



The dominant model of meat production and consumption as a socially acute question for activist education

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Abstract

Public debate often centers on issues that affect our lives and which reflect interests of various social groups and scientific communities, leading to controversies about what we may call socially acute questions (SAQs). In this paper we focus on two SAQs linked to the dominant model of meat production and consumption in Western countries, namely its impact on the environment and the health problems associated with high-meat diets. Given the importance of education in relation to these SAQs, our main objectives here were to examine the extent to which a Cartography of Controversy (CoC) approach is a useful tool for exploring and visualizing the views and ideas of preservice teachers about the controversies associated with this model of meat production and consumption, and to compare their initial maps with our own, one that is informed by a more detailed socio-epistemological analysis. As a complement to this inquiry, we also present the *SAQ–Eating Meat* project, the aim of which is to encourage citizens to reflect on how food production and consumption may impact health and the environment, and then to take action toward change. In comparison with our own map, those produced by students did not reflect the full complexity of the controversies surrounding the dominant model of meat production and consumption, and some actants were missing. The results nevertheless suggest that a CoC approach is a useful way of engaging students with SAQs and that it offers them a framework in which to extend their inquiry and knowledge, providing a platform from which they may move toward taking action for change.

Keywords Socially acute questions · Cartography of controversy · Climate crisis · Non-communicable diseases · Meat

Resumen

Al debate público frecuentemente saltan problemas, que afectan a nuestras vidas, cargados de los intereses de diversos grupos sociales y científicos, es decir, surgen controversias sobre cuestiones socialmente vivas (Questions Socialement Vives, QSVs). En este trabajo se abordan de forma conjunta dos QSVs vinculadas al modelo dominante de producción y

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consumo de carne en los países occidentales: su impacto en el medio ambiente y los problemas de salud asociados a las dietas con alto contenido en carne. Dada la importancia de la educación en relación con estas QSVs, nuestros principales objetivos aquí fueron examinar hasta qué punto el enfoque de la Cartografía de la Controversia (CoC) es una herramienta útil para explorar y visualizar los puntos de vista y las ideas del profesorado en formación inicial sobre las controversias asociadas a este modelo de producción y consumo de carne, y comparar sus mapas de controversias iniciales con el nuestro, el cual está informado por un análisis socio-epistemológico más detallado. Como complemento a este trabajo, también presentamos el proyecto QSVconsumocarne cuya finalidad es el fomento en la ciudadanía de la reflexión sobre el impacto de los alimentos en la salud y el medio ambiente para posteriormente pasar a la acción. En comparación con nuestro propio mapa, los elaborados por el alumnado no reflejaban toda la complejidad de las controversias en torno al modelo dominante de producción y consumo de carne y faltaban algunos actantes. No obstante, los resultados sugieren que el enfoque de CoC es una forma útil de involucrar al alumnado en preguntas frecuentes y que ofrece un marco en el que ampliar su indagación y conocimiento, proporcionando una plataforma desde la que pueden pasar a la acción para el cambio.

Important issues that affect people's lives and which reflect opinions and vested interests of different groups frequently emerge in society. When these issues involve controversies that are constantly referred to in the media and social networks, they are known as socially acute questions (SAQ). This term derives from the French *questions socialement vives*, where the qualifier *vive* means acute (Legardez and Simonneaux 2006). The dominant model of meat production and consumption in Western countries is associated with a number of SAQs. Meat is a key component of contemporary food systems, but there are now widespread calls for these systems to be more ethical, healthy, equitable, and sustainable (Freudenberg and Nestle 2020). Furthermore, this dominant model of meat production has been shown to be vulnerable during the Covid-19 pandemic (Kevany 2020), and concerns have been raised about its role in current and future zoonoses (Spinney 2020). It is also notable that younger generations are increasingly moving toward meat-free or meat-reduced diets (Bryant, van Nek and Rolland 2020). The importance that is now ascribed to these issues is reflected in the growing attention they are receiving in both traditional media and social networks (Peiró 2020).

Our focus in this paper is on two SAQs linked to the dominant model of meat production and consumption in Western countries, namely its impact on the environment (e.g., loss of biodiversity, water pollution) and the health consequences of high-meat diets (e.g., cardiovascular disease). Hereinafter, these issues will be considered as a single SAQ.

The way in which we respond to these environmental and health challenges, including through science and technology, will be crucial to the future of our societies, and this presents citizens with numerous opportunities to assume responsibilities (personal and social) and to take action, both individual and collective (Hodson 2003). In order to do so, however, they need to be well informed about all the factors that may be driving these challenges, as well as about the behaviors and attitudes that might reduce their impact. As Benjamin Lester, Ma, Lee and Lambert (2006) noted some time ago in relation to the greenhouse effect and global warming, these are issues that require a deep understanding of basic scientific concepts, but they also offer ample opportunities for social activism. Accordingly, proponents of activist education see the science classroom as both a context and a pretext for bringing about change, whether social, political, economic or environmental (Alsop and Bencze 2009). This implies

taking purposeful action with the aim of changing society, for example, by creating informative websites, writing to newspapers, organizing petitions and community meetings, making public statements, putting up posters or handing out leaflets, or organizing demonstrations, etc. (Hodson 2014). However, citizens must not only learn to assume responsibility and act personally in response to social problems but also know how to influence the behaviors of others, including friends, local political representatives, relatives, neighbors, and local shopkeepers, etc. (Hodson 2014). With these goals in mind, and in the context of science education, projects such as *We Act* (Reis 2014) and STEPWISE (Science and Technology Education Promoting Wellbeing for Individuals, Societies, and Environments) (Bencze 2017) seek to go beyond traditional classroom learning and transfer ideas and actions to society.

Inherent to the SAQ of the dominant model of meat production and consumption are many science topics and almost all aspects of the current environmental crisis (causes of global warming, the contamination of soil and both surface and subterranean water, the use of drugs in livestock farming, etc.), not to mention a range of health, economic, political and ethical problems. By addressing these topics and problems, therefore, it is possible to raise people's awareness and prepare them for activism informed by science and technology (Bencze and Alsop 2014). It should also be remembered that health and the environment are contexts close to students' interests and needs (Zeyer and Dillon 2014), and they thus provide an opportunity to link science education to personally relevant questions (Blanco-López, España-Ramos, González-García and Franco-Mariscal 2015). In doing so, educators may draw on several interconnected approaches such as science, technology, society, and environment (STSE) (Pedretti, 2003), controversies (Kelly 1986), socio-scientific issues (Zeidler 2014), SAQs (Legardez and Simonneaux 2006; Simonneaux and Legardez 2011), and activism (Bencze and Alsop 2014). Mention should likewise be made of the Cartography of Controversy approach (Latour 2007), which is a useful way of visualizing complex social phenomena such as SAQs. This approach derives from actor-network theory (e.g., Callon, Rip and Law 1986; Latour 2005), the aim of which is to characterize how *actants* (human and/or non-human actors) interact and have an impact within a given network.

Taking into account all of the above, our main objectives in this paper are to examine the extent to which a Cartography of Controversy approach is a useful tool for exploring and visualizing the views and ideas of preservice teachers about the controversies associated with the dominant model of meat production and consumption, and to compare their initial maps with our own, one that is informed by a more detailed socio-epistemological analysis. As a complement to this inquiry, we also present details of an ongoing project aimed at promoting citizen action through increased awareness of the impacts that food systems are having both on the environment and on people's health. The project seeks to use various channels of dissemination and participation (websites, social networks, etc.) in order to link formal, informal, and non-formal education on this issue, focusing on its causes and the actors involved so as to bring about change (Hodson 2014).

Delimitation and analysis of the SAQ

A food system consists of a set of actors and the inter-related activities they perform with the aim of feeding the population. These activities include methods of production (planting and harvesting crops, livestock rearing, etc.), processing and packaging, transport and distribution, retail, preparation and consumption of food, and waste management. Food systems may be local, regional or global. Whereas local and regional

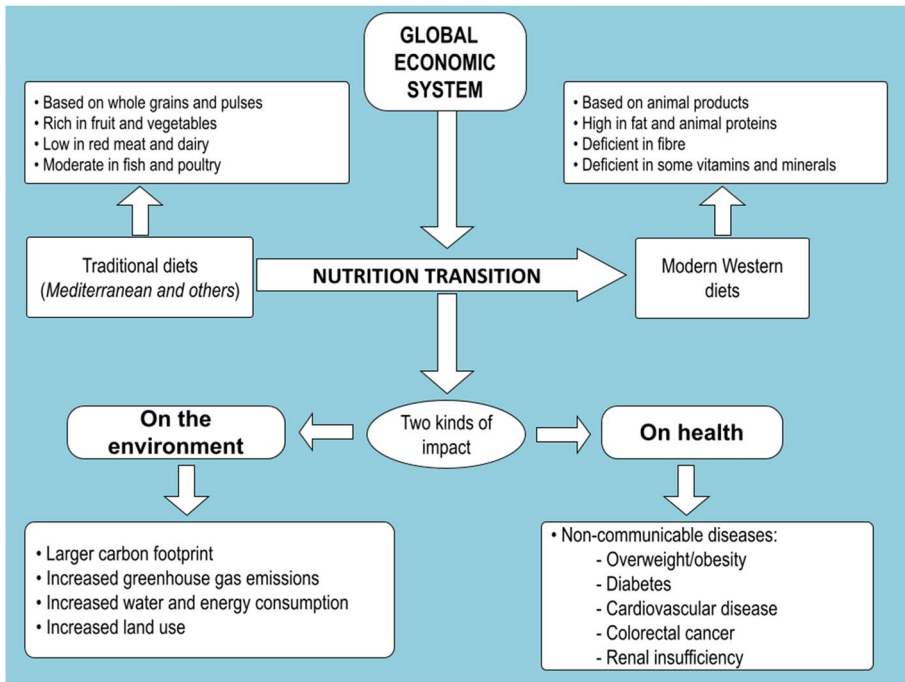


Fig. 1 Representation of how dietary changes have given rise to the SAQ addressed in this paper (Source: Authors)

systems generally reflect the traditions, cultures, economic structures, climate, and ecosystems of a particular area or country, the dominant system in our globalized world has emerged from the deregulation and neoliberal policies which have become hegemonic in recent decades, and in this respect it reflects the power wielded by the large corporations that dominate the market and whose primary aim is to maximize profits.

Notably, the dominant food system is characterized by the consumption of large quantities of natural resources such as water (Molden 2013), land, and energy (Poore and Nemecek 2018), resulting in loss of biodiversity and contributing significantly to climate change. In addition, the increasing reliance of many countries on ultraprocessed foods (Monteiro, Cannon, Lawrence, Costa Louzada and Pereira Machado 2019) implies long supply chains from source to processing sites to consumers, and this is associated with pollution and unnecessary food waste; furthermore, the way in which these foods are advertised and marketed encourages overconsumption, a consequence of which is the rise in non-communicable diseases (Springmann, Godfray, Rayner and Scarborough 2016). Indeed, the growth of this food system, which is often the beneficiary of significant public investment and resources (Lazarus, McDermid and Jacquet 2021), has generated serious health problems and is one of the main drivers of environmental degradation worldwide (Fig. 1).

Regarding health consequences, over 2 billion people globally are now overweight, although over 800 million individuals remain undernourished and about 2 billion suffer from micronutrient deficiencies (FAO and WHO 2019). Importantly, it is estimated that dietary risks were responsible for 11 million deaths in 2017 (Afshin, Sur, Fay, Cornaby,

Ferrara, Salama, Mullany, Abate, Abbafati, Abebe, and Afarideh 2019), more than any other individual factor. More specifically, research has linked high consumption of red and processed meat to an increased risk of various non-communicable diseases such as diabetes, cardiovascular disease, and several types of cancer (Bouvard, Loomis, Guyton, Grosse, El Ghissassi, Benbrahim-Tallaa, and Straif 2015). As for the environment, the global industrial food system accounts for a quarter of greenhouse gas emissions and occupies around 40% of the Earth's ice-free land area; agriculture alone is responsible for roughly 70% of freshwater withdrawals worldwide and relies on fertilizers that disrupt the nitrogen and phosphorus cycle and cause water pollution through runoff (FAO and WHO 2019). These figures illustrate how the way in which food is produced, consumed, and wasted has a major impact on the health of both people and the planet (Willett, Rockström, Loken, Springmann, Lang, Vermeulen, and Jonell 2019). A transition to more sustainable food systems is therefore urgently needed if we are to achieve the UN's Sustainable Development Goals (SDGs).

A key feature of today's industrial food system is its capacity to produce large amounts of animal-based foods (meat and dairy) while keeping costs low. This has been achieved through several means:

1. Rearing fast-growing breeds of animals.
2. Large-scale production of crops (often genetically modified) to provide the raw materials for cheap animal feed.
3. Proliferation of Concentrated Animal Feeding Operations (CAFOs) that house thousands of animals.
4. Establishment of large, highly mechanized slaughterhouses.
5. Dedicating large sums of money to advertising campaigns across a range of media platforms.
6. Receipt of substantial government subsidies.

The CAFOs, defined as facilities in which over a thousand animals are housed and fed in a confined space for at least 45 days a year, are particularly important here. These industrial-scale farms, which were developed with the aim of reducing the cost of livestock rearing, have several controversial implications:

1. They produce enormous amounts of waste.
2. They contribute to climate change due to methane production by cattle.
3. They cause air and water pollution.
4. They promote the emergence of antibiotic-resistant micro-organisms.
5. They often fail to respect the labor rights of workers.
6. They do not respect animal welfare.
7. They harm rural communities.

There appears, however, to be a lack of public awareness about the negative consequences that high levels of meat consumption have for human and planetary health (Marinova and Bogueva 2019), not to mention misconceptions about the environmental impact of different diets (Brocos and Jiménez-Aleixandre 2020) and reluctance among consumers to reduce meat consumption for the purpose of environmental sustainability (Austgulen, Skuland, Schjøll, and Alfnes 2018). Furthermore, there are several important obstacles to reducing meat consumption:

- The centrality of meat in family, social and cultural traditions and its associations with status, masculinity, and a sense of strength and health.
- The ability of the meat and dairy industry (hereinafter, the meat industry) to respond with intense advertising campaigns and lobbying when it perceives that sales and profits may be affected.
- Research studies that are funded by the meat industry with the aim of giving scientific backing to the benefits of meat eating or challenging the wider consensus regarding its negative impacts, with the results of these studies forming the basis of advertising and media campaigns. In some cases, lobbying by the meat industry has succeeded in changing official dietary recommendations so that they do not undermine sales.
- Finally, a defining feature of neoliberal policies is to provide economic support to large corporations, whether through subsidies, tax exemptions or deregulation.

Alongside these attempts by the meat industry to promote consumption, guiding principles for sustainable healthy diets have been drawn by international organizations (FAO and WHO 2019), and there have been several calls to create a healthy, equitable, and sustainable food system (Freudenberg and Nestle 2020). Mention should be made in this context of a recent report by the EAT-Lancet Commission, a consortium of 37 nutritionists, ecologists, and experts from 16 countries (Willett, Rockström, Loken, Springmann, Lang, Vermeulen, and Jonell 2019). The report proposed a flexitarian reference diet for planetary health that aimed to meet three objectives: to provide a healthy diet for an estimated global population of 10 billion people by 2050; to reduce the incidence of non-communicable diseases and overall mortality due to current Western diets; and to increase environmental sustainability so as to prevent the collapse of systems that will occur if changes of this kind are not implemented.

It is important to bear in mind that the dietary changes required will imply doubling global consumption of fruit, vegetables, nuts, seeds, and legumes, while reducing meat and sugar consumption by half (meat would play a greater role in those regions where sufficient nutrients cannot be obtained from other food sources). Moving toward such a diet could reduce food's land use by 76%, including a 19% reduction in arable land, while greenhouse gas emissions would fall by 49% (Poore and Nemecek 2018). The alternative is stark. If, as predicted, the world's population continues to rise and more people follow a Western-style diet, the production of meat, dairy, and eggs would need to increase by about 44% by 2050 (Vaidyanathan 2021), something that is beyond the bounds of possibility for our planet.

How citizens in Western societies respond to the need to reduce current levels of meat consumption will be a key factor in determining the extent to which we are able to tackle many of the environmental and health challenges that humanity is now facing. Science can inform and provide the data, but this alone seems insufficient to drive behavior change (Austgulen, Skuland, Schjøll and Alfnes 2018). Individual values also come into play, and the decisions of policy makers will be influenced by the social, economic, and political implications of change. Clearly, then, this is a socially acute question that, despite already being a topic of debate in the media, parliamentary, and academic spheres, cannot be resolved by experts alone. Indeed, all of us as citizens have a role to play, as what is at stake is our daily diet.

Controversies associated with this SAQ

The analysis of the dominant model of meat production and consumption in Western countries, which must be seen against the backdrop of agreed measures for tackling climate change and a sharp projected rise in the world's population by 2050, is a SAQ involving numerous controversies, among which we consider the following to be noteworthy:

- Although the consensus among the majority of scientists (Mbow and Rosenzweig 2019) is that a third of greenhouse gas emissions are attributable to the dominant food system, with the meat and livestock industry in particular accounting for a high proportion, there are some scientists with closer ties to the meat industry who argue that the figures are exaggerated (Place and Mitloehner 2021). Accordingly, some reports in the media (e.g., Sorman 2018) continue to suggest that controversy persists among scientists.
- Alongside this, media reporting about vegan diets frequently raises controversies about their nutritional balance, leading major professional bodies (American Dietetic Association 2003) to clarify publicly that these diets, if planned correctly, are nutritionally appropriate and beneficial in terms of preventing certain diseases.
- Lobbies and pressure groups with links to the powerful meat industry are capable of acting quickly and effectively to prevent the public from gaining full access to information that might undermine the sector, whether in relation to health (Rejón 2016) or climate change (Mitloehner 2017). They also maintain an active presence in certain political spheres so as to promote policies that are economically beneficial to the industry (Spanish Ornithological Society and World Wildlife Fund Spain 2010). This highlights the inter-relationships between actants in the controversies surrounding the impact of the meat industry on climate and health.
- In the political and economic context of the past decade, Spain has witnessed a proliferation of factory farms (Bayona 2019), generally involving pigs, in depopulated rural areas with high unemployment. This model of intensive meat production, which is presented by some economists and politicians as an example of dynamic enterprise, is based on mass consumption and cheap production, mostly for export (Romero 2018), and it creates low-quality jobs while having an enormous impact on water resources in the region concerned (Bayona 2019). The controversy here concerns the implications that these intensive production methods have for human and planetary health.
- The symbolic value that societies in the West attach to meat as a food (Rozin, Hormes, Faith and Wansink 2012) produces strong disagreements between strict vegetarians and omnivores (Allen, Wilson, Ng and Dunne 2000). The positions of the former (Joy 2010) have been strengthened over the past decade through a growing animal rights and welfare movement (Lymbery 2014) and the increasing popularity of veganism (Parker 2018).
- There is also an ethical controversy around whether it is acceptable to raise and slaughter animals for food, especially if they suffer in the process: some people argue that doing so is not necessary for our survival, and hence it is morally unjustifiable. The moral argument of people who refuse to eat meat has been bolstered recently by the fact that eating meat, at least in the quantities typical of Western societies, is not sustainable. Although the majority of people remain unpersuaded by these arguments, they appear to have gained traction among younger generations, who are increasingly supportive of vegetarian and vegan diets.

Proposed alternatives

There now appears to be a growing consensus around two issues (Willett, Rockström, Loken, Springmann, Lang, Vermeulen and Jonell 2019):

- Current food systems must be replaced with ones that do not pose a risk to people's health and the planet.
- Global adoption of the kind of diets recommended by nutritionists due to their demonstrated benefits (e.g., the Mediterranean diet) would have an important positive impact on health and contribute decisively to the sustainability of a new food model capable of feeding a human population that is expected to reach 10 billion by 2050.

The goal is not that everybody becomes a vegan but that we reduce significantly the quantity of animal-based products that many of us now eat. At the scale of the food system, this also implies changing our models of production, transformation, and marketing, as well as an acceptance that less consumption will be beneficial for both human and planetary health. It is worth considering, for example, that the traditional Mediterranean diet of the 1960s included just 35 g per day of red meat and poultry combined (Kromhout, Keys, Aravanis, Buzina, Fidanza, Giampaoli, and Pekkarinen 1989), although 50 years later the Spanish population was consuming twice this amount (Del Pozo, García, Cuadrado, Ruiz, Valero, Avila, and Varela 2012). It is in this context that the aforementioned report by the EAT-Lancet Commission (Willett, Rockström, Loken, Springmann, Lang, Vermeulen, and Jonell 2019) proposes that a daily intake of 43 g of red meat and poultry combined could form part of a Great Food Transformation that would support environmental sustainability (see Fig. 2 for comparative data regarding actual and recommended meat consumption). Mention should also be made here of the emerging controversies around suggestions of cultured—and, in some cases, 3D-printed—meats to overcome many social and environmental problems linked to animal husbandry (Jönsson, Linné, and McCrow-Young 2019).

Although these proposals might seem hard to implement, they are believed to be achievable through a combination of education, taxation, subsidies for plant-based foods, and changes to school and workplace menus. It should also be noted that movements aimed at reducing meat consumption (Meatless Monday 2011) or which call on governments to take urgent action to address global warming and climate change (www.fridaysforfuture.org, School Strike 4 Climate, Youth 4 Climate) are increasingly popular among—and driven by—young people.

Addressing this SAQ from the field of education

Although food, health, and the environment are topics that have been widely addressed in the educational field, it is only more recently that attention has been paid to the relationship between them (Campbell-Arvai 2015). Doing so offers students an opportunity to engage positively with environmental issues and their personal health, while for science educators it is way of expanding learning objectives to include critical thinking and reflection on the problems humanity is facing and to consider aspects such as social justice and environmental values, rather than focusing solely on the acquisition of science and technology knowledge and skills considered useful within capitalist societies. According to Léonie Rennie

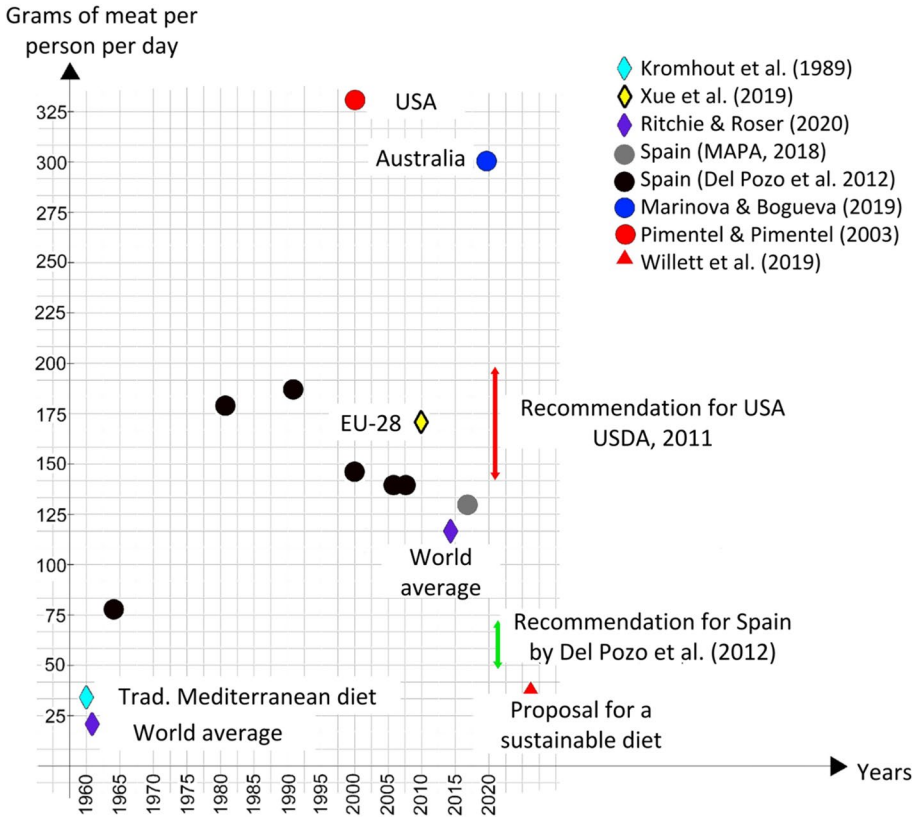


Fig. 2 Comparison of meat consumption (or recommended consumption) in different years and countries (Source: Authors)

(2006), the goal of science education is that students become interested in and engage with discourses of and about science, are able to identify questions and draw evidence-based conclusions, are skeptical and questioning of claims made about scientific matters, and are capable of making informed decisions about the environment and socio-scientific issues that impact their lives.

In terms of how these goals may be achieved, a recent study by Christodoulou, Levinson, Davies Grace, Nicholl and Rietdijk (2021) shows how a Cartography of Controversy (CoC) approach can fulfill different educational purposes depending on where in the learning process it is employed. Specifically, these authors illustrate how the task of mapping a controversy may be framed to familiarize students with an SAQ, to allow them to explore it in greater depth, or to consolidate the understanding and knowledge they have acquired. Regardless of how the task for students is framed, it is essential that their teachers have previously conducted a more in-depth socio-epistemological analysis of the SAQ (Simonneaux and Legardez 2011) so as to provide a reference with which to compare the maps produced by students.

In the next section of this paper, we describe two experiences that illustrate how the CoC approach may be applied. The first concerns the development of an activist education project based on our socio-epistemological analysis of the controversies surrounding

meat production and consumption. The second involved using cartography as a familiarization task with two groups of preservice teachers so as to explore and visualize their views and ideas about this SAQ. Accordingly, students were introduced to the idea of mapping a controversy and identifying actants, but they were not given specific information about the SAQ or asked to conduct their own more detailed inquiry into it; the aim was merely to obtain a visual representation of their initial ideas by getting them to produce a map showing the network of actants they considered to be involved, and the relationships between them. Simonneaux (2020) similarly describes an abbreviated version of the CoC approach in which students merely have to draw up a map of a controversy. The next step would obviously be for students to engage in a more in-depth inquiry, revising and/or building on their initial maps as they acquire more knowledge and consolidate their learning.

An activist education project: SAQ–Eating Meat

Within the context of our group’s research on teaching science and competences (ENCIC), (<http://encic.es/>) we decided to address the controversies surrounding the dominant model of meat production and consumption in Western countries through a project, currently ongoing, aimed at encouraging citizens to reflect on the environmental and health implications of this model (Zeyer and Dillon 2014), and then to take action toward change.

The project has the following objectives:

- Investigate the impact that the dominant model of meat production and consumption in Western countries has on the environment and health, and map the controversies (Latour 2007) it generates.
- Build a website that can be used by citizens to analyze this problem of vital importance and which allows them to participate in debates on the subject, the aim being to encourage them to engage both personally and collectively with the problem and take decisions that contribute to solving it.
- To explore whether incorporating the results from the mapping of controversies into teacher training programs would facilitate further reflection among students and provide a platform for an activist approach to science education.
- Familiarize both qualified and preservice teachers with the idea of mapping controversies (Hervé 2019), a tool of enormous utility for describing and analyzing the debates that emerge in response to SAQs.

Stage 1: Developing an atlas of the SAQ

Drawing on the approach described by Tommaso Venturini (2010), we conducted a socio-epistemological analysis of the SAQ (Simonneaux 2014) and developed an atlas comprising a map of the controversies (Latour 2005, 2007) it generates, a database, a glossary, and a timeline.

Mapping controversies

The CoC approach comprises the following steps: (1) Choice of a SAQ, (2) Identification of the actants involved in the SAQ and their spheres of influence (the poles of the map),

(3) Locating actants at each pole, and (4) Identification of possible relationships between actants.

Latour (2005) emphasizes that all actants must be given due consideration, and accordingly we consulted a wide variety of source documents in order to identify the actants involved in this SAQ. Most of these documents were published in Western countries in the period since 2018, although our database (Our database comprising over 270 publications can be accessed here: <https://t.ly/cMus>) also includes some material from previous years. To ensure that all relevant voices were heard, the database was built by considering the scientific literature, news articles, interviews, statistics, archive material, documentaries, and videos. It should also be noted that, as recommended by Venturini (2008), the team behind the project (the authors of this paper) includes experts in the fields of interest (i.e., human food systems and environmental education), who gathered the data, as well as an expert in visualization, a webmaster, and a project manager.

The map of controversies was created using *Draw.io*, a software application able to produce conceptual maps which can be uploaded and synced with cloud platforms such as Google Drive, thus enabling the map to be shared with and edited by multiple users, while also saving a version history. The use of this platform also allowed us to create a document in web format (HTML) that could be hosted on the project website, thus enabling the map of the SAQ to be constantly updated, whether through the addition of new actants, new relationships between them or new publications of relevance.

This approach allowed us to establish key actants and the relationships between them, as well as aggregations of actants that, in defending their own interests, collaborate with one another to preserve the interests of major social powers. These temporal aggregations of actants, which we labeled in accordance with the terminology used by other authors (Nédelec and Molinatti 2018), reflect a translational model of power (Latour 1984), and due to their heterogeneity and capacity to shape, control, and secure the gestures, behaviors, opinions or discourses of living beings, they may be considered an example of what Foucault (2008) calls *dispositifs* (apparatuses). From this perspective, science education may contribute to the social analysis of this SAQ by examining controversies associated with it and raising awareness to prepare students for activism. The four poles in our proposed map of the SAQ (Fig. 3) were as follows:

- The Political. Here we find the various governments and parliaments whose laws and regulations establish the rules which govern meat production and consumption. In the case of the European Union, an important actant is the Common Agricultural Policy, which, through the enormous subsidies it distributes, promotes certain activities and hampers others.
- The Economic. This pole is associated with the actants responsible for livestock farming (intensive and extensive), the meat industry, advertising, and financial institutions (banks and insurers). Lobbies and pressure groups are also located here.
- The Scientific. This pole is defined by scientific activity, whether in relation to health and nutrition or the environmental sciences.
- The Sociocultural. Here we find those actants with a sociocultural relationship to the question, for example, the green and animal rights movements, vegetarians or supporters of meat eating.

It is seen in Fig. 3 that the actants featured on the map include governments and other international agencies, meat producers, consumers, business sectors whose livelihood depends on food consumption, and various organizations and associations whose influence

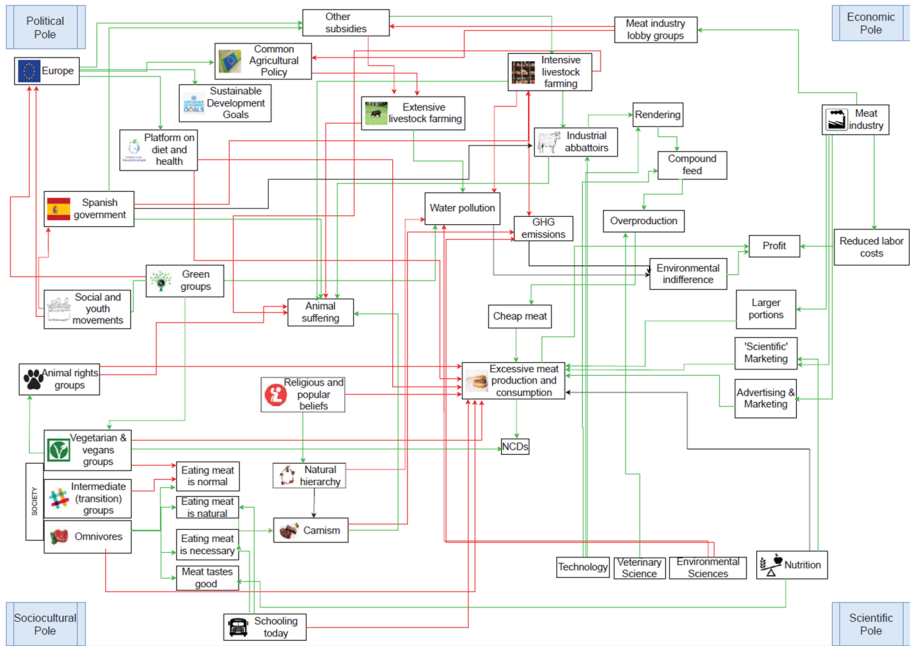


Fig. 3 Proposed map of the SAQ. Version developed as of 21/07/2020

on meat eating impacts directly on the environment, human health, animal welfare, and overconsumption of meat. The relationships between actants are indicated by means of arrows, which are either green or red depending on whether they support or challenge, respectively, the behavior of the actant at which the arrow is pointing. The black arrows indicate a relationship that may support or challenge the actant indicated. The specific location of each element on the map depends on the number of spheres (poles) in which its activity takes place; the closer an element is to a given pole the more of its activity is carried out in that sphere.

Based on our initial analysis of the SAQ, and drawing on actor-network theory (e.g., Latour 2005), the criteria for deciding which actants to include in the map had to do with their role in the network, that is to say, whether or not they modified in any way the course of events and the relationships between the other actants at this time. An important aspect in the creation of these networks is that any action by an entity that forms part of the network produces a change in it. As Venturini (2010) put it: “consider any controversy and you will have a clear illustration of the meaning of the hyphen in Actor-Network Theory. In controversies, any actor can decompose in a loose network and any network, not matter how heterogeneous, can coagulate to function as an actor” (pp. 261–262). It is this dynamic quality that accounts for the hyphenated name of the theory: Actor-network.

The map shown in Fig. 3 represents (as indicated in the figure legend) our view of the SAQ at a particular point in time, and thus it should be considered an approximation to this complex set of issues. Indeed, one of the characteristics of the map is its provisional nature, because the analysis of the problem is ongoing, insofar as it concerns a SAQ. New research, reports, and opinions will emerge, and they will no doubt oblige us to reconsider some of the elements that currently feature in the map (e.g., identification of new actants,



Fig. 4 Screenshot of the homepage of the website *Eating Meat: A Socially Acute Question (SAQ)*

inclusion of new relationships between actants and/or modification of existing ones, etc.). These changes may originate from within the research group responsible for creating the map or be the result of contributions and/or collaborations with others who participate in the project through the tools described below.

The database

The atlas of this SAQ includes an open database that is continually being updated. It includes academic documents (research articles published in scientific journals, reports by official bodies, statistics, etc.), news articles, audiovisual material (documentaries, short and full-length films, etc.), interviews, etc. For each document (entry) we provide a reference, a web link for accessing the document and/or where more information can be obtained, a brief explanation of its relationship to the SAQ, and a list of the actants implicated in the document.

The glossary and timeline

The atlas also includes a glossary of terms designed to facilitate understanding of the controversy and public participation in the project. The terms are ordered alphabetically in Spanish, along with their corresponding English translation. Another feature of the atlas is a timeline of the controversy that references important milestones (historical events and/or persons) which have shaped this SAQ up to the present day. Each entry along the timeline is accompanied by an image and a link.

Stage 2: Building a website as an action linked to this SAQ

Meeting the project objectives described above requires a platform for action that enables citizens to contribute to the analysis of this SAQ and propose solutions to the problems it involves. To this end, we have created the following website: <https://consumocarne.qsv.encic.es> (Fig. 4).

The primary goals of the website are to provide citizens with access to resources that can increase their knowledge, understanding, and ability to analyze the issues involved, and to give them the opportunity to take part in the debate. This includes inviting them to modify the map of controversies based on their own knowledge, whether existing or acquired through engagement with the website. The idea is that this will encourage them to engage both personally and collectively with the problem and take decisions that contribute to solving it.

Because the website is meant to be a space that can help to transform public debate and promote democratic participation, it has specific information and discussion sections aimed at the general public. However, it also offers resources for addressing this SAQ in the educational context. Specifically, the "In Education" tab includes links to publications, experiential activities carried out to date, and proposals for addressing this SAQ with students. All visitors to the website (whether teachers or members of the public) can collaborate with the project through the "Get Involved" tab, and our aim is that this space becomes a virtual forum for debate and discussion on this SAQ. There is also the option of participating via Facebook and Twitter.

Stage 3: Actions in the context of education (formal, informal, and non-formal)

The considerable educational interest in observing and describing controversies led Latour and coworkers to design a series of techniques and devices for exploring these debates in all their complexity, and in such a way that they could be visualized. The approach they developed to mapping controversies has since become an entire method of inquiry (Venturini, 2010). In the educational field, however, Hervé (2019) has highlighted three difficulties that teachers encounter with this method, and which reflect some of the challenges associated with teaching SAQs: Studying controversies is time-consuming (as much as a whole semester), students may have an insufficient level of skills and knowledge, and teachers feel they lack training to teach controversies. Shorter routes to the analysis of SAQs are therefore required, although Venturini (2012) considers that the endpoint should always be the creation of a website where students can host the maps and material they have used and developed in the process of exploring and describing the controversy.

The website we developed seeks both to connect people to the problem of eating meat through social networking and also to provide teaching material for formal education. The content of the site is dynamic and is constantly being updated through the contributions of our research group and of volunteers who upload material of scientific and educational relevance to the controversy. The map of the controversy that we have created also serves as an example that can be used as the starting point for creating new maps of this or other SAQs.

Using the CoC approach to explore the initial views and ideas of preservice teachers about the dominant model of meat production and consumption

The work conducted so far on this project has fed into a number of experiential activities that we have carried out with preservice early childhood and high-school teachers at the University of Malaga (Spain) (Cabello-Garrido, Cebrián-Robles, Cruz-Lorite, González-García, and España-Ramos 2021). From an educational perspective, the aim of these activities was to introduce students to the idea of mapping controversies as a tool for analyzing complex social problems prior to taking action. In addition, and from a research perspective, we wanted to learn more about their existing mental maps of this SAQ by asking them to map the controversy, after which their responses could be compared with the map drawn up by the research team. The idea here is that discussion of differences between the maps can shed light on and bring into focus previously hidden aspects of a complex social problem (Latour 2005).

The activity with preservice early childhood teachers involved a total of 103 students corresponding to two class groups (of 51 and 52 students, respectively), all of whom were currently enrolled in the same *Teaching Natural Sciences* module of their degree program. All these students were women and were aged between 20 and 28 years. The aim of the activity was to explore their existing views and ideas about the dominant model of meat production and consumption in Western countries and to introduce them to the CoC approach as a way of exploring the controversy. Accordingly, the cartography was framed as a familiarization task (Christodoulou, Levinson, Davies Grace, Nicholl, and Rietdijk 2021), and students were not given any information or instruction related to the controversy prior to producing their map, nor were they asked to conduct their own inquiry before doing so. Due to restrictions imposed in response to the Covid-19 pandemic, this activity was conducted online using Google Meet and the Miro (miro.com) online whiteboard, with parallel sessions being run for each of the two class groups. Students were first asked to list, individually, 6 actants associated with the issue, the goal here being to encourage personal reflection on the problem. They were then invited to form small groups (3–4 students) with classmates of their choosing. Each small group then had to discuss and choose, from among all the actants listed by group members, the four which they considered were most relevant to an analysis of the problem and which, therefore, should be included in the map. Once each small group had added its actants to the online whiteboard, the class as a whole had to discuss and agree how they should be grouped and distributed across the map, thus enabling the four poles to be established; they also had to agree on how these poles would be labeled. This was followed by further discussion among the class as a whole in which they had to propose relationships between the different actants, indicating whether these were unidirectional or bidirectional, and also the nature of the relationship between the two elements (i.e., did one of the two elements support or challenge the other). The final task for students, once again working as a class, was to propose specific actions that could help to improve certain aspects or problems highlighted by their map.

Figure 5 shows the map produced by one of the two class groups. It can be seen that the poles are labeled Economy (yellow), Environment (green), Health (pink), and Society (blue), and that students proposed primarily unidirectional relationships both between actants and between actants and the controversy they had been asked to consider (i.e., the health and environmental implications of meat production and consumption). The actions proposed by this class group included regulations on advertising, greater emphasis on

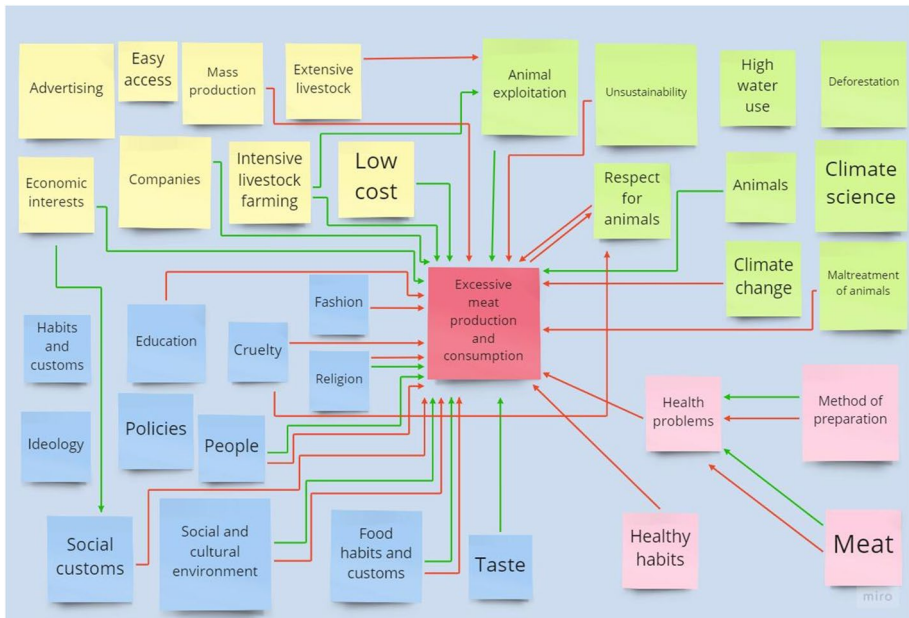


Fig. 5 Screenshot showing the map produced by one of the two class groups of preservice early childhood teachers. Arrows are green or red depending on whether the relationship between the two elements was considered by students to be supportive or challenging, respectively

health education, subsidies for extensive livestock farming and tighter regulation of intensive farming, and challenging myths about food through information and awareness-raising campaigns, both generally and specifically on the topic of vegetarian and vegan diets.

Another activity involved 28 preservice high-school teachers (18 women and 10 men, aged between 22 and 35 years), most of whom had a degree in Biology; the remainder had qualifications in the fields of earth sciences and health. This was a face-to-face activity that took place prior to lockdown in 2020. Once again, students were not given any information or instruction related to the controversy prior to the activity, and hence the cartography was framed as a familiarization task (Christodoulou, Levinson, Davies Grace, Nicholl, and Rietdijk 2021). In a first step, each student produced an individual list of three actants, which were then shared and grouped into poles following discussion among the class as a whole. Students then worked individually to propose relationships between the different actants, followed again by class discussion to agree on those which should be added to the map. The map produced by these students (Fig. 6) was very similar to that created by the class of preservice early childhood teachers (Fig. 5) in terms of the poles it included: Culture/Society, Health, Environment, and Trade/Economy.

A total of 26 actants were identified, some of which (e.g., the price of meat and the issue of animal welfare) coincided with those featured in the map produced by the preservice early childhood teachers. However, the map produced by the preservice high-school teachers also included some actants that, in our view, reflected their greater scientific knowledge, for instance, the risk of colorectal cancer, the amount of water required to produce a kilo of meat, and land grabbing. It is seen in Fig. 6 that these students proposed a total of 15 relationships (9 between actants and 6 between actants and the central controversy), all of which were unidirectional.

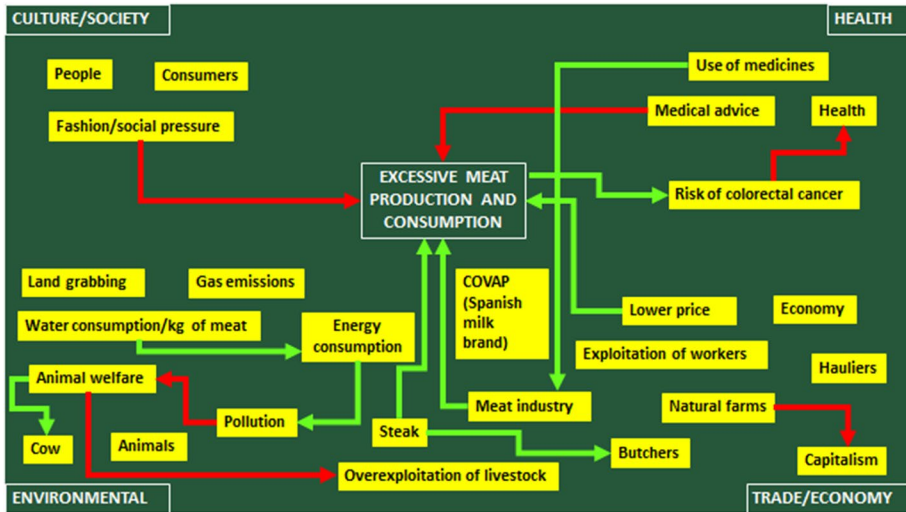


Fig. 6 Reproduction of the map produced by preservice high-school teachers

Comparison of student maps with the one created by the researchers

In this section we compare the maps produced by the two groups of students with our own. Obviously, our own map was the result of a lengthy and detailed socio-epistemological analysis of the SAQ, and it should also be remembered that the cartography was framed solely as a familiarization task with students, who were not given any information or instruction related to the controversy prior to producing their maps, nor were they asked to conduct their own inquiry before doing so. These aspects should be considered as potential limitations of the present study.

The comparison of maps focuses on the following aspects: the number and type of actants, the number and labeling of poles, the number of relationships established, and the complexity of the relationships established between actants (both within and between poles). Table 1 presents a summary of the results obtained.

The total number of actants provides an indication of the extent of the analysis carried out. Although we expected our own map to feature a greater number of actants, students' maps also included a considerable number (equivalent to 60% and 77% of the total number of actants in our map). Like our own map, students' maps also included four poles, although there were a number of differences in this respect:

- They did not consider the political dimension of the SAQ, neither as one of the poles nor, in general, through the type of actants they included. Notably, their maps did not make reference to government regulations or subsidies related to meat production. Although the map produced by the preservice early childhood teachers did feature 'Policies' as an actant, it was not linked to any others or to the center of the map.

- The students' maps did not consider scientific issues beyond those related to human health, and it is noteworthy the lack of reference to veterinary science, food technology, environmental science, and nutrition.

- The economic dimension in students' maps is limited to production/sales, and issues related to product promotion, advertising, and marketing are almost completely absent

Table 1 Comparison of student maps with that created by the researchers

		Preservice high school teachers	Preservice early childhood teachers	Researchers
Actants	N° of actants	26 (100%)	33 (100%)	43 (100%)
	N° of actants that are not linked to others	9 (35%)	8 (24%)	0
	N° of actants represented with either an incoming or outgoing arrow	12 (46%)	22 (67%)	16 (37%)
	N° of actants represented with both incoming and outgoing arrows	5 (19%)	3 (9%)	27 (63%)
N° of poles		4 Culture/society, Health, Environmental, Trade/Economy	4 Economy, Environment, Society, Health	4 Political, Economic, Sociocultural, Scientific
Relationships	Total n° of relationships	15 (100%)	35 (100%)	79 (100%)
	N° of relationships established between an actant and the controversy (center of the map)	6 (40%)	27 (77%)	14 (18%)
	N° of relationships established between actants of the same pole	8 (53%)	4 (11.5%)	42 (53%)
	N° of relationships established between actants of different poles	1 (7%)	4 (11.5%)	23 (29%)

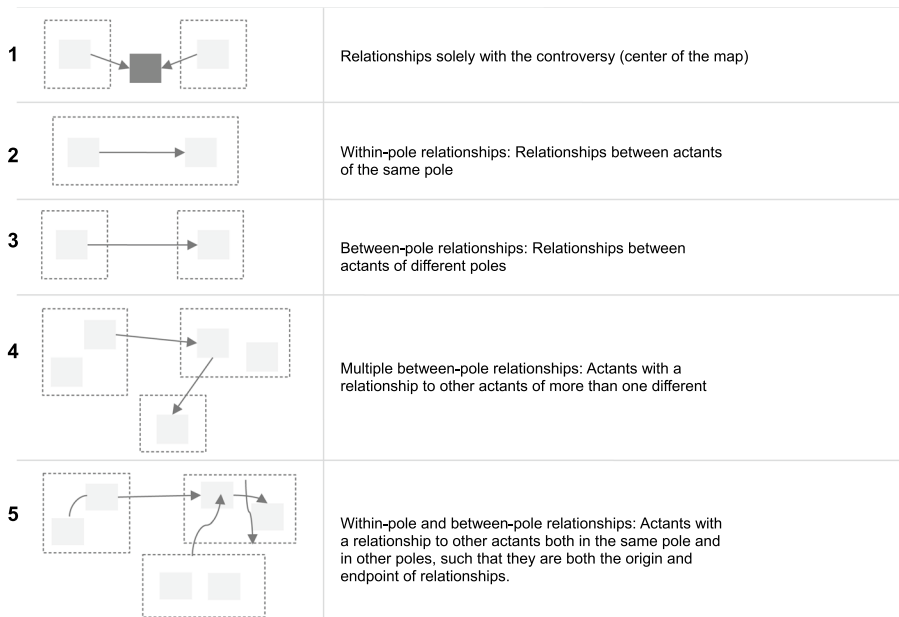


Fig. 7 Levels of complexity in the relationships established when mapping the controversy

(advertising does feature as an actant in the map produced by the preservice early childhood teachers, but it is not linked to others).

- The cultural and symbolic dimension of meat consumption is only referenced in the map produced by the preservice early childhood teachers (it is absent from the map created by their preservice high school counterparts).

The total number of relationships established may be considered an indicator of the depth of analysis carried out, as well as of the extent to which the complexity of the question is appreciated. The total number of relationships established in the map produced by preservice high school teachers was less than half the number in the map produced by the group of preservice early childhood teachers. However, the preservice high school teachers proposed a greater number of relationships between actants of the same pole, which suggests that although the total number of relationships they established was lower, the connections they proposed were more complex.

Based on the type of relationships established in our own and the students' maps, it is possible to identify five levels of increasing complexity, as represented in Fig. 7.

At the most basic level (not depicted in Fig. 7), students included an actant in their map but did not relate it either to other actants or the controversy (center of the map), suggesting that while they sense it to be relevant to the question, they lack the information or knowledge to locate and connect it more precisely. At the next level (level 1 in Fig. 7), direct relationships are established between an actant and the controversy (center of the map). These relationships are usually the first to be established when mapping the controversy surrounding an SAQ, and it is often the case that in doing so, other intermediate actants emerge that begin to reveal the complexity of relationships. In our view, the high percentage of direct (actant–controversy) relationships in students' maps suggests a lack of

depth in their analysis, which is likely due to the design of the activity (e.g., the time available, the framing of the cartography as a familiarization task).

The number of relationships established between actants of different poles may be considered an indicator of the extent to which the complexity of the question is appreciated, and in this respect, it is noteworthy that few relationships of this kind were represented in students' maps. The final level of complexity in Fig. 7 refers to actants with a bidirectional relationship to others, whether between or within poles. The presence of actants represented with both incoming and outgoing arrows (i.e., they are both the origin and endpoint of a relationship) results in a denser map, indicative of greater complexity in the analysis of the controversy. Bidirectional relationships of this kind were less commonly represented in students' maps than in our own.

Final considerations

We found the CoC approach to be a useful way of engaging students with the controversies surrounding the dominant model of meat production and consumption in Western countries, and it enabled us to visualize their initial views and ideas about this SAQ. The differences observed when comparing their maps with our own more detailed map help to identify those areas where students' knowledge and understanding of the controversy needs to evolve. For instance, although students' maps commonly included actants related to aspects of human health or harm to the environment, other actants with a less direct relationship to the central controversy, such as economic or policy issues, were often overlooked. It is important to remember, however, that the cartography was framed here solely as a familiarization task for students (Christodoulou, Levinson, Davies Grace, Nicholl, and Rietdijk 2021), and in this respect the present study is merely a first step toward the incorporation of the CoC approach into our science teaching program. As we noted earlier, the next step would involve providing students with more information about this SAQ so that they could engage in a more in-depth inquiry, revising and/or building on their initial maps as they acquire more knowledge and consolidate their learning. If one of the goals of this learning process is that students move toward taking action for change, then coupled with the website we have developed with the aim of engaging and informing citizens about this SAQ, it would be an example of what Hodson (2014) refers to as indirect activism.

To conclude, the CoC approach would appear to be a useful pedagogical method for helping students engage with and develop their knowledge about SAQs of the kind we consider here. In particular, it provides the opportunity to:

- Locate students' initial ideas, attitudes, and beliefs about an SAQ within a broader framework, identifying misconceptions, hidden actants, and lesser known spheres of influence (poles), etc.
- Select more specific problems for inquiry, while remaining aware of their close relationship to the controversy being addressed.
- Provide students with sources of complementary information so as to increase their knowledge of aspects of the controversy about which they had previously been unaware.

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