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# Students' discussions of cultural, social, economic, and political aspects of the COVID-19 pandemic

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*Worldwide, students have experienced the impacts of the COVID-19 pandemic. This paper investigates students' reflective discussion of the consequences of measures taken during the pandemic in Norway. Socio-critical mathematics perspectives are used as a theoretical framework when analysing 13–14-year-old students' discussions of the pandemic. The students read, discuss, and present findings from media articles provided by their teacher. We found that the students identify and use mathematics-based argumentation when reflecting on cultural, social, economic, and political aspects from their own real world. They ask questions, investigate, listen to peers' argumentation, show awareness of, and discuss challenging issues such as mental health, increased violence during home-schooling, unemployment, loss of income, and rising inequality in society. We suggest that mathematics education can promote students' reflective discussion of wicked problems.*

*Keywords: Socio-critical mathematics, mathematical representation, discussion, wicked problems.*

## Introduction

The ongoing COVID-19 pandemic is an example of complex real-world problems often referred to as wicked problems. Characteristics of wicked problems are that time is running out, no optimal solution, conflicting interest, no central authority, and policies discount the future irrationally (Levin et al., 2012). During the pandemic, citizens worldwide dealt with a highly mathematics-based language and mathematical representations. For instance, the Reproduction (R) number showing how many people one infected person infects on average is central in describing, understanding, and predicting scenarios in Norway. Kolloosche and Meyerhöfer (2021) describe the R-number as having “formatted our perception of the status of the pandemic” and “justified specific political measures” (p. 10). They highlight that although substantial measures are taken partly based on this number, the significance of the R-number remains questionable.

In the Norwegian mathematics curriculum (MER, 2019), it is stated as vital that students critically reflect on models, statistical representations, and mathematical argumentations to make justified stands in essential issues in their lives and society. In this paper, we are inspired by Nakling's (the third author) master thesis, involving 13–14-year-old students' mathematical argumentation about risks of infection control measures of COVID-19. The students used media articles to discuss risks and impacts for groups in society. In this paper, we use the empirical data to consider how students can engage in wicked problems. Specifically, we investigate *How do students apply mathematics to critically reflect on the consequences of measures taken during the COVID-19 pandemic?*

## **Socio-critical perspectives in mathematics education**

The use of models in the pandemic is often connected to statistics, for instance, in reporting numbers of infected. Weiland (2017) argued that students should learn “to tackle complex sociopolitical issues in conjunction with learning powerful statistical concepts and practices in an effort to be able to read and write both the word and the world with statistics as critical citizens” (p. 45). Reflecting critically on societal issues in authentic applications of mathematics in real life can involve empowering students in discussions about the consequences of using mathematics, statistics, or mathematical models in society (Barbosa, 2009; Blomhøj, 2009; Gibbs, 2019). Barbosa (2009) emphasised that students’ reflection of the nature, criteria and consequences of mathematical models in society is crucial and should be the primary goal for socio-critical discussions. Relatedly, Blomhøj (2009) described that critical reflection may concern “the societal issues where mathematical modelling and models are used as means for analyses and critique of political decisions or societal phenomena” (p. 13). However, Gibbs (2019) found limited empirical research on students’ socio-critical perspectives and reflexive discourse during modelling. She argues that such discourse is crucial to move from modelling as a school activity to understanding the role of mathematics in society and that reflecting through mathematics can make it clear that a reduced representation can be an incomplete representation of the social phenomenon.

When students engage in socio-critical modelling activities, they “make assumptions about variables and quantities needed for their models” based on their own identity and history (Brunner et al., 2021, p. 139). However, the foundation, variables, and quantities may be invisible when using existing models or statistical representations. Therefore, when working with mathematical representations, it is essential to consider the properties of models or the statistics, what variables are included, and perhaps more importantly, what is not included. For instance, the R-number gives important estimates nationwide of health issues regarding changes in numbers of infected, hospitalised, etc. However, it does not include the impact of the pandemic on variables such as mental health issues.

A democratic society needs to develop competence in the general population “to critique mathematical models and the ways in which they are used in decision making” in society (Blomhøj, 2009, p. 11). The prevalence of mathematical applications in the pandemic, and the use of these in decision-making, call for students’ awareness of consequences of these applications so that they can critically reflect on such as the foundation, who has chosen the variables, what kind of variables are considered as important, and what does the models, statistics, and numbers tell us. Hattori et al. (2021) describe how socio-critically open-ended problems could foster critical mathematical literacy. They emphasise that students should develop abilities to critically perceive mathematics according to the situation and make social decisions based on values using mathematical thinking. They described how students discussed problems related to the pandemic in groups and argued for solutions based on personal values and mathematical argumentation.

Rosa and Orey (2015) highlight mathematical modelling as a teaching methodology to develop students’ social-critical efficiency. They encourage investigating familiar problems to the students so that the content becomes the stimuli for students’ critical reflections on the role of mathematics

in society, showing that mathematics applied is not neutral. Cultural, economic, environmental, political, social, and natural aspects of reality are contents they suggest as essential for socio-critical modelling. The COVID-19 pandemic is an issue with multiple aspects, as regulations have a range of impacts. One could say that pandemic regulations are based on a model of reality, where different facts and considerations are taken into account. However, it is only partly mathematical, as sub-models, numbers and statistics, together with some weighting of concerns, as elements of a rather unarticulated model. While Rosa and Orey (2015) emphasize the importance of engaging students in the whole modelling process, it is also of value to critically reflect on their suggested aspects through numbers, statistics and modelling presented in the media together with the role of these numbers. In this paper, we ask how students apply mathematics to critically reflect on the consequences of measures taken during the COVID-19 pandemic. We investigate students' utterances in light of Rosa and Orey's (2015) aspects and pay attention to aspects that may be in conflict with each other.

### **A Norwegian context during COVID-19 pandemic**

The Norwegian Government has various policies to limit and delay COVID-19 outbreaks, such as restrictions on travels and group meetings, prohibiting public events, and closing schools and national borders. In the initial stages of the pandemic, the government designed a strategy based on keeping the R-number below 0.9, the so-called suppress strategy. This strategy was partly based on the capacity of hospitals and uncertainties regarding treatment, potential vaccines, and how the virus would affect people and the nation. Closing schools and borders severely impacted citizens and the national economy, and later, a shift in the policy focused on social consequences such as loneliness and unemployment. The Norwegian population shows significant trust in authorities, e.g. they trust the information provided by the government, and there is an estimate of 90% vaccine coverage.

Teaching in Norway varied between digital home-schooling and physical attendance at school, with varying restrictions on social distancing. The students in the empirical data experienced a long period of home-schooling during their last year of primary school. In their first semester at lower-secondary school, teaching varied much between home and school, and when at school, students were grouped into so-called cohorts. Their mathematics teacher, Nakling, did his master thesis in his class.

### **Method**

To investigate students' discussions, we used empirical data from Nakling's master thesis. Nakling designed the lessons, and Hauge and Steffensen participated in the collection of data. The teaching took place during a two-week project and consisted of four lessons, each lasting 2 x 45 minutes. The students were 13–14 years old, the class consisted of 30 students, and they worked in groups of five, a total of six groups. Their teaching plan can be described in three parts. During the first part, the students worked with graphs to ensure students' understanding of what they represented. For example, the teacher showed a graph that simulated the progression of hospitalised infected individuals over time compared to the capacity of hospitals, with and without societal interventions. The students were prompted to consider potential consequences whether measures were taken too

early or too late. In the second part, the student worked in groups. Each group was assigned one role from society: nurses, parents, unemployed, psychologists, university students, and teachers. The teacher had selected 3–4 media articles for each of the groups, who were to present the situation of their assigned role based on mathematics-based content. The third part was a plenary activity. Here, each group first presented their findings orally, followed by a plenary classroom discussion about the pandemic and risk assessment for groups in society.

The students' utterances were video recorded during group work and in the plenary part. Only students who had given consent were recorded, resulting in data from four of the six groups. When analysing students' utterances, we took starting point in the six aspects of reality described by Rosa and Orey (2015). The cultural, social, economic, political, environmental, and natural aspects were used to identify and categorise students' utterances. While some of the utterances overlapped different categories, others did not. The idea behind this categorisation was to get an overview of the width of the student's reflections. The categories are used to structure the discussion part. The theoretical described above are used to understand, interpret, and support the discussions.

### **Students' discussion on cultural, social, economic, and political aspects**

In the following, we analyse excerpts from the students' group work, plenary presentations and plenary discussion to show students' reflexivity related to Rosa and Orey's (2015) aspects of reality. We connect these to mathematical models, here broadened to include applied mathematics and statistics in general. We further discuss this in relation to how their experience with the pandemic possibly has influenced their reflectivity.

#### **Cultural and social aspects**

The media articles provided by the teacher included a range of cultural and social aspects as a consequence of the handling of the pandemic, such as increased violence towards children during home-schooling and mental health issues. In the group discussing risks for parents, a researcher asks if they have considered any risks. Chris starts by saying it is relatively easy to handle the pandemic and suggests that laws could regulate people's behaviour and that people who violate these could get punished. He declares: "If you say you get the death penalty if you walk out the door", indicating that if people just stayed at home, the virus would not spread. In Norway, relatively few were fined for violating COVID-19 regulations. On the contrary, many restrictions were encouraged rather than forced, basing restrictions on people's trust in authorities and their wish to contribute to the common good. This reflects a cultural and social aspect of Norwegian society. However, this careful approach was criticised in the media when the number of infected people increased. Chris' only concern seems to be to stop the pandemic without introducing other concerns.

As a response to Chris, Kari says she has read about some of the risks of home-schooling. She argues it will affect children because parents get strained during lock-down:

Kari: Some take the stress out by being violent to their children [...] primary students are less followed up by teachers [...] 1 of 3 parents was angrier at their children. It was more violence, and parents had anxiety, depression and stress symptoms.

Kari's argumentation challenges Chris "simple" solution that everybody should stay at home. She brings forward new perspectives, namely that if you impose people to stay at home, this can have severe consequences. The numbers are taken from one of the media articles her teacher has provided to support her argument. She further reflects on youth managing home-schooling better than children in primary school. Kari connects this to her and her peers' own reality and identity, as highlighted as relevant by Brunner et al., 2021, when making assumptions about real-world situations. Kari's critique of Chris' claim is partly supported by numbers and is related to humans' well-being and what is considered appropriate behaviour. She thereby draws on cultural and social aspects.

Later in the group discussion, Chris says:

Chris: I now think the problem is that it is hard to justify a choice if we do not have all the facts or know all the risks. If you compare them, which is most important if there is a great danger of many dying if we go for it? But it can have such big consequences. Then we have to find out which one weighs the most. And in that way, we can decide. But if we do not know all the risks, it can be very difficult.

Chris problematises the group discussion, including his previous claim. He critically reflects on decisions based on limited facts and knowledge of risks. Perhaps he still believes in a shut-down and penalties for leaving home without permission, but he realises there are competing concerns that must be weighted and with unknown consequences. Critical reflections on facts and uncertainties are essential in modelling, and when Chris uses his hands to visualise the weight of each risk, he communicates a model for decision-making. The pandemic is surrounded by uncertainty about facts and perceived risks, so Chris points to a highly relevant political aspect: what, how and who to choose.

Ingeborg raises concerns about mental health issues when presenting her group's findings in the plenary activity (from the psychologist group):

Ingeborg: Almost 40% between 16 and 25 year- olds state they are unhappy with life in the pandemic. About 1 of 3 Norwegians feel lonely during the pandemic. During spring 2020, there is an increase of 45% in pills against anxiety, depression, and insomnia.

Ingeborg uses mathematics-based language, emphasising numbers such as 40%, 45% and 1 of 3 when she presents the magnitude of concerns. Statistics is thereby used to critically reflect on a social issue. Her tone of voice is serious, and she keeps eye contact with her classroom peers. Later, in the plenary discussion, students continued to elaborate on mental health issues. For instance, Anna (from the student group) said: "It was rather lonely, really. They just said 'don't be with others, just stay home', and it came rather suddenly and we didn't get any information". She relates to the numbers expressing loneliness and voicing her own experience. Other students expressed it as important to be allowed to visit some friends during lock-down. In the plenary discussions, the teacher asks the students what they would argue as appropriate measures in society if they were decision-makers? Iris (from the nurse group) replies: "It is a bit difficult, but cohorts in schools are good because it keeps people apart, and at the same time, people don't need to develop anxiety and depression". When referring to mental health issues, she nodded towards the psychologist group, perhaps as a potential solution to the issues they described. She probably referred to cohort

regulation as a way to still have social relationships, basing this on personal experiences and a way of making social decisions based on values and using mathematical thinking as described by Hattori et al. (2021).

### **Economic and political aspects**

In the group discussing risks related to unemployment, Miriam says to her group members: “Many struggle and many borrow money to survive. Many have become unemployed due to the pandemic, and struggle with such strict measures”. Miriam uses the word “many” multiple times to emphasise the problem of unemployment. Because she has read articles presenting numbers on unemployment, “many” refers to these numbers and communicate that she is concerned about the economic aspect. The numbers have thereby contributed to pointing at risks as a result of restrictions. Miriam seems to have forgotten the specific numbers when Haavard asks curiously:

Haavard: Can you tell us a little about those who have lost their jobs?  
Miriam: Then I will find some numbers.

Miriam starts looking for numbers. In the following discussion, they use phrases such as “8% have difficulties”, “1 of 4 households are affected”, and “15% have no savings left”. There is a distinct move from the less precise “many” towards a mathematical-based language. They also give a more nuanced picture of what kind of struggles there are. The move to precise numbers is probably due to the task given by their teacher and that they are going to present their findings to the rest of the class. Miriam’s use of “many” can be regarded as her interpretation of the situation is severe.

They use both the Internet and the provided articles, which brings up conflicting numbers. In her initial search, Miriam found that 25% of household is economically exposed. A moment later, she exclaims, “Oh, no, sorry. Now I entered another website. This is from October tenth”. After examining together with Haavard, she continues: “So, 18%, or about 430 000 households, are still exposed. This is in December”. After some discussions, she concludes, “The number of economically exposed households has thus decreased”. The conflicting numbers resulted in critical reflections on the relevance and validity of the numbers in play, which are crucial in developing and considering statistics and mathematical modelling. It is also part of reading and writing the world and the world with statistics, as described by Weiland (2017). This focus on relevance related to updated statistics is seen when they later investigate the issue of people’s savings.

When asked if they had noticed any risks, Haavard replies: “It may be a bit odd saying this, but they risk starving to death. Honestly. Or, it’s unlikely, but they actually can”. So far, the discussions have focused on the number of people losing their jobs or struggling without reflecting on how this struggle could manifest. Now, Haavard is bringing up the risk of starving. Miriam adds, “But 5% need to borrow money for food”. As previously, she provides numbers to strengthen her argumentation. Although Norway has a fair welfare system, with no cases of extreme poverty, there is an increase in low-income families. Typically, people with low-income jobs took the biggest blow financially in the pandemic. The students’ focus on the risks of unemployment brings awareness to these aspects.

The economic consequences were later connected to political aspects. Miriam suggests that in their presentation, they should say that, “It will create inequality in society for a long time”. The issue of

long-term perspectives of inequality is new, and Haavard struggles to formulate Miriam's utterance on their PowerPoint slide. He asks her about it, and she reformulates: "This crisis can lead to bigger differences. And the economy can be destroyed. It will take a long time to recover". She focuses on inequalities and long-term perspectives. In their critical reflection on the consequences of measures, they do not explicitly connect and critique the nature of the numbers, statistics, or mathematical models themselves, as described by Barbosa (2009) and Blomhøj (2009). The topic of inequality and differences in society can, for some students, have strong proximity and for others be at a more distance. However, an awareness of this aspect is essential for all students. During their investigations and discussions about numbers and statistics of unemployment and people struggling economically in the pandemic, they have started to explore the important issue of inequality in society.

### **Concluding comments**

In this research, we have investigated students' discussion of the consequences of COVID-19 measures. The students develop a critical understanding of real-world problems through mathematics-based information by showing awareness of and discussing the measures' cultural, social, economic, and political aspects. Rosa and Orey's (2015) environmental and natural aspects might have been included in their discussion if other articles had been chosen for the students. For instance, more biological aspects of the virus or reduced CO<sub>2</sub>-emission due to less traffic and fewer flights. The cultural and social aspects in the students' discussions involved mental health issues and family violence during home-schooling. The numbers identified by the students represented mental health issues, which Anna, Iris and other students associated with feelings of loneliness. When students reflect on these problems with peers, mental health issues can be normalised and make them less challenging to discuss. The use of numbers showing the extent of people struggling with mental health issues during the pandemic may have contributed to forward discussions on this topic. Undoubtedly, the pandemic severely impacted the economic and political aspects of society. When governments closed restaurants, hotels, etc., and maintained strict travel restrictions, many people lost their jobs and income. Miriam and the other students started to explore some of the statistics and numbers related to loss of income and increasing inequality in society. Social inequality is a concern in critical mathematics education, and inequality seems to have increased during the pandemic (Borba, 2021).

Although students identified and used the numbers to discuss wicked problems and consequences of measures taken, most of the time, they did not critically question statistics or numbers in itself. Thus, implications of this research can be that teachers can have an important role by asking questions leading to such inquiries. They could encourage them to critically examine what is behind the numbers, statistics, and mathematical representation, what they consist of, sources, its use, and the consequences of mathematical application in society. Perhaps students could have made a model themselves to inform decision-making. Such a critical gaze can bring further awareness of the limitation of mathematics, but still how mathematics permeates wicked problems like the pandemic. Engaging students in these issues facilitates their understanding of different perspectives and as critical mathematical citizens. While this research is limited to a few students in a short



period, it provides insights into how students relate to mathematical argumentation during a time of crisis.

Other characteristics related to the student's discussions involved questioning, listening, investigating, and changing perspectives due to others' argumentation. They moved from giving simple solutions to wicked problems towards sharing more nuanced reflections like Chris did when reflecting on risk and potential measures. When society deals with wicked problems and decision-making, it is impossible to predict all consequences. At the beginning of the pandemic, concerns were raised about the capacity of health institutions, and mathematical representations heavily informed governments in their decision-making. Later, concerns for young children and mental health issues were given more significance. Other values came into play. When measures are implemented in uncertain times, it is crucial that uncertainty is conveyed and risks are presented openly to give citizens reason to follow given advice, as doubting the science behind COVID-19 can be fatal. However, wicked real-world problems need multi-disciplinary approaches where it is essential to consider cultural, social, economic, and political aspects, to understand the complexity of the problem and avoid misuse of information, mistrust and polarisation in society. Although other school subjects might have added perspectives and depth to the students' discussions, the activity shows that mathematics education has a vital role in involving students in investigating mathematics-based information in times of crisis, discussing aspects of their own reality.

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