

Studies on Mathematics Education and Society

# LANDSCAPES OF INVESTIGATION

CONTRIBUTIONS  
TO CRITICAL  
MATHEMATICS  
EDUCATION

EDITED BY MIRIAM GODOY PENTEADO  
AND OLE SKOVSMOSE



<https://www.openbookpublishers.com>

© 2022 Miriam Godoy Penteadó and Ole Skovsmose. Copyright of individual chapters is maintained by the chapters' authors



This work is licensed under an Attribution-NonCommercial 4.0 International (CC BY-NC 4.0). This license allows you to share, copy, distribute and transmit the text; to adapt the text for non-commercial purposes of the text providing attribution is made to the authors (but not in any way that suggests that they endorse you or your use of the work). Attribution should include the following information:

Miriam Godoy Penteadó and Ole Skovsmose (eds), *Landscapes of Investigation: Contributions to Critical Mathematics Education*. Cambridge, UK: Open Book Publishers, 2022, <https://doi.org/10.11647/OBP.0316>

Copyright and permissions for the reuse of many of the images included in this publication differ from the above. This information is provided in the captions and in the list of illustrations.

Every effort has been made to identify and contact copyright holders and any omission or error will be corrected if notification is made to the publisher.

All external links were active at the time of publication unless otherwise stated and have been archived via the Internet Archive Wayback Machine at <https://archive.org/web>

Digital material and resources associated with this volume are available at <https://doi.org/10.11647/OBP.0316#resources>

Volume 1 | Studies on Mathematics Education and Society Book Series | ISSN Print: 2755-2616 | ISSN Digital: 2755-2624

ISBN Paperback: 978-1-80064-821-0

ISBN Hardback: 978-1-80064-822-7

ISBN Digital (PDF): 978-1-80064-823-4

ISBN Digital ebook (EPUB): 978-1-80064-824-1

ISBN Digital ebook (AZW3): 978-1-80064-825-8

ISBN XML: 978-1-80064-826-5

ISBN HTML: 978-1-80064-827-2

DOI: 10.11647/OBP.0316

Cover image: Fall by Tara Shabnavard

Cover design by Anna Gatti

# 4. Bringing the Debate over Marijuana Legalisation into the Mathematics Classroom

*Agustín Méndez and  
Mario Sánchez Aguilar*

---

We describe a teaching experience that is based on the ongoing discussion about the legalisation of marijuana, which continues to be a hot topic in Mexico and Latin America. The teaching experience took place in a private teaching institution attended by upper-middle-class students, mainly from families with a conservative political inclination. The analysis of the teaching experience focusses on the types of reflections that were triggered among the students during its implementation, and the role of mathematics in such reflections. The results of the analysis show that some of the discussions that were triggered by this activity went beyond the walls of the classroom, involving students from other school grades or even their families. We think that this contribution may be of interest to mathematics teachers interested in practical activities inspired by the critical mathematics education perspective—particularly those that have been tried out in actual mathematics classrooms.

In this chapter we describe the implementation of a teaching activity for the mathematics classroom inspired by the perspective of critical mathematics education (Skovsmose, 2014). Our intention when

designing and implementing this activity was for students to look at problems in their social environment through mathematics. Thus, we decided that the focus of the activity should be a socially relevant discussion, and therefore we selected the issue of the legalisation of marijuana, which continues to be a hot topic in Mexico.

The teaching activity that we report on is far from being a traditional activity for the mathematics classroom. In addition to being a means to analyse a socially relevant issue, the activity supports students in performing inquiries and investigative work. In this sense, the activity that we present could be considered a *landscape of investigation* (Skovsmose, 2001).

A distinctive feature of the educational experience that we report here is that the teaching activity was implemented in a private educational institution attended by upper-middle-class students. Different conditions had to be in place in order to introduce these students—who were in comfortable positions in life—to a landscape of investigation where some of their ethical values were involved and challenged.

We present an analysis of the teaching activity, focussed on the types of reflections that were elicited among the students during its implementation, and the role of mathematics in such reflections. The results show that some of the discussions that were triggered went beyond the walls of the classroom, involving students from other grades and even students' families.

Before describing the teaching activity and its implementation, next we briefly review some of the notions from the critical mathematics education approach that served as a source of inspiration and theoretical support for the development of the activity. In particular, we refer to some concerns of this approach.

## 1. Some Theoretical Notions to Frame Our Work

The critical mathematics education (CME) approach is a theoretical approach within the field of mathematics education research that can be described in terms of its “concerns” or issues of interest. One of its main concerns is to provide students with a mathematical education that allows them to identify, judge and criticise the uses—and misuses—of mathematics in their own social settings. Under this perspective it is

intended that students use mathematics as a tool that enables them to analyse and criticise their own social reality. In particular, Skovsmose and Nielsen (2014, p. 1257) affirm that two of the concerns of CME are:

(a) Citizenship identifies schooling as including the preparation of students for being an active part of political life.

(b) Mathematics may serve as a tool for identifying and analysing critical features of society, which may be global as well as having to do with the local environment of students.

The teaching activity presented in this chapter embraces these two concerns. It is an activity through which students identify and analyse an issue that is socially relevant in their local environment, but also intersects with certain political interests and ethical values of the society to which they belong. An explicit and open discussion about these political interests and ethical values is a formative experience for students that introduces them to different worldviews and initiates them into the political life of their society.

As mentioned, the teaching activity presented in this chapter can be considered as a *landscape of investigation* since it allows students to abandon—at least temporarily—the exercise paradigm that usually predominates in their mathematics lessons. It introduces them to a scenario in which independent investigative work is promoted, as well as the elaboration of conclusions and the subsequent collective discussions.

According to Skovsmose (2001), there are at least three types of landscapes of investigation, which are distinguished from each other by the references they use to provide meaning to the activities they contain: (1) landscapes with reference to pure mathematics, (2) landscapes with reference to a semi-reality, and (3) landscapes with real-life reference. The teaching activity presented in this chapter is a landscape of investigation with real-life reference. Through this milieu of learning, students are introduced to the discussion of the legalisation of the recreational use of marijuana in Mexico. This is achieved by promoting among the students the inquiry, analysis and discussion of figures and official data on the production, distribution and consumption of marijuana in Mexico.

Another peculiarity of this landscape of investigation is the school context in which it was implemented: a private educational institution attended by upper-middle-class students. Skovsmose (2016) mentions

that, although this kind of student may not be subject to social risks—and may even directly benefit from social injustices and economic inequalities—a critical approach to mathematics instruction can help them develop a critical consciousness that supports them in deepening their knowledge and understanding of the socio-political contexts of their lives (p. 3). In this chapter, we empirically explore the gains that students in comfortable positions can obtain by engaging in a landscape of investigation within their mathematics lessons.

Another key notion in this work is that of *reflection*. Several scholars argue that reflection plays a fundamental role in the mathematical development of individuals. For example, researchers in line with the Piagetian tradition (e.g. APOS Theory, Arnon et al., 2014) underline the importance of reflecting on the actions that one applies to mental (mathematical) objects, to internalise them and thus achieve more robust levels of understanding. Reflection is also considered a crucial element in the professional development of mathematics teachers (Chapman, 2008).

CME conceptualises reflections as part of a collective endeavour embedded in dialogue and interaction. According to Alrø and Skovsmose (2002), reflection means considering at a conscious level one's thoughts, feelings and actions (p. 184). Furthermore, "reflections become an essential part of a developed literacy and it takes on a political dimension by addressing the broader context of the particular elements of learning" (p. 165). This broader context of the particular elements of learning is captured through the dimensions *scope of reflections*, *subject of reflections* and *context of reflections*.

Of special interest for our analysis is the *scope of reflections*, which refers to what is addressed in a reflection. For instance, when a group of students is collectively solving a mathematical task, they can reflect on the reliability of their calculations, on the usefulness of solving the task, or on whether they will have to solve a similar task in the next examination. In this study, we identify and categorise the scope of reflections that emerges when students are involved in a landscape of investigation focussed on analysing and discussing the legalisation of marijuana in Mexico. We were interested in discerning the extent of the reflections elicited by this landscape of investigation.

## 2. Design and Implementation of the Landscape of Investigation

An activity can only function as a landscape of investigation if the students accept the invitation for it to do so (Skovsmose, 2001, p. 125). “Accepting the invitation” means that students decide to get involved in the activity, because they find it interesting, attractive or somewhat relevant. We as teachers decided that the legalisation of marijuana in Mexico would be the focus of the activity. One of the reasons for placing the issue of marijuana legalisation at the heart of the activity was to encourage a larger number of students to accept the invitation. Marijuana legalisation is a controversial topic in Mexico that can be looked at from different perspectives: economic, ethical, medical, political, social, recreational, cultural, etc. We expected that this multifaceted and socially relevant problem would arouse the interest of the students, especially in the context of the mathematics classroom.

In order to achieve some distance from the exercise paradigm, the landscape of investigation was designed by the authors of this chapter (the first author was the class teacher) as an open, collaborative, investigation-oriented activity, which was implemented over several sessions. The activity was introduced to the students through a printed document that refers to the national debate on the use of marijuana, which took place in Mexico at the beginning of 2016. The document also refers to the bill by the former Mexican president, which was sent in April 2016 to the Senate of the Republic in order to allow the medicinal and scientific use of marijuana, as well as to permit consumers to carry up to 28 grams of the drug.

The activity is based on a role-play scenario where the students serve as “advisers to the Senate of the Republic” and provide a justified answer to the following central question: “Should marijuana be legalised in Mexico?” Additionally, students had to answer supplementary questions such as: “Economically speaking, what institutions and sectors of society would be affected by the legalisation of marijuana?” and “Does marijuana consumption depend on social class?” The role of the supplementary questions was to encourage the students to explore diverse angles of the legalisation issue, sometimes with the help of mathematics.

To provide answers to the posed questions, the students had to carry out an investigation and present a report. During the introduction of the activity, students were given some web addresses where they could find figures and data related to the national debate on the use of marijuana (for instance, <http://www.gob.mx/debatemarihuana>); however, they were free to draw on any other source of information in order to formulate their answers. At the end of the activity, the students had to submit their answers in the form of a written report to the Senate of the Republic. They were advised to include figures, tables and graphs as part of their report. Along with the report, students had to present their answers to their classmates and teacher. A more detailed account of the design of this landscape of investigation can be found in Méndez (2018).

The landscape of investigation was implemented between April and May 2017 in a private educational institution attended by upper-middle-class students. In particular, the activity was applied in a lower-secondary-school group consisting of thirty-two students: fifteen girls and seventeen boys, with ages ranging between fourteen and fifteen years old.

The landscape of investigation was developed as part of the regular mathematics lessons—ten sessions of fifty minutes each—although several students did investigative work outside of class time. Half of the sessions took place in the school's computer lab, with the aim of facilitating the search for information on the internet; the rest of the sessions took place in the mathematics classroom, though the students were free to use their mobile devices—such as smartphones and tablets—to support the inquiry process. During the first session, the activity was explained, and the students were provided with a printed copy of its guidelines.

The students were organised into eight teams of four members each. The idea was to integrate heterogeneous working groups based on their mathematics grades during the school year; that is, we sought to have teams composed of one high-achieving student, one low-achieving student, and two students with average levels of achievement. Students were familiar with this form of collective work, since it was a common way to form teams in their school.

It is important to note that, in order to achieve the implementation of this landscape of investigation, institutional and parental support were



both essential. The school principal had a supportive attitude towards the project; however, because the legalisation of marijuana is a sensitive issue for some students and their families, the principal requested written authorisation from the students' parents to allow their children to participate in the project, and to allow us to record their activity for research purposes.

### 3. Analysis of the Implementation

To infer the students' reflections that arose during the implementation and development of the landscape of investigation, empirical data from different sources were collected and analysed.

At the beginning of each session, one student from each work team was designated to audio-record the interactions and exchanges between the team members with a smartphone. At the end of the session, the students sent their recordings to the mathematics teacher via email, Google Classroom or WhatsApp.

In addition, the teacher who implemented the activity (the first author of this chapter) took field notes during all sessions. In these notes, certain reactions, comments, and questions that students asked during the sessions were recorded. The final presentations made by the students were also audio-recorded and their final written reports were collected for analysis.

Although the first author of this chapter led the implementation of the activity in the classroom, both authors were involved in the data analysis. The audio recordings underwent a tape-based analysis (Onwuegbuzie et al., 2009), in which we first became familiar with the data by listening to the audio recordings independently and repeatedly. Then, we discussed and identified the segments of the audio recordings where the students had reflected on the activity, and transcribed them in order to classify their scope and use the transcription as empirical evidence. It is worth mentioning that we only analysed the data from three randomly selected groups. Due to time constraints—this educational experience was developed within the time frame of a Master's degree—it was not possible to analyse the data generated by all eight groups.

## 4. What Kind of Reflections Emerged?

Our analysis of the data led to the identification of three categories of student reflections, each with a different scope: (1) ethical and moral reflections, (2) economic and political reflections, and (3) mathematical and technical reflections. As will be seen, these categories of reflections are not mutually exclusive, thus it is possible to identify intersections between some of them.

Next, we illustrate the students' reflections with transcripts taken from the activity dialogues and the final presentations. The students' names have been anonymised, and the transcripts translated from Spanish into English.

### 4.1 Ethical and Moral Reflections

These types of reflections emerged when students expressed certain values and norms regarding the consumption of marijuana. Some of these values could be considered "conservative", while other students provided alternative points of view that tended to challenge those positions or exemplify different possible scenarios:

*Student 1:* It is very easy to influence friends and family to use marijuana, especially adolescents [...] because teenagers always want to be just like their friends, and that is a very bad thing, since marijuana is what opens the door to more addictive and harmful drugs.

*Student 2:* Because marijuana itself is not so bad; what happens is that while you are stoned by the effect of marijuana, you might encourage yourself to try other types of drugs, which can be even more harmful.

*Student 3:* But one of the diseases that is controlled with marijuana is Parkinson's. Scientists at the University of São Paulo detected that the cannabis-derived substance cannabidiol could lessen the associated psychosis suffered by Parkinson's patients, such as reduction of tremors, anxiety, sleep disorders and depression.

### 4.2 Economic and Political Reflections

These reflections arose when students made reference to economic and political aspects associated with the legalisation of marijuana that affect local populations, the state, or the country in general. An example was

provided by a student, who pointed out that the country's economy would be very different if the money generated by drug trafficking was collected in the form of taxes:

*Student 4:* I believe that the economy of our country would be very different because the consumption of drugs and all the drug trafficking generates three hundred and twenty billion dollars per year [...] most of that comes from the consumption of marijuana. If that [money] instead of going to the drug traffickers was used as taxes, those taxes would be generated by the country and that would go into the GDP, so the country's gross domestic product would be better and it would benefit many people.

Another example is the students who addressed the issue of civil liberties:

*Student 4:* We should conclude that we must legalise marijuana because the state cannot deprive a country of its rights and freedoms. For this reason, [the state] cannot play the role of a father or try to say what is good or bad for the people [...] it is the people themselves who must know how far to go.

*Student 3:* It has become viral or popular to say that marijuana has many benefits in comparison to its negative effects [...] it is not very important to think about its pros or cons, what we must really think about is the role that we play as a society in exercising our rights and freedoms.

### 4.3 Mathematical and Technical Reflections

This kind of reflection was presented mainly at the end of the teaching activity. Although the students were advised to read articles in which data, numerical tables, graphs, and percentages were presented, only a few arguments emerged in which mathematics was used. Upon being explicitly questioned during their final presentation, two working teams declared that mathematical knowledge was not very necessary for travelling through this landscape of investigation.

*Student 4:* In this laborious investigation we have used mathematics in things such as, for example, statistics on how much money would be earned or lost with the legalisation of marijuana, and the surveys that are applied to find out the opinions of citizens about the subject.

*Student 5:* Well, the mathematical elements, I think they help us to know that, for example, drug trafficking generates three hundred and twenty billion dollars a year from different drugs and a quarter of that is thanks to marijuana. Then if that money did not belong to drug trafficking but was generated for the country, it would be a very different thing. Then the mathematical elements helped us to create an opinion that we will express later.

But after their inquiries and discussions, what were the students' responses to the main question: should marijuana be legalised in Mexico?

Most of the students thought that marijuana should be legalised; however, they also expressed some reservations. During their final presentations, the students highlighted advantages such as the medical potential of the herb, the economic benefits that legalisation would generate for the country, the economic weakening that organised crime would suffer, and the protection of consumers. However, the students also warned of dangers such as an eventual increase in drug use among young people and children:

*Team 4:* The benefits would be for people with diseases like Parkinson's. But this could affect the family environment, since children could learn to smoke, produce and even sell the product.

## 5. Gains and Lessons Learned: A Conclusion

The students who participated in this landscape of investigation had the opportunity to discuss and learn about a topic that is relevant to the society in which they live, and is significant for their future lives. In addition, by moving away from the exercise paradigm, the class was able to establish a forum where they listened to the opinions and positions of their peers on the subject, but also formed and expressed their own opinions based on the information examined and the collective interactions.

These students also expressed an interest—in some cases quite an unusual interest—in the mathematics lessons. The majority of the students engaged with the activity, carrying out a deep investigation of the topic, and even involving students in more advanced classes and their own relatives in their inquiries. It is fair to assume that some students

considered this type of approach to be interesting and engaging, thus fostering more positive attitudes towards the mathematics class.

Before implementing the teaching activity, we had reservations about the viability of its implementation in a real mathematics classroom. That is, we thought it would be very difficult to implement such an extensive landscape of investigation (ten sessions of fifty minutes each) during regular classes in a private school. Nevertheless, one of the lessons learned was that the implementation of this type of educational approach is possible, but that strong institutional and parental support is essential.

On a more critical note, we want to point out that it was not trivial to bring mathematical content into the discussions, arguments, and reflections of the students. Although we chose a topic of study that is surrounded by information expressed in different mathematical registers (percentages, graphs, numerical tables), students rarely used these resources in their arguments and reflections. In cases where students did make use of mathematics, it was limited to concepts such as arithmetic and statistics. This trend has been reported in similar teaching experiences (e.g. Frankenstein, 2010; Reaño, 2010), thus we think that it is an aspect that should be analysed in greater detail in future experiments framed in CME.

## References

- Alrø, H. & Skovsmose, O. (2002). *Dialogue and learning in mathematics education. Intention, reflection, critique*. Kluwer. <http://doi.org/10.1007/0-306-48016-6>
- Arnon, I., Cottrill, J., Dubinsky, E., Oktaç, A., Roa Fuentes, S., Trigueros, M. & Weller, K. (2014). *APOS theory. A framework for research and curriculum development in mathematics education*. Springer. <http://doi.org/10.1007/978-1-4614-7966-6>
- Chapman, O. (2008). Imagination as a tool in mathematics teacher education. *Journal of Mathematics Teacher Education*, 11(2), 83–88. <http://doi.org/10.1007/s10857-008-9074-z>
- Frankenstein, M. (2010). Developing a critical mathematical numeracy through real-life word problems. In U. Gellert, E. Jablonka & C. Morgan (Eds), *Proceedings of the sixth international mathematics education and society conference* (pp. 258–267). Freie Universität Berlin.

- Méndez, A. (2018). *Una aplicación de la educación matemática crítica para la clase de matemáticas*. Master's thesis. Instituto Politécnico Nacional de México.
- Onwuegbuzie, A. J., Dickinson, W. B., Leech, N. L. & Zoran, A. G. (2009). A qualitative framework for collecting and analyzing data in focus group research. *International Journal of Qualitative Methods*, 8(3), 1–21. <http://doi.org/10.1177/160940690900800301>
- Reaño, N. (2010). Racist beauty canon, natural beauty and critical mathematical education. In U. Gellert, E. Jablonka & C. Morgan (Eds), *Proceedings of the sixth international mathematics education and society conference* (pp. 130–133). Freie Universität Berlin.
- Skovsmose, O. (2001). Landscapes of investigation. *ZDM—Mathematics Education*, 33(4), 123–132. <http://doi.org/10.1007/BF02652747>
- Skovsmose, O. (2014). Critical mathematics education. In S. Lerman (Ed.), *Encyclopedia of mathematics education* (pp. 116–120). Springer. [http://doi.org/10.1007/978-94-007-4978-8\\_34](http://doi.org/10.1007/978-94-007-4978-8_34)
- Skovsmose, O. (2016). What could critical mathematics education mean for different groups of students? *For the Learning of Mathematics*, 36(1), 2–7.
- Skovsmose, O., & Nielsen, L. (2014). Critical mathematics education. In A. J. Bishop, K. Clements, C. Keitel, J. Kilpatrick & C. Laborde (Eds), *International handbook of mathematics education* (pp. 1257–1288). Springer. [http://doi.org/10.1007/978-94-009-1465-0\\_36](http://doi.org/10.1007/978-94-009-1465-0_36)