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# Emil's Friday for future – perspective of Paul Ernest's interest groups on teaching about carbon footprint

Ysette Weiss<sup>1</sup> and Rainer Kaenders<sup>2</sup>

<sup>1</sup>University of Mainz, Mathematical Institute, Mainz, Germany; [yweiss@uni-mainz.de](mailto:yweiss@uni-mainz.de)

<sup>2</sup>University of Bonn, Mathematical Institute, Bonn, Germany

*In times of increasing possibilities of appropriation and one-sided reporting by public media, how can students learn to critically question these and their own argumentations in mathematics lessons? The cultural-historical perspective can raise awareness of often non-obvious perceptions and learning objectives that represent the views of political, social and cultural groups. Considering carbon footprint as an example, we make a subject-matter didactics analysis a common German approach and show that the perspective of interest groups makes implicit learning goals visible.*

*Keywords: Ernest's interest groups, carbon footprint, educational goals, Fleck's thought collectives.*

## Introduction

In recent years, in Germany one can increasingly observe one-sided representations, trivializing reductions of complex facts and detachments of political situations from their socio-cultural and cultural-historical contexts in public discourse. These tendencies can partly be explained by exceptional situations such as epidemics and war. In times of crisis, it is difficult and sometimes impossible to examine different positions with regard to current events and to search for longer-standing cultural-historical causes. Nevertheless, the culture of discussion and the ability to discourse contribute significantly to the strength of social cohesion and are essential for long-term social developments.

The inherent tendency to ideologize and polarize in the context of crisis situations makes pluralistic perspectives and reflection on historical causes difficult. This makes it all the more important, especially in these times, to promote awareness of the legitimacy of different cultural-historical perspectives. The idea of possessing the “right knowledge”, “the one truth” or “the superior morality” has negative connotations in critical discourses and is linked to terms like “echo chamber” or “information cocoons”. A cultural-historical view of these phenomena is offered by Ludwik Fleck (1979) with his theory of *thought collectives* and their *thought styles*. In Fleck's model, the focus is on the natural development of thought collectives in the context of the institutionalization of knowledge transmission, as well as the emergence, differentiation, and specialization of scientific disciplines. From this perspective, it is obviously hardly possible to convince others by “the truth” or to teach “the truth”. Even in the natural sciences, truths are bound to convictions of thought collectives and are the result of social processes and cultural-historical developments – mostly unreflective.

Furthermore, whether we like it or not, we can never sever our links with the past, complete with all its errors. It survives in accepted concepts, in the presentation of problems, in the syllabus of formal education, in everyday life, as well as in language and institutions. Concepts are not spontaneously created but are determined by their “ancestors”. That which has occurred in the past

is a greater cause of insecurity-rather, it only becomes a cause of insecurity – when our ties with it remain unconscious and unknown. (Fleck, 1979, p. 20)

The scientific truths are not only bound to the subject-specific methods of their extraction; they also depend on the thought style of the thought collective. Fleck distinguishes between the *esoteric circle* of experts and specialists and the *exoteric circle* of laymen and those interested in a subject.

The general structure of a thought collective consists of both a small esoteric circle and a larger exoteric circle, each consisting of members belonging to the thought collective and forming around any work of the mind [Denkgebilde], such as a dogma of faith, a scientific idea, or an artistic musing. (Fleck, 1979, p. 105)

In the formation of a thought style the migration of ideas throughout the collective between the esoteric and the exoteric circles play a major part. For the social support of the development of the esoteric circle, elementarizations and popularizations of specialized knowledge, as well as the public visibility of the experts, play a role. Thus, convincing someone does not mean presenting one's own arguments in one's own thought style, but presupposes an understanding of the counterpart's thought collective, incorporates his thought style and thus cultural-historical and social values.

Value systems that have evolved over the course of cultural history are particularly difficult to access for outsiders, but they are also only accessible to a limited extent for members of the thought collective, since they are implicitly encoded in valid authorities, social interaction and hierarchies, among other things. Special efforts are therefore required, especially in the case of acute social problems, not only to critically reject other points of view, but also to open up to the thought styles that underlie the differing from one's own opinions. Mathematics and the natural sciences often occupy a special position in the solution of social problems because, on the one hand, their models are considered to be objective, universal and realistic and, on the other hand, the positivism and belief in technology of the exoteric circles of many thought collectives support an image of mightiness and power of these sciences to overcome global problems by using technical solutions.

Nevertheless, scientific thought styles are also shaped by the social conditions of their bearers. The corresponding thought collectives thus develop perspectives and approaches to solutions that are implicitly socially motivated. Especially in the case of scientific and technical answers to social problems, the underlying authorities (esoteric circles) should therefore be scrutinized for implicit social and economic interests of their thought collective.

Can mathematics education contribute to the elucidation of cultural-historical and power-political motives of scientific representations? Topics such as “How to lie with statistics?” of Darrel Huff and Irving Geis (1954) and its successor literature or “Mathematical modelling based on accessible data collection” (e.g. Bauer, 2021) are such valuable endeavours. Nonetheless, the goal of these efforts is to evaluate and judge other approaches from within the culture of one's thought collective. To what extent the mathematical approach via statistics is a meaningful approach at all and to what extent the use of mathematizations is an expression of corresponding interests is hardly in focus.

In the tradition of subject-matter didactics (cf. Hefendehl-Hebecker, 2016), we try to show using the ways to stop climate change currently suggested to students in German mathematics lessons, on the one hand, that these approaches are based on constructivist-idealist basic principles and, on the other

hand, we will relate them to Ernest's interest groups. These classifications developed in the 1980s refer to local political institutions and party systems of the British society. However, the cultural-historical characterization of interest groups allows to make implicit features of different thought collectives explicit. The problem of climate change is a global one. Therefore, we add to the Ernest's interest group another perspective, which allow us to identify interests related to the globalization of economy and education.

### **Interest Groups according to Paul Ernest**

Ernest's notion of interest groups in mathematics education considers, on the one hand, fundamental ideas about the nature of mathematics and its role in society and, on the other hand, institutionalized socio-political institutions and forces in British society in the 1980s (see also Sauerwein, 2020, pp. 6-7). In the following, we mainly present characteristics that are relevant to the question of whether social problems directly affecting large parts of humanity, such as climate change, should be the subject of mathematics education and, if so, how they should be dealt with.

The characteristics of Ernest's group of *industrial trainers* are strongly influenced by the fact that mathematics – like any other knowledge – is seen as a fixed framework of facts, skills and theories, beyond any doubt (cf. Ernest, 1991, pp. 140-151). Whereas in the 1980s the focus was primarily on arithmetic skills and mastery of the arithmetic calculus, today, justified by given central educational standards, one could for instance also include mastery of the routine to change between arithmetic, graphic and verbal representations. The belief in rigid social hierarchy and authorities determines the goals of school for the individual children. For the majority, this means that/ school is a place where they are expected to learn obedience and discipline: Basic mathematical skills are to be learned unquestioningly through hard work. 30 years ago, Ernest characterised the interest group of the industrial trainer by the irrelevance of social and societal issues for teaching mathematics. We see this as less characteristic today due to the central default of topics in stochastics and statistics, as well as the sham applications that have prevailed for decades as word problems.

For the *technological pragmatist* mathematics is not questioned, but is seen primarily as a tool, useful for vocational education. In terms of applications, there is no best method, it depends on the user with his skills and knowledge, as well as on the individual practical situation. Mathematical education is therefore always geared towards what is needed in later professional life. Useful knowledge and skills enable promotion opportunities through performance in application-related mathematics. Whereas with the industrial trainers a rigid social hierarchy determines the goals of the school for the individual children, here social hierarchies are more permeable. Mathematics is seen as a tool for technical and industrial progress. (cf. Ernest, 1991, pp. 151-167)

For *old humanists*, mathematics is an objective, independent truth based on logic and reason. Pure mathematics is neutral and value-free, but has an inner, pure aesthetics that is superior to applied mathematics. This pure knowledge is to be passed to those who are interested, knowing full well that this is not accessible to everyone in its entirety. Mathematics is taught for its intrinsic value and is seen as a central part of culture and as an intellectual challenge. (cf. Ernest, 1991, pp. 168-180).

The interest group of *progressive educators* has two epistemological perspectives, the “rationalist” and the “empiricist”. On the one hand, a Platonist view that the knowledge must be rediscovered and,

on the other hand, that the learner's knowledge develops through interaction with the environment (in the tradition of Piaget, among others). Both traditions have in common that objective truth is accepted, but not yet regarded as achieved. In this sense, mathematical truth is accepted as absolute and certain, but it is above all to enable each individual to approach this absolute knowledge. The role of society is minor and functions primarily only as a context for the development of the individual. This focus on the individual then also leads to the fact that the concrete contents of the mathematics curriculum are secondary. Rather, the main focus is on the individual personal development. Therefore, the experiences acquired in mathematics lessons should lead to a curiosity and creativity as well as a positive attitude towards mathematics, whereby what is seen as a mathematical activity depends on the individual. (cf. Ernest, 1991, pp.181-196)

The *public educators* see mathematics from a social constructivist perspective, in which knowledge is situated and social, political and economic concerns are highly interdependent. Schooling is seen as necessary in order to participate as a critical citizen in democratic processes, to perceive and address existing injustices in society. This critical thinking should also be promoted in mathematics education and includes, above all, that pupils actively deal with mathematics and learn to formulate and solve mathematical problems in social contexts. (cf. Ernest, 1991, pp. 197-216)

The industrial trainer's perspective is oriented towards conservative vocationally relevant values. In recent years, however, a divergence can be observed between such skills propagated as valuable by industry associations and their real role in professional life. Even conservative value systems are no longer directly aligned with current social practice, but with economic interests of large corporations, as digitalization concepts in primary and secondary schools and vocational education show.

### **An example of German mathematics teaching on climate change**

There are numerous projects in Germany to use current scientific data available in the public media to relate mathematical education and social participation. We focus on a project on carbon footprints.

#### **The political background**

The teaching unit, which was the starting point for this study for us, is typical for many activities on the topic of sustainability in Germany. The individual education ministries of the federal states and the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) support specific projects on sustainability in the classroom and support teachers in planning topics and projects. These measures take place within a larger framework, which has been defined in a series of international agreements like for instance in the United Nations Agenda 2030 with 17 "Sustainable Development Goals". The federal ministry BMUV (2018) puts it this way: "Education for sustainable development aims to enable learners to acquire 'competency to shape'. That means: the ability to actively and on one's own responsibility shape the future and thus contribute to a fair and environmentally friendly development in the world."

#### **The Carbon Footprint Lesson Project**

The lesson draft "Powerless in the climate crisis?" from Patrick Bulthaup and Tomma Jetses (2022) is intended for grade 2 and 3 of secondary education and takes up three double lessons or likewise one project day. The key question of the draft is: "What can you achieve through your own actions

and how exactly do you design climate-friendly alternatives? How big is one's own influence on climate change?" In accordance with the ministry's approach, this is also about "one's own actions" and "one's own influence". The question of whether answers to the climate catastrophe can be obtained at all by individualizing the problems remains unanswered.

Then the questions asked above are narrowed down to the question: "How can you succeed in reducing your own CO<sub>2</sub> emissions by 30%?" Three statements are made with regard to which the students need to be changed: "Statement 1: I am convinced that I can make an important contribution to climate protection through my own actions." as well as "Statement 2: I can judge when and where I cause a lot of CO<sub>2</sub>." and "Statement 3: I pay attention to my CO<sub>2</sub>-balance every day." Using a scale, the students' statements are sorted between three opposing statements, such as "I pay attention to my CO<sub>2</sub>-balance every day." and "I never pay attention to my CO<sub>2</sub>-balance." or: "In the future, I won't pay attention to my CO<sub>2</sub>-balance." and "I would like to pay close attention to my CO<sub>2</sub>-balance in the future." Before being treated in the workshop, the self-assessments of the students must be classified more or less to the right, as they are obviously not yet sufficiently sensitized with regard to their own carbon footprint. This turned out to be different after the series of lessons.

The lesson plan is deliberately limited to the aspect of nutrition. After the topic of the lessons and the CO<sub>2</sub>-calculator for nutrition have been introduced in tasks 1 and 2, everything moves towards:

Task 3: What is the carbon footprint of Emil's diet? Emil has decided to pay more attention to his CO<sub>2</sub>-balance and would also like to eat more climate-friendly. In order to get an overview of his current carbon footprint, he wrote down his meal plan for the past week.

Determine the CO<sub>2</sub>-balance for Emil's diet on Friday with the help of the given data (in the "CO<sub>2</sub>-calculator" file of task 2) and the spreadsheet "Emil's meal plan".

Task 4 informs the students that Emil has decided to set up a *Friday for Future* for himself. The students should now help him to reduce the carbon footprint of his diet by at least 30%.

The so-called process-related competences are discussed as it is required in the educational standards, whereas possible pedagogical consequences are hardly addressed in the article for teachers.

### **Discussion of Local Interest Groups**

The cited project makes the global problem of climate change a teaching topic and wants to show pupils possibilities to solve this problem or at least to contribute to the solution. How big the impact of changing the diet of a child in the proposed way (from grade 7 onwards in Germany) would be, is not discussed. Nor does it address the impact that changing the behavior of all children in Germany from grade 7 onwards would have. The solution proposed by the project authors assumes that the problem is the same for all pupils, regardless of their background and socialization, and accordingly provides a solution that is the same for each individual pupil. Through an examination of conscience, a change in behavior, in this case a change in the diet of each individual, is to be achieved. However, although everyone is supposed to do the same, it is not an action of solidarity.

At first glance, the approach seems to correspond to the educational ideas of the progressive educators: Children are encouraged to do things for themselves; contexts are general educational, like knowing the causal relationships between the production and transport of food and the associated

CO<sub>2</sub>-pollution; the creative development of one's own diet seems to support the individual development and individual interests. A closer look reveals however, that main educational principles of progressive educators are not satisfied. We see that here climate protection is becoming a question of normative self-optimization. Especially in the life phase of the affected children, nutrition has something to do with social practice that they can only influence to a small extent. Shouldn't they perhaps get to know this social practice better before influencing it? In addition, nutrition is a private and intimate (shameful) thing that is quickly associated with guilt and misconduct. Dietary rules play an important role in all major religions, where diet is associated with spiritual states. Many eating disorders are also psychological in nature. So, is it responsibly to focus children's attention so much on nutrition when it comes to solving problems that should maybe be achieved politically? Here the CO<sub>2</sub>-balance becomes an examination of conscience and the photos of shrink-wrapped minced meat and bananas presented in the project as ecotrophological immodesties do the rest. These arguments contradict the constructivist ideals of the progressive educators, for which the individuality and best development opportunities for the individual child are of primary interest.

The described school project does not reflect the interests in mathematics education of the old humanist, since, in their opinion, current contextualization of mathematics as well as the use of mathematics as a tool to solve contemporary problems are not major goals of mathematical education. Although it is certainly important to the old humanist that humanity continues as a whole, the mathematics classroom is not the place to decide this. The technological pragmatists see mathematics as a tool for problem solving. In this project, however, mathematics is used only for the presentation of the problem. Technical solutions like more environmentally friendly technologies, alternative forms of energy production, possibilities of storing CO<sub>2</sub> in the underground or extracting it from the air through carbon engineering or direct air capture technology are not addressed. In mathematics education that is aligned with the interests of the technological pragmatists their reality-based use of mathematics to solve environmental problems would focus on the necessities of given societal practice, such as career preparation for specialized engineers, technicians, craftspeople, ... who can drive the transformation of the economy with the goal of climate neutrality (cf. Stomporowski, 2022).

On closer inspection, the project fulfills some of the ideas of the industrial trainer interest group: the learning goals are based on authority, the conscientious execution of the skills to be learned leads to social appreciation, mathematics education is seen as a school of character, whereby the study of mathematics promotes self-discipline and the fulfillment of duty. However, the interests of the industrial trainers are contradicted by the lack of orientation towards vocational training and the unrealistic nature of the psychological proposed approach. While the mathematics lessons of the progressive educators and old humanists are aimed at children from educated middle-class households, the mathematics education goals of the industrial trainers also try to improve the social participation of children from educationally disadvantaged backgrounds. For the latter independent creative developments of food diaries are far from their social reality. From the perspective of the interest group public educators, the cited school project seems to be compatible with their aims to learn to participate as a critical citizen in democratic processes and to formulate and solve mathematical problems in social contexts. The description of the public educators and their relationship to mathematics as a tool does not, however, allow conclusions to be drawn as to whether

poststructuralist or materialist ideas are assumed. In the first case, for the achievement of social changes, education or behavioral change of the individual is in the foreground, e.g. through the use of language and the examination of conscience. In the second case, especially in dialectical historical materialism, the focus is on the existing social practice, defined by economic property and power relations, and its change through economic redistribution.

### **The lesson project against the background of global interests**

The interest groups are made up of groups of stakeholders (with possible intersections) within society. Their influence on mathematics lessons is linked to an idea of their own society in which the representatives of these groups move within their thought collectives – and last but not least, their own children grow up in it. Globalization, however, has created a new interest group. The people in this interest group shape local changes but do not take local responsibility. These are people who have taken a race into space while millions of people have perished economically in the pandemic. Some call these people the oligarchs, the billionaires, or just the rich. They and their supporter form the global interest group we will call *neoliberal agents*. The emergency aid and development organization Oxfam (Maitland, A. et al., 2022) stated in its report “Carbon Billionaires: The investment emissions of the world’s richest people”, which it published on the occasion of the UN world climate conference COP 27 in Sharm El Sheikh:

The true scale of the investment emissions of these individuals is not systematically calculated or reported. However, using new analysis based on publicly available data, Oxfam calculates that the annual carbon footprint of the investments of just 125 of the world’s richest billionaires in our sample is equivalent to the carbon emissions of France, a nation of 67 million people.

This represents an average of 3.1 million tonnes per billionaire, which is over one million times higher than 2.76 tonnes – the average for someone in the bottom 90% of humanity.

Oxfam writes about the database: “Our final database at the end of this process contained 183 corporates, with investments by 125 billionaires worth a total of \$2.4tn.” From which we conclude that the average asset of the billionaires is \$1.920 Billion. Furthermore, we read in the report:

More recently, Twitter accounts tracking private jet travel have brought the issue of carbon inequality to public attention with revelations that, in a matter of just minutes, billionaires are emitting more CO<sub>2</sub> than most people will emit in a year. The billionaire space race has highlighted how a single space flight can emit as much CO<sub>2</sub> as a normal person will in their lifetime. Adding fuel to the fire, this same group of people have the resources to avoid the consequences of climate change, which will be felt most heavily by the poorest people. ... Our analysis also found billionaires had an average of 14% of their investments in polluting industries, such as fossil fuels and materials like cement. This is twice the average for investments in the Standard and Poor 500 group of corporates.

The cited school project is exemplary for the majority of socio-politically oriented projects in Germany with its learning objectives to cope with social problems by reflecting and changing one's own consumer behaviour. Of course, it is important for the students, but especially for the teachers, to reflect on their own behaviour and to place it in a larger framework, e.g. a thought collective. A next step should nevertheless be to include other thought styles as well. In order to give not only



children of a small educated bourgeois thought collective the opportunity to experience self-efficacy through psychologically accompanied and parent-financed nutrition plans, teachers should be aware of the diversity of social interests and solution strategies and reflect on their own interest group. *Fridays for future* started as an act of solidarity of affected young people and represents a global response to the actions of the global interest group of neoliberal agents. The Friday for future individualized on Emil can be understood as a response of the neoliberal's collective of thought to it.

We used the perspective of interest groups to analyse and interpret the learning objectives of the CO<sub>2</sub> learning environment in the context of political power interests. Among other things, it became visible that the different ideas of the interest groups about the nature of mathematics also have an influence on the role that mathematics is assigned in solving problems, in particular the CO<sub>2</sub> problem. The perspective of thinking collectives allows to better understand the attractiveness and plausibility of the proposed solutions from the point of view of the students. The latter leads in particular to the realization that it is not about teaching "correct behaviour", but about understanding and expanding one's own scope for action within the current value system, which is shaped by one's own thinking collective.

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