta found that mathematics education can be linked to democracy in at least three ways: (1) as a provider of critical mathematical skills without which it would be difficult to identify how mathematics is applied to support decisions done in society and to analyse the consequences, positive and negative, these applications can produce; (2), as a source of values, like tolerance and respect for diversity, and attitudes about truth that demand the critical analysis of information; and (3) as a social gatekeeper and a filter that not only restricts students´ opportunities for mathematical development, but may even limit their civic participation and decrease their chances of economic and social success.

The question I will attend to in the rest of the paper is: Which features of a mathematics classroom might then over time support the development of democratic competences and values?

Features of a mathematics classroom linked to democracy

A basic idea behind the promotion of democratic competences and attitudes in students is proposed by Vithal (1999): within a mathematics classroom where it is possible for students to experience democratic life students learn to listen to others' ideas to understand them, they ask questions, argue, take decisions, and also learn to critically analyse arguments made by authorities, e.g., the teacher, the textbook and decision makers in society. In this type of mathematics education one can identify features of a *math talk learning community* where a primary goal is to understand and extend one´s own thinking as well as the thinking of the other participants in the classroom (Hufferd-Ackles, Fuson & Sherin, 2004). The students come see themselves as co-learners, co-teachers and co-evaluators and as co-responsible for the learning of everyone in the classroom. In such a classroom an investigative culture can emerge over time (Skovsmose & Säljö, 2008). Typical for an investigative culture is *inquiry* processes and collaborative activities leading to more open questions and tasks and less concentration on narrowly focused instruction.

Investigations in mathematics classrooms can be of very different types. They can be located within mathematics, for instance within geometry when students explore geometric properties using a dynamic-geometric software, but also within semi-realities, for instance when students investigate the shortest distance for a taxi-driver between two points in a city (Skovsmose & Säljö, 2008). The investigations can also be located in real-life contexts, for instance concerning pollution or other wicked problems, or when students become involved in city planning and determine the ideal placements of bus stops along a particular route (Stemhagen & Henney, 2021). The explorations can be *project-based,* as they were in one of the schools Boaler (2002) studied. In the mathematics classrooms of this school, students learned intellectual authority as well as a very active stance towards mathematics in their lives (see Boaler & Selling, 2017). An example of the many projects the students entered was located within mathematics as they investigated the shape of the volume 216 (Boaler, 2002).

Skovsmose and Säljö (2008) associate inquiry to the development of critical thinking and general reasoning skills that play a central role in a democratic society. They describe inquiry processes as dialogues where participants are willing to question one´s understandings and pre-understandings and to examine what is new and different but also what is considered knowledge already acquired. When a student enters a dialogue in the mathematics classroom it means that the student takes ownership of the process of investigation. One cannot force anybody into inquiry processes. Both the teacher and the students must be willing to enter the *landscapes of investigation*, a concept Skovsmose and Säljö use to refer to "learning milieus different from those structured through exercises" (2008, p. 41). A landscape of investigation may be situated in a mathematical environment but also in significant everyday events and daily concerns and in considerations of mathematical operations and their consequences. In any case the landscape must be explored in order to function as a scenario for inquiry processes, and it can only serve as such if the students accept the invitation to enter the landscape.

The type of inquiry dominated classroom culture that emerges through landscapes of investigation is very different from the exercise paradigm culture which we often see in mathematics classrooms. According to Skovsmose and Säljö (2008) in mathematics classrooms settled within the exercise paradigm the activities to a large extent involve students struggling with pre-formulated exercises that get their meaning through what the teacher has just lectured about. In this type of classroom an exercise traditionally has one, and only one, correct answer, and finding this answer will steer the whole cycle of classroom activities and the obligations of the partners involved. The teacher is obliged to explain how to solve a particular type of exercise; the students must try to do so, and the teacher must check the students' solutions, as mistakes have to be eliminated from the mathematics classroom. A student could sometimes be asked to present a solution to the whole class, and so the cycle continues. A cycle that in the worst case reproduces the core

assumptions that according to Coles and Sinclair (2022) are generally believed to be true about mathematics in school: that mathematics is a building block subject where you learn one block at a time and where you end up being either right or wrong; that it is a culture-free subject only some people can learn to master and that is a hard subject because it is abstract. It goes without saying that the features of an exercise paradigm culture where such core assumptions emerge in the mathematics classroom are hardly conducive for students to experience the type of life that we can call democratic.

Final comments

It is a demanding endeavour to implement activities in the mathematics classroom to promote democratic competences in students, filled with challenges, tensions and paradoxes (see Aguilar & Zavaleta, 2012). The teacher needs mathematical skills, including being mathematically creative, and a good understanding of how concepts and mathematical structures are interconnected. The teacher also needs attitudes conducive to promoting democratic competences in students, like willingness to work in situations that are full of uncertainty, or willingness to speak up if colleagues treat misconceptions or mistakes as failures and not as possibilities to understand the students' mathematical reasoning. Pedagogical skills are also necessary. Perhaps the teacher has designed socially relevant and open activities but meet uninterested students. Also, there is a tension between democracy and authority. Sometimes it might be necessary to engage students in non-democratic practices to promote democracy. For instance, when at a student group is non-functional some kind of authority is needed. High stakes assessment might also create dilemmas, for example in a situation when the students are engaged in learning the mathematics that help them solve a social problem in their own community, but then the mathematical skills they have developed through this activity are not assessed in the final exams.

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