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Challenges of creating climate-friendly schools: How barriers develop out of organising processes at schools and prevent them from adopting transformative measures

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ABSTRACT

The urgency of cutting carbon emissions and the lagging implementation of transformative, climate-friendly measures has been firmly expressed by climate scientists. In this context, schools are called upon to organise processes which can lead to more climate-friendly schools. In search of solutions to this challenging task, high school students, teachers and the research team in the transdisciplinary project k.i.d.Z.21_aCtiOn2 sought to reduce carbon emissions in partner schools in Germany and Austria. The collaboration built on the young people having previously been involved in a climate change education programme which prepared them to become agents of change in their schools. Alongside the project's attempts to transform the schools into more climate-friendly organisations, various hindering aspects have been identified through Situational Analyses, a qualitative approach building on Grounded Theory which made use of participants' and researchers' mappings of situations. The mappings captured all involved actors, their roles in the transformation processes, carbon emission sources, the students' proposals and to what extent these were considered or implemented. Overall, this situated, participatory approach identified 15 types of barriers. Building on previous organisational research on schools, a coupling theory approach has been adopted to analyse the extent to which the interrelations of involved actors contributed to these barriers. The study provides detailed descriptions of how barriers to carbon reduction measures arise in schools. Other initiatives of creating climate-friendly educational institutions can build on the outlined importance of capturing all involved actors and their couplings in order to understand, and potentially prevent, barriers.

1. Introduction

Achieving organisational change towards a climate-friendly future is one of the most challenging transformations required in the 21st century. Climate change renders new forms of acting and living inevitable in order to deal with already measurable changes and avoid dramatic, uncontrollable climate change. However, despite the analyses and warnings generated by climate scientists and the urgency for fundamental change (IPCC, 2022a, 2022b), climate-friendly transformation is slow and confronted with many barriers, which need to be addressed (Baste and Watson, 2022). The latest IPCC report is yet another reminder of the necessity to accelerate the implementation of measures, since the currently established policies result in projected emissions that would lead to an increase in temperature between 2.2 °C and 3.5 °C until the year 2100 (IPCC, 2023, p. 23). As all sectors need "comparable transformation pathways" (Rockström et al., 2017, p. 1269) to reach the global CO_2 reduction goals set out in the Paris Agreement and limit global warming to 1.5 °C (UNFCCC, 2015), educational organisations also have to adopt climate-friendly measures. Linking *Quality Education* (SDG 4) and *Climate Action* (SDG 13), climate-friendly transformation processes in schools can prove valuable for various reasons (United Nations, 2015). In the following, all actions contributing to schools' reduction of carbon emissions are considered as climate-friendly measures, however, carbon compensation or offsetting options were not relevant to the project.

Building on the importance of transforming schools as one puzzle

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piece of more generally creating more climate-friendly organisations, this paper is guided by the following question: *How can organising processes between different actors in schools result in barriers to climate action?* For the study of organising processes, we chose a coupling approach as theoretical background. Expanding on previous research of schools' coupling processes, we designed a three-step study on organising processes that shape barriers to climate action. First, to investigate the context in which the participating schools sought to reduce their emissions, we summarise the situational maps created by the young people participating in the transdisciplinary project k.i.d.Z.21_aCtiOn2. Second, we present the researchers' maps of barriers which arose in this project and provide examples of the three most prevalent barriers to climate-friendly measures at schools. Third, we analyse the coupling processes of factors identified in step 1 and how they affect the barriers described in step 2. As a result, we explore possibilities of approaching barriers to schools' climate-friendly transformation by acknowledging the different forms of coupling that characterised their development.

2. Schools' situated organising

2.1. The necessity of implementing climate-friendly transformation in schools

Initiating organisational and behavioural change in schools in line with climate-friendly transformation is crucial for several reasons. Schools contribute to climate change through a variety of direct and indirect CO_2 emissions, including for instance energy sources they use, field trips they organise and the incorporation of climate change education, or the lack of it. As recent Austrian reports (Allianz Nachhaltige Universitäten in Österreich, 2021; Bohunovsky and Keller, 2023) stress, climate change education and the integration of more climate-friendly processes in schools are critical to achieving the SDGs (United Nations, 2015) and the goals of limiting global warming set in the Paris Agreement (UNFCCC, 2015). Potentially, schools could become climate-friendly role models not only for students and parents, but also for local businesses and other organisations (Pirker et al., 2024). Although an in-depth analysis of related policy documents in Germany and Austria lies beyond the scope of this paper, it should be mentioned that both countries have acknowledged the importance of implementing mitigation measures in schools and of fostering high quality climate change education (Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology, 2024; Federal Ministry for Economic Affairs and Climate Action, 2024). The German National Climate Initiative, among others, supports climate change mitigation efforts of schools alongside other initiatives which offer advice to schools on potential renovations of schools. Several programmes and awards for schools in Austria support the adoption of more climate-friendly practices (e.g. Klimabündnis Österreich, n.d., Ökolog, n.d.). Although they are not among the largest emitters, the potential for introducing climate-friendly measures in schools is undeniable. In Austria, about 1.1 million students (Statistik Austria, 2022) attended almost 6000 schools in the school year 2021/22, the period of data collection for this study (Statistik Austria, 2022). In Germany, about 10.9 million students attended schools of general education and professional schools in the same school year (Statistisches Bundesamt, 2022a), with altogether about 32.000 schools in Germany (Statistisches Bundesamt, 2022b). Spending several hours at school almost every day, young people not only learn through lessons, but just as much through their entanglements with materials and places in their school (Lynch and Mannion, 2021). Given this multifaceted potential of schools to contribute to a climate-friendly future both in terms of direct carbon reduction and in view of their role as educational institutions, more research on the transformation processes in schools is essential.

Climate-friendly transformations of schools are particularly interesting to organisational studies, as schools seem rather resistant to change despite the potential of reducing costs and the urgent necessity of transformation (Keller et al., 2022b). Educational systems have been described as displaying "considerable robustness and resilience in the face of both environmental and intended change" (Goldspink, 2007, p. 44). Nevertheless, the outside world affects schools and causes them "to respond, but the pattern of response depends on an organisation's self-understanding" (Tsoukas and Chia, 2002, p. 578). Grand, overarching developments lead to various forms of organisational responses and reshapings, which can be characterised by discontinuities, disruptions and fluidity (Styhre, 2002, p. 343).

2.2. Organising climate-friendly transformations

Apart from the quite general assessments of schools' organisational change summarised above (2.1), there is a lack of research on the organisation of more climate-friendly schools. As organisation theory is strongly rooted in business studies, schools often remain underrepresented in related discourses (Meyer, 2002a). Overall, the value of organisational theory approaches in tackling the grand challenges of the 21st century is still widely underestimated. Besides, studies on the organising of businesses as well as experiences of business managers cannot easily be transferred to the context of schools (Meyer, 2002b). Schools are distinct from other organisations which build more heavily on "the authoritative coordination of work" (Gamoran and Dreeben, 1986, p. 613). Among the few existing studies on organising climate-friendly transformations and the appearing barriers, there is an analysis of green banking (Park and Kim, 2020), a study on the barriers to introduce more sustainable school meals (Eustachio Colombo et al., 2021) and a report on vulnerable groups' barriers adopting healthy and climate-friendly behaviour (Lampl et al., 2023). These findings shed light on the fact that barriers to climate-friendly transformation vary greatly depending on the specific situations and involved actors. Accordingly, there have been calls for research into the reasons for the development of barriers (Biesbroek et al., 2013; Lee et al., 2022).

2.3. Barriers to climate-friendly transformations

While numerous research studies have dealt with obstacles to individuals' climate-friendly behaviour change (e.g. Frick et al., 2021; Kollmuss and Agyeman, 2002; Muroi and Bertone, 2019; Sass et al., 2020) or barriers to climate-friendly transformation on a societal level (e.g. Biesbroek et al., 2013; Burch, 2010; Thaler et al., 2019), the barriers to organising climate-friendly transformations remain understudied. Meanwhile, many of the change interventions in climate-friendly transformation projects remain unsuccessful (Beycioglu and Kondakci, 2021), and most responses to climate change build on the "continuation of the system that caused the problem in the first place" (Nyberg et al., 2023, p. 17). However, system change is increasingly considered as something that cannot be managed as a linear process (Kuenkel, 2019, p. 9), instead, "the trajectory of change is more often spiral or open-ended" (Weick and Quinn, 1999, p. 382) and should be firmly tied to local situations (Beycioglu and Kondakci, 2021; Weissbrodt et al., 2024).

The study of changes and barriers is further complicated due to their invisibility (Smith, 1982, p. 327). To identify barriers, we decided to rely on participating high school students as actors who were eager to implement change. The difficulties they had to face could thereafter be conceptualised as barriers. Instead of 'barriers' other authors referred to obstacles, counterforces, difficulties, problems and knots (Kahn, 1982, p. 416). However, to emphasise and visualise the various types of hindering aspects the participants were confronted with in their transformation attempts and, in most cases, were not able to overcome, we choose the term 'barrier'. Drawing from a review of barriers to climate change adaptation, we define barriers for this study as aspects that negatively influence the process towards climate-friendly transformation or limit possibilities of reaching defined transformation aims (Biesbroek et al., 2013, p. 1127). Furthermore, we consider barriers as

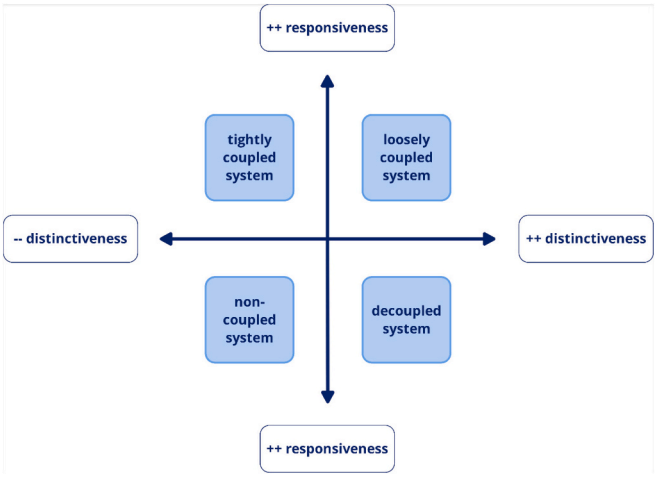

Fig. 1. Types of systems and coupling (building on Orton and Weick, 1990, p. 205).

sensitising concepts which "suggest directions along which to look" (Blumer, 1954, p. 7). As such, they are "providing clues and suggestions" (Blumer, 1954, p. 8) and to raise awareness of possibilities of creating climate-friendly schools.

2.4. Elements of organising processes: social worlds and arenas

As a background to our analysis of barriers to climate-friendly transformations situated in the organising processes of schools, we refer to the concepts of social worlds and arenas as units of analysis.

Social worlds are defined as collectives whose participants develop shared perspectives (Clarke et al., 2018, p. 148). Every social world has at least one primary activity, sites for its activities and technologies for carrying out those activities (Strauss, 1978, p. 122). Despite sharing various commonalities, social worlds also entail conflicts, negotiations and discontent (Clarke, 1991; Strauss, 1978). These debates and disagreements "lie at the very heart of permanence and change of each social world" (Strauss, 2010, p. 227).

Representatives of different social worlds meet in arenas and argue about the topics of concern and possible directions of action (Strauss, 2010, pp. 226–227). Thus, an arena is defined as a "field of action and interaction among a potentially wide variety of collective entities" (Clarke, 1991, p. 128). Social worlds participate in an arena when they have some kind of commitment to act within this arena – this includes cooperation or exchange as well as conflict-laden and competitive actions (Clarke, 1991, p. 128). Accordingly, barriers to change cannot be associated with specific actors alone but always develop from the relationships between actors and issues, between social worlds and arenas.

Building on Strauss' seminal work on social worlds/arenas theory (1978), Clarke established the mapping of social worlds and arenas as part of her Situational Analysis (2005). Overall, the analysis of social worlds and arenas aims to capture people's organising in structural situations and their interactions with others (Clarke, 1991, p. 135). Since arenas are central to social change (Strauss, 2010, p. 226), the analysis of social worlds and arenas is not merely an assessment of a given situation, but can also yields insights into transformational pathways.

2.5. Coupling processes shaping transformation

In order to analyse the organising processes of schools that lead to the development of barriers to transformation, we utilise an approach of coupling, originally developed by Weick (1982a, 1982b, 1976). As coupling theories put special focus on the connected, related organising of different elements (Beekun and Glick, 2001), they offer a solid foundation to analyse the possibilities and barriers to climate-friendly transformations in schools. As previous research on coupling processes in schools (see chapter 2.6) shows, the study of organising as coupling enables an in-depth understanding of how different elements interact with each other depending on a specific situation. Recent studies continue to adopt coupling as a process of organising (see e.g. Spain and Woulfin, 2019; Spillane et al., 2011). Accordingly, we understand organising as continuous, "ceaseless change, emergence and self-transformation" (Nayak and Chia, 2011, p. 282).

Approaching different systems and their coupling processes the following two axes are decisive: higher or lower levels of responsiveness and higher or lower levels of distinctiveness (Fig. 1) (Orton and Weick, 1990, p. 205). The resulting forms of systems are understood as the corner points of a continuum from no coupling over various forms of loose coupling to very tight coupling. We sought to analyse all existing forms of coupling and their influences on the possibility of climate-friendly transformations in schools.

Loosely coupled systems dialectically combine distinctiveness and responsiveness since their elements are responsive to each other, but nevertheless, physically or logically separated (Weick, 1976). Thus, "activities and decisions made at one level do not necessarily reverberate in clearly patterned ways elsewhere" (Gamoran and Dreeben, 1986, p. 613). The elements of loosely coupled systems are united by "shared beliefs, norms and institutionalized expectations" (Meyer, 2002b, p. 536), but there is lacking or sporadic coordination, regulation and inspection of activities within the system (Weick, 1976). They can be persistent and resistant to change, but loosely coupled systems are also characterised by their adaptability and the capacity to accommodate to change (Orton and Weick, 1990, pp. 213–214). Hence, loosely coupled systems bear the advantages of being more flexible and more capable of handling uncertain conditions than others (Beekun and Glick, 2001). Summarising five core aspects of loose coupling, we adapted the following definition in this study: "A affects B (1) suddenly (rather than continuously), (2) occasionally (rather than constantly), (3) negligibly (rather than significantly), (4) indirectly (rather than directly), and (5) eventually (rather than immediately)" (Weick, 2001, p. 383).

In *tightly coupled systems*, high levels of responsiveness are combined with low distinctiveness (Fig. 1). Typically, they facilitate "predictable, standardized work activity across multiple linkages" (Spain and Woulfin, 2019, p. 163). Hence, change processes in tightly coupled systems differ from those in loosely coupled systems in various ways. Implementation of measures may be faster and more controllable since "a tight network will foster change that is less divergent but hinder a change that is more divergent" (Burke, 2014, p. 430 referring to Battilana and Casciaro (2012)). Tightly coupled systems build on strong hierarchies, top-down control and interdependencies (Burke, 2014;

Hargreaves, 2011). One possibility of tightening the coupling is the establishment of presumptions, expectations and commitments (Weick, 2001, p. 49). Alternatively, forceful, persistent and confident action can lead to increasingly tight coupling (Weick, 2001, p. 50). To identify cases of tight coupling in our study, we utilised Weick's definition comprising the following aspects: "1) there are rules, 2) there is agreement on what those rules are, 3) there is a system of inspection to see if compliance occurs, and 4) there is feedback designed to improve compliance" (Weick, 1982b, p. 674).

Combining distinctiveness with a lack of responsiveness, *decoupled systems* miss the connections and tensions described in both loosely and tightly coupled systems (Fig. 1). Following Orton and Weick (1990), we use the terms *decoupled systems/decoupling* in this study. However, we also refer to studies which rather use *uncoupled systems/uncoupling* (e.g. Cohen et al., 1972). We consider these terms to be synonymous. Decoupled systems "maintain standardized, legitimating, formal structures while their activities vary in response to practical considerations" (Meyer and Rowan, 1977a, p. 357). In general, decoupling tends to happen in cases in which organisations are not capable or inclined to act according to external pressures (Bromley et al., 2012, p. 488). Others even claim that decoupled systems' "tasks and issues are not coordinated at all" (Maassen and Stensaker, 2019, p. 465). One example of decoupling in the context of schools relates to goal setting: "Schools produce students, not learning" (Meyer and Rowan, 1977a, p. 357). In addition to this decoupling of goals and activities, all kinds of schools' subunits, external aspects and pressures may become decoupled.

The final form of coupling introduced in Fig. 1, *noncoupled systems*, was irrelevant to our analysis. Hence, these will not be presented in more detail.

2.6. Previous research on coupling in schools

Existing studies on coupling in schools centre for example around curriculum improvement (e. g. Glatthorn, 1981), or deal with the influence of coupling on improving learning and the training of school staff (Bush, 2017). Loose coupling in schools "usually refers to teacher autonomy and the insulation of each classroom from external surveillance and interference, even by colleagues and superiors" (Hargreaves, 2011, p. 688). Educational improvement is considered the prevalent type of change studied in the coupling literature on schools (Hautala et al., 2018, p. 241), leaving both non-pedagogical aspects and the necessity of climate-friendly transformation untouched.

Weick's (1976) seminal work on schools as loosely coupled systems provides a strong foundation for further inquiry of current organising processes in schools. He argues that schools should be understood as a "federation of dissimilar segments" (Weick, 2001, p. 39). As they do not only consist of teachers, learners, and their interactions, but are complemented by many additional persons, tasks and responsibilities, different elements are in many cases merely loosely coupled. Weick argues that "the task of educating is simply not the kind of task that can be performed in a tightly coupled system" (Weick, 1982b, p. 674). The concept of loosely coupled schools includes connections to administrations outside schools as well as the relations between different elements inside schools (Murphy and Hallinger, 1984, p. 7). Hence, the construct of coupling can be used to analyse the connections between different elements of schools (Logan et al., 1993), or the "interrelatedness of behavioural patterns among teachers, leadership and organization" (Hautala et al., 2018, p. 251).

Notwithstanding the tendency to describe schools as loosely coupled systems, other forms of coupling have also been detected in this context. For example, it has been argued that the bus schedule is rather tightly coupled (Weick, 1982b). In the case of the USA, tighter coupling of schools and the educational system as a whole was predicted (Fusarelli, 2002, p. 562). A study on the context and specifics of the educational success in Singapore has stressed the importance of tight coupling for aligning policy and practice (Dimmock and Tan, 2013). Overall, tight coupling in educational organisations was found to focus on "rules, regulations, monitoring and certification", to bind "members to the organizational goals" and to strive for "organizational effectiveness" (Hautala et al., 2018, p. 248). Alternatively, schools have also been described as institutionalised organisations, where decoupling is used to maintain existing structures and regulations, while being largely independent in their specific actions and developments (Meyer and Rowan, 1977b). Against this backdrop, we sought to scrutinise various coupling processes in schools in the concrete situation of assessing and reducing CO_2 emissions.

3. Methods

3.1. Research context: research-education-cooperation k.i.d. Z.21_aCtiOn2

This paper builds on the collaborative, transdisciplinary situational analyses conducted in the school years 2020/2021 and 2021/2022 in the project *k.i.d.Z.21_aCtion2* which was facilitated in order to support Austrian and German schools in their processes of assessing and reducing CO_2 emissions. Accordingly, the project's name consists of the German acronym for "competent into the future" (k.i.d.Z.21) and a reference to necessary action on CO_2 reduction (aCtiOn2). Considering the global relevance of climate action and climate change education (UNESCO, 2019), the barriers and possibilities of collaborating with young people on organisational change, and particularly more climate-friendly schools, however, seem to be highly relevant beyond the scope of this project.

For this study, seven school classes from six different schools (see Table 1) were invited to participate dependent on their preliminary participation in the research-education cooperation *k.i.d.Z.21* (Keller et al., 2019; Kubisch et al., 2022). A series of educational workshops was developed for the students in which they were guided through a process of identifying their school's carbon emissions and developing effective, climate-friendly measures (Keller et al., 2022a; Keller et al., 2024). The different activities covered aspects such as understanding difficulties of behavioural change, creating visions of more climate-friendly schools and scrutinising the schools' potentials for change. In a transdisciplinary manner, the participants were involved as the experts of their schools and asked to develop group projects on their proposals for climate-friendly measures. They were enabled to apply the previously acquired awareness of causes and consequences of climate change in the context of creating more climate-friendly schools. Putting the students' ideas, experiences, and wishes at the centre of our collaboration, we refrained from the often unsuccessful but nevertheless most common way of trying to initiate change in schools, as a top-down, planned change (Beycioglu and Kondakci, 2021), and instead directly involved the students in the process of organising change (Rousell and Cutter-Mackenzie-Knowles, 2020). Hence, we set out on a collaborative "wayfinding", which permits dealing "with the unexpected, the unthought and the unthinkable" (Chia, 2017, p. 115).

Thus, a situated and place-based approach, building on the individual schools' specifics, was developed. Our role as researchers and change agents in the continuous change processes was to support the participating students to recognise, visualise and reframe existing practices (Weick and Quinn, 1999, p. 366). Increasing the focus and sensitisation towards climate-friendly transformation and offering support and inspiration, we contributed to creating climate-friendly measures and milestones. It was, however, neither a process we initiated from scratch nor one we aimed to end, rather we were "interrogating *organization as a process* that schools go through, and the current *form* as an outcome of that process" (Trinidad, 2022 emphasis in original). By "placing ourselves at the centre of an unfolding phenomenon" (Tsoukas and Chia, 2002, p. 571), we sought to study the change processes, track and evaluate the barriers that arise in the becoming of more climate-friendly schools. In the course of the identification of the barriers, the coupling

Table 1
Background information on the participating schools and their contexts (for a previous version, see Liebhaber et al., 2023).

	School 1	School 2	School 3	School 4	School 5	School 6
Country	Germany	Austria	Austria	Germany	Austria	Austria
Inhabitants of locality	14,000	20,000	130,000	19,000	860	207,000
Students at the schools	750	760	900	580	250	520
Participating students	28 (1st year) 20 (2nd year)	39	16	18	22	29
Year(s) of participation	2020/21 2021/22	2020/21	2020/21	2021/22	2021/22	2021/22
School type	academic high schools				Higher Federal Teaching & Research Institute	secondary school for economic professions
Public transport options	buses	buses	buses & trams	buses	(partly) buses	buses & trams
Food options	kiosk	kiosk	kiosk, bakery, super-market	kiosk, super-market	canteen	food vending machines, super-market
Heating and electricity status	some solar cells on roof, students identified doors and windows where lots of cold air gets in	heating cannot be regulated in school, windows tend to be opened with heating on	old school building with old heating and windows, will be renovated soon	caretaker reluctant to share details on electricity, LED lamps proposed by students	new school building, climate-friendly heating and electricity	old school building, heating and lighting are often not switched off
Collaboration with teachers	long-term partner of research group, very motivated	strong focus on exact calculations, lots of support for students	long-term partner of research group, aware of critical role of head-teachers	very keen to facilitate effective change, encouraging students	focus on sustainability awards and exact calculations as starting point	experienced with environmental education, debates with pessimistic students

processes between different social worlds (e.g. teachers, students and the administrative district office), and the arenas, where these stakeholder groups interfere (e.g. school, lessons and excursions), were investigated to better understand how barriers develop out of organising processes.

3.2. Methodological approach

As *k.i.d.Z.21_aCtiOn2* connected climate change education and the creation of climate-friendly measures, the situational mapping tracked important aspects of schools aiming at climate-friendly transformations. For instance, the importance of more-than-human aspects as well as non-pedagogical staff has been revealed (Liebhaber et al., 2023). However, adopting an organisational studies approach to turning schools more climate-friendly, the focus here lies on the barriers, the affected social worlds and arenas, as well as coupling processes connected to the detected barriers. In a process of iterative looping between empirical data and the evolving theory (Clarke et al., 2018, p. 28), connections between the confronted barriers to climate-friendly transformation and coupling processes were investigated.

More specifically, the methods used for this study are composed of five steps (see Fig. 2). Data was collected using the mapping methods laid out in Adele Clarke's Situational Analysis (Clarke, 2005; Clarke et al., 2018). The messy maps created by students (step 1.1 in Fig. 2) and the maps on the students' projects (step 2.1 in Fig. 2) comprise a complex set of information on the situation of young people trying to create more climate-friendly schools. By virtue of the graphical depiction of all elements relevant to a situation as well as their relations, we considered Situational Analysis, in particular the situational maps and the maps of social worlds and arenas, as helpful in understanding barriers and the connected coupling processes.

In step 1.1 of the data collection (Fig. 2), we tasked the participating students with creating their own situational maps (see Appendix 1 for an example of one of these so-called 'messy maps'). They were asked to assess the starting point of the project *k.i.d.Z.21_aCtiOn2* in a digital mapping tool. To guide this process, they received a link to an online board in which the questions and fillable fields were prepared beforehand. The situation they should analyse was summarised in the middle of the maps as 'Your school aims to calculate and reduce its carbon emissions'. Based on this situation, the following four questions were included as branches in the maps:

- Which persons are important at your school?
- Which groups of people (e.g. classes) or projects are important at your school?
- What discussions have already taken place at your school about climate change and climate protection?
- How and where do you generate carbon emissions at school?

This data collection by the participating students followed Clarke's research with messy situational maps. We received three extensive messy maps of the schools participating in the first school year in step 1.1. Combining the information of the schools' individual maps, we assembled them in a map of social worlds and arenas (step 1.2 in Fig. 2) and visualised them as fluid entities with porous boundaries (Clarke, 1991, p. 137). Overall, steps 1.1 and 1.2 were necessary to determine the actors and situational aspects which might shape the barriers to implementing climate-friendly measures.

Adding to this understanding of the involved social worlds and arenas, steps 2.1 and 2.2 then were directed towards a more detailed understanding of the barriers themselves (see Fig. 2). In step 2.1, the researchers gathered further data in situational maps following the same structure and questions as created for the students' maps in step 1.1. The captured elements are regarded as constitutive of the examined situation (Clarke and Star, 2008, p. 128), including the ideas, goals and results of the students' projects for more climate-friendly schools, but also related or affected persons and groups and ongoing discussions (see Appendix 2 for an exemplary snippet of one of these maps). The mapping of all aspects in this situation built on the "poststructural assumption […] that *everything in the situation both affects and co-constitutes most everything else*

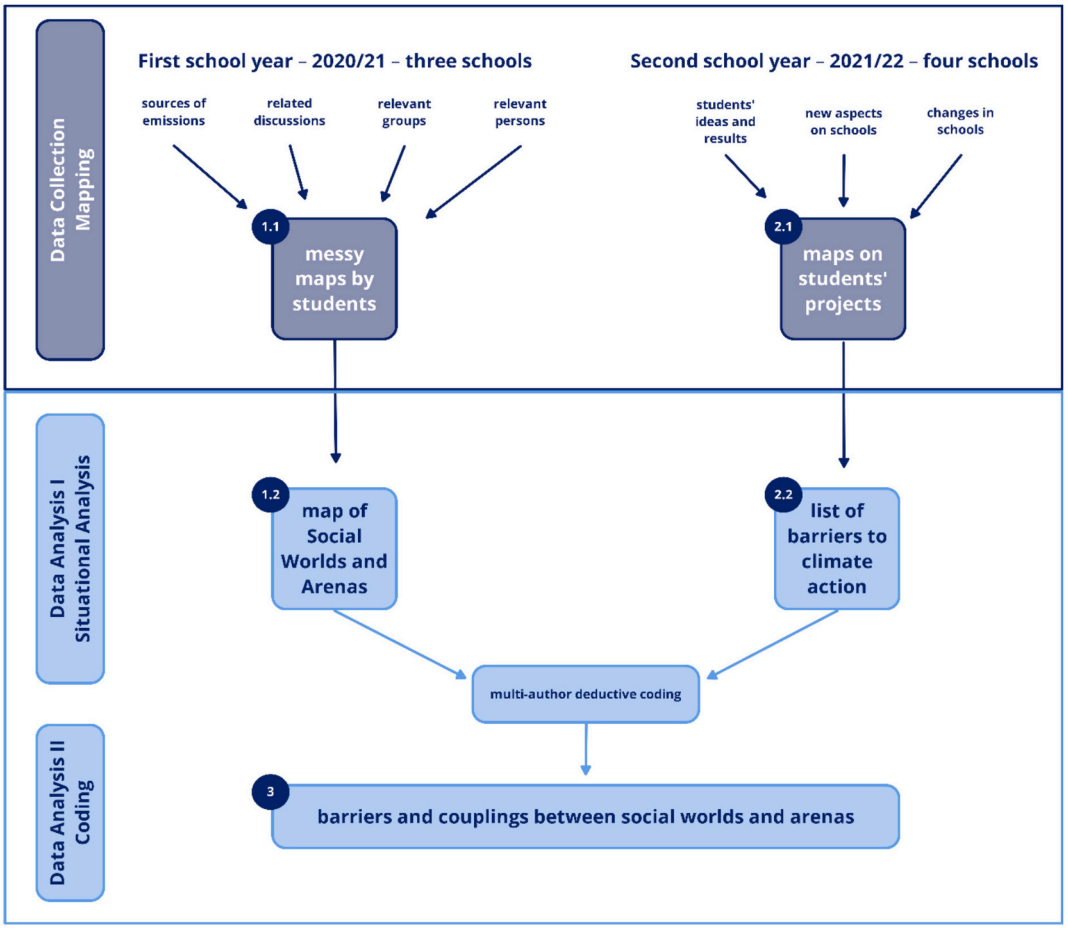

Fig. 2. Methods towards understanding the influence of organising processes on the development of situated barriers to climate-friendly transformation (the numbers indicate the five methodological steps).

Table 2
Operationalisation of Coupling Theory for Coding Process, including criteria for and examples of multi-author coding.

Coupling Type	Definition	Examples
Decoupling	Two elements are clearly distinct from each other and have no direct influence on each other. There may be a complete lack of communication or interaction. Another entity or person is needed to mediate in these situations.	• Decoupling between students and headteachers: Headteachers are not attending the final presentation of students' ideas. There is no platform for students to communicate their proposals. • Decoupling between students and the arena of heating: The students do not know how to regulate the heating. In another school, the heating is always on, and the students cannot change it.
Loose Coupling	The two elements have a high level of responsiveness, but because of their simultaneous distinctiveness their influence on each other can vary. It may be sudden, occasional, negligible, indirect and eventual. There can be some form of communication but no direct feedback. Participants may be confronted with a situation or barrier but can actively decide if and how to react.	• Loose coupling between students and cafeteria staff: Students talk with cafeteria staff and suggest changes, but they provide no feedback and are not motivated to implement the students' ideas. • Loose coupling between students and the arena of commuting: Students describe public transport as often too full and disgusting. They cannot change means of public transport or their schedules but decide to avoid it where possible.
Tight Coupling	The elements' high responsiveness and low distinctiveness lead to clear hierarchies. Change may be quickly and directly implemented. There is feedback, at least one loop, between the social worlds or arenas. This type of coupling may also involve decisions that no one else can take.	• Tight coupling between teachers and the arena of electricity: Teachers always switch on lights when entering the classroom. • Tight coupling between students and the arena of food and nutrition: Food is wasted when students do not like the lunch prepared for them and decide not to eat it despite having booked it beforehand.

in the situation in some ways" (Clarke et al., 2018, p. 46 emphasis in original). Throughout the collaboration in the second school year, we constantly added new aspects and developments drawn from participating teenagers' experiences, e.g. when the students gained new insights or encountered barriers. Thus, the multi-level situational mapping of barriers in step 2.1 resulted from the intensive transdisciplinary collaboration with the participating students over several months. After each of the different workshops in which the researchers supported the students in assessing and reducing the schools' CO_2 emissions, the maps were complemented with new aspects respectively. For instance, one branch of a map started with the students' question on what happens with their school's waste. Each time they found something new or shared an update with us, we added that in these maps. This included new ideas and challenges, new details and numbers, the students' reflections and worries. Thereby, data on the whole process, arising barriers and connected themes, people and discussions was collected. By tracking this process, step 2.2 (see Fig. 2) revealed barriers that led to the point, when students abandoned or changed their projects. After the end of the school year, we derived concrete examples of situations in which the students were confronted with barriers in four different schools. In order to render these barriers more tangible for further analysis, we assigned different categories of barriers. Through the complex mapping of all aspects relevant to the situation, we were later on (see next step) able to link the development of the barriers to certain social worlds and arenas.

Lastly, the participants' analysis of the situation of schools seeking to assess and reduce their emissions (steps 1.1 and 1.2), and the researchers' analysis of arising barriers (steps 2.1 and 2.2) were connected in order to understand how the barriers developed out of the related situations in step 3 (see Fig. 2). Hence, we identified connections between social worlds and arenas that were relevant to the respective situation of each barrier since a general assessment of coupling processes is not achievable and, depending on a given situation or domain, specific elements might be more or less coupled (Gamoran and Dreeben, 1986). Accordingly, coupling is described as a process, not as a static relationship, it is "something that organisations do, rather than merely as something they have" (Orton and Weick, 1990, p. 218). The coexistence of different forms of coupling has been shown on various levels of organising as well as in connection to different topics (Rasche, 2012; Trinidad et al., 2023). Thus, our goal was to analyse the simultaneous forms of coupling in schools and their effects on change processes. Through multi-author deductive coding, pairs of social worlds and arenas were assigned to every situated barrier. In most cases, more than two social worlds or arenas were connected to a barrier, and multiple pairs were detected for most of the barriers. To determine how these barriers developed out of organising processes, we then analysed the forms of couplings of each of these pairs. For that purpose, three authors independently coded the entire data set, two of whom were involved in the facilitation of the participatory research while the third had no prior knowledge of the data. Each pair of social worlds and arenas was coded as "tightly coupled", "loosely coupled" or "decoupled". In order to detect these coupling processes, a detailed analysis of situational elements was necessary, including what was and what was not done (Weick, 1976, p. 10). To render this process reproducible, we operationalised the three types of coupling based on coupling theories (see Table 2). We also settled beforehand on assessing the coupling only in relation to the specific example in which the barrier to climate-friendly transformation arose – instead of a more general assessment of the involved elements' relation. Whenever the coding was not identical, the three coders discussed their reflections of the barriers with a fourth author with whom a consensus was reached on how the situated pair could best be described. This process was guided by reassessing together how exactly social worlds and arenas interacted when barriers arose in the collaborative process with the students.

4. Findings

In the following, we first present the situated social worlds and arenas relevant to climate-friendly change processes of schools (findings of step 1 of Fig. 2). Afterwards, the barriers that arose through the transdisciplinary attempt of assessing and reducing the schools' CO_2 emissions are outlined (findings of step 2 of Fig. 2). Connecting these findings, we provide an account of the identified coupling processes which describe the barriers' development (findings of step 3 of Fig. 2).

4.1. Social worlds and arenas in the schools

To capture the situational human and more-than-human aspects relevant to the schools' attempts towards climate-friendly transformation, we mapped the social worlds and arenas which the students mentioned in their situational analyses (see step 1.2 of Fig. 2). Fig. 3 summarises only the social worlds and arenas which are relevant to the three barriers most prevalent to young people's attempts of creating more climate-friendly schools (see 4.2). The dotted lines of both, social worlds and arenas, emphasise their porous boundaries – they are in continuous processes of shaping and reshaping. The social world of students, and the arena of the school, are at the centre of this map as the inquiries and development proposals were led by the students. The close collaboration and transdisciplinary learning settings led to an in-depth study of how the students experience climate-friendly transformation attempts in their schools and how their efforts might be hindered by

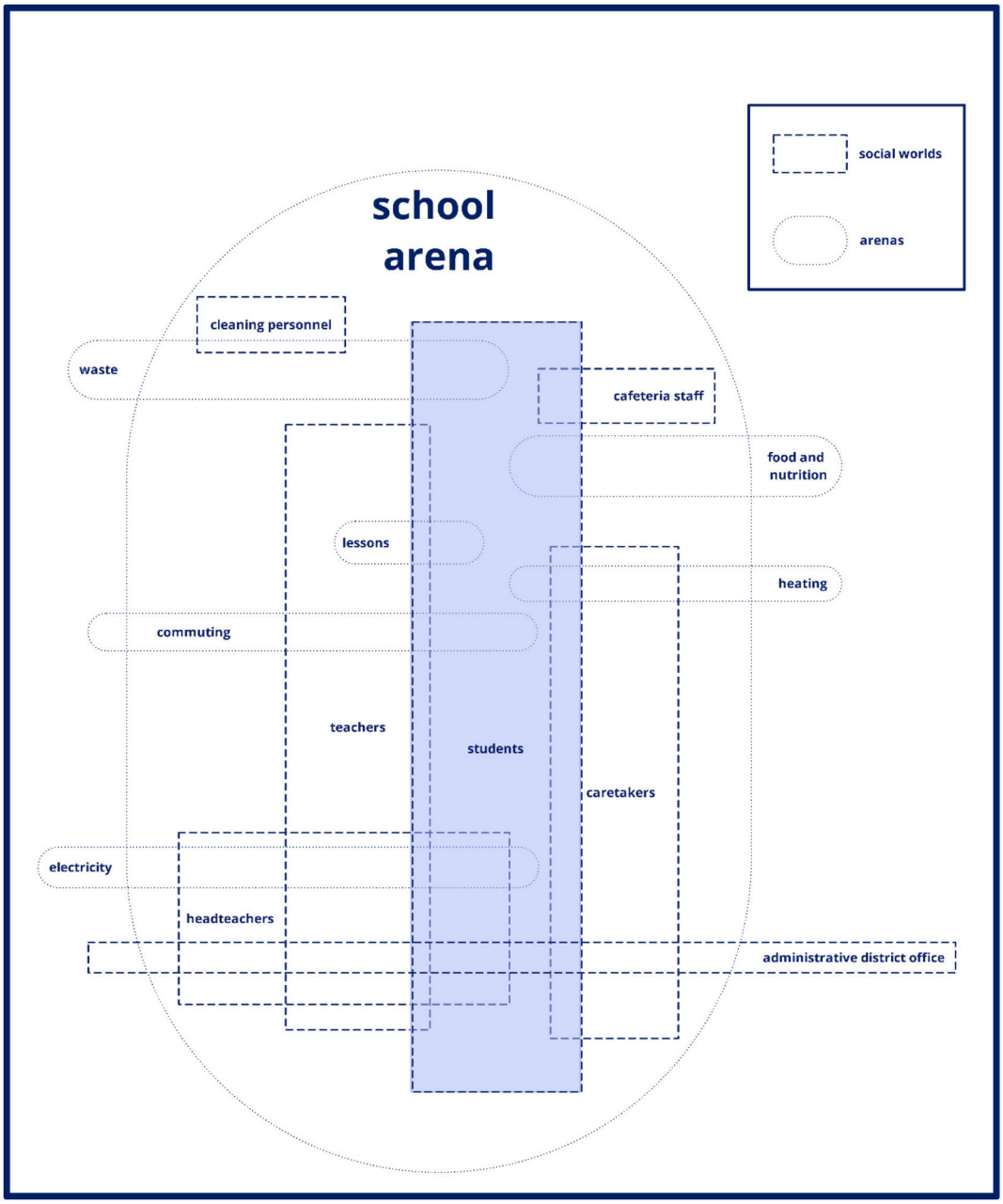

Fig. 3. Map of social worlds (cuboids) and arenas (ovals) which were relevant to the three most prevalent barriers young people had to confront trying to reduce their schools' carbon emissions. The young people are highlighted as they were at the centre of the transdisciplinary collaboration with Austrian and German schools.

Table 3
Barriers identified in the transdisciplinary attempt to create more climate-friendly schools with Austrian and German high school students. The numbers in parentheses indicate how often these barriers were identified.

Barriers	Description
Infrastructure (7)	Infrastructures inside and outside the schools influence the students' and school personnel's possibilities of adopting climate-friendly behaviour.
Dependencies (6)	Many changes depend on authorities' decisions inside and outside the schools.
Frustration (6)	Confronting the complexity and scale of the transformation required, the students lack reassurance that their efforts will lead to real changes.
Individuality / Freedom (5)	Some climate-damaging behaviours are not abandoned because they allow people to make choices based on their individual preferences.
Money (5)	The assessment of schools' emissions and steps to reduce them involve various costs. For some, this may even mean a reduction in income.
Lack of information (4)	The detailed information on emission areas necessary for the creation of CO_2 balance accounts and targeted measures is often difficult to access.
Lack of motivation (3)	At both individual and collective levels, motivation to adopt climate-friendly behaviour is often lacking or difficult to generate.
Habits (3)	Entrenched habits persist despite better knowledge and strategies to convince and remind people of climate-friendly behaviour.
Discouragement (3)	Parts of the school community, particularly the authorities, discourage students and neglect their potential impact.
Feeling of powerlessness (2)	Affected by complex power structures, students feel powerless to take action against climate change.
Indifference (2)	Despite the students' efforts and motivation, some school staff reacted with indifference or even disapproval.
Unclear responsibilities (2)	The variety of pathways to more climate-friendly schools, combined with uncertainties about effectivity, lead to unclear responsibilities.
Individual preferences (1)	Personal preferences outweigh climate-friendly tendencies.
Convenience (1)	Because climate-friendly options often require more effort and less comfort, people tend to choose the more convenient actions.
Vagueness / Uncertainties (1)	Responsibilities for taking steps towards climate-friendly transformations are dispersed, vague and not clearly communicated.

other social worlds. Headteachers, caretakers, parents, etc. were not involved to the same extent and thus their perspectives on schools becoming more climate-friendly are not directly represented in this analysis. Starting to grasp the situation from the students' perspectives then connections to all the other mapped arenas were identified, as they all relate to the school arena and are, in addition, tied together by several social worlds which interact in different arenas. For example, the social worlds of students and of teachers perform the shared activities and functions of their worlds in different arenas, such as the arenas of lessons and of excursions. Alternatively, the social world of students also shares activities and functions with the social world of caretakers, such as in the arena of commuting. There are other arenas, such as food and nutrition, gardening, heating and electricity which heavily affect students in their daily lives in school, but in which they do not or cannot actively participate. They registered those arenas in their mappings without indicating their involvement in the related discourses.

It is also important to emphasise that some social worlds, particularly the students, are a very heterogenous group, including various subworlds. Hence, some students might be closer to certain arenas than others – some are trying to get involved in the arenas of gardening, food and nutrition, while others are making no attempts to establish closer couplings. Despite the focus on assessing and reducing the schools' emissions, the mapping illustrates many arenas that stretch far beyond the school itself and in addition, affect young people in other situations beyond their time at school.

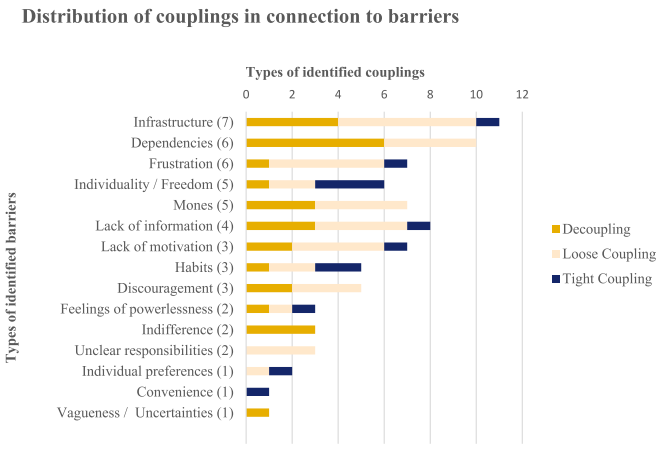

Fig. 4. Distribution of tight and loose couplings as well as decouplings between social world and arenas, connected to the barriers which were revealed through the transdisciplinary attempt to create more climate-friendly schools with Austrian and German high school students. The numbers in parentheses after the barriers indicate how often these barriers were identified. The number of identified couplings varies according to the number of social worlds and arenas involved.

4.2. Barriers to schools' climate-friendly transformation

In the process of assessing and reducing the CO_2 emissions in the participating schools, the students had to confront several barriers. Overall, 15 types of barriers to climate-friendly transformations have been identified through the situational mapping during the second school year in the project *k.i.d.Z.21_aCtiOn2* (see step 2.2 of Fig. 2 and Table 3). Some barriers already existed before the students started their attempts to implement climate-friendly transformations but were not visible or relevant to them at that time. Others developed through or during the students' projects for more climate-friendly schools. All barriers represent the students' perspectives and experiences in their attempts to introduce climate-friendly measures.

To illustrate aspects of the barriers' concrete, situated formation in the schools, we provide some more details on the most prevalent barriers. **Being tied to rigid infrastructures** became apparent, for example, in students' projects which dealt with mobility and possibilities to use public transport for commuting to the schools and thereby reduce the schools' emissions. One student group in an Austrian city emphasised how they believe that everyone in their school would get their own motorbike or buy a car as soon as possible. Existing public transport infrastructures were in many cases disapproved by students and school staff because of high prices, discomfort, lacking availability and extended commuting durations. Some students reported that they had to pay for their bus tickets when reaching a certain age and many would then decide to commute by motorbike or car. Teachers and older students thus tended to use motorised vehicles to get to school to avoid these inconveniences while existing infrastructures seemed too rigid and lacking the possibilities to be transformed by students. It should be noted that other barriers such as the lack of funding as well as entrenched habits also contributed to challenges in transforming commuting habits. Waste separation in the schools, as another example, was also impeded by non-climate-friendly, rigid infrastructures, such as not enough available bins or missing time resources of the cleaning personal to separate waste properly. **Being dependent on others' actions** refers to decision levels outside the students' direct sphere of influence. In order to achieve their goals, they depend on corresponding actions by staff inside and outside the schools, such as teachers, headteachers, caretakers but also representatives of the administrative district office. These dependencies became apparent in terms of far-reaching, structural decisions, but also affected students' personal decisions such as food

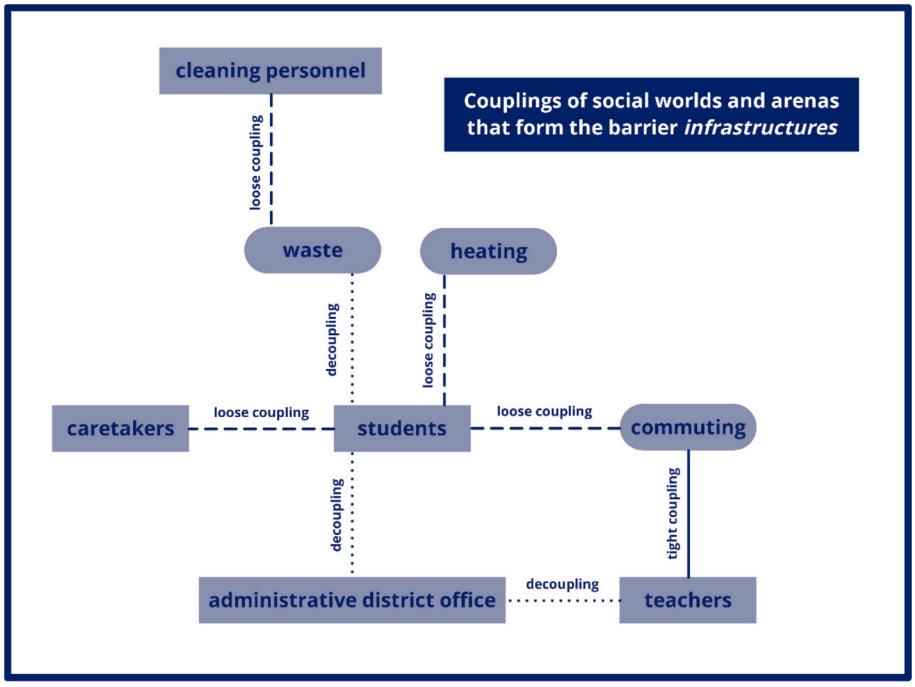

Fig. 5. Identified couplings in connection to the barrier of infrastructures inside and outside the schools influencing the students' and school personnel's possibilities of adopting climate-friendly behaviour. The dashed lines represent instances of loose coupling; the dotted lines represent instances of decoupling.

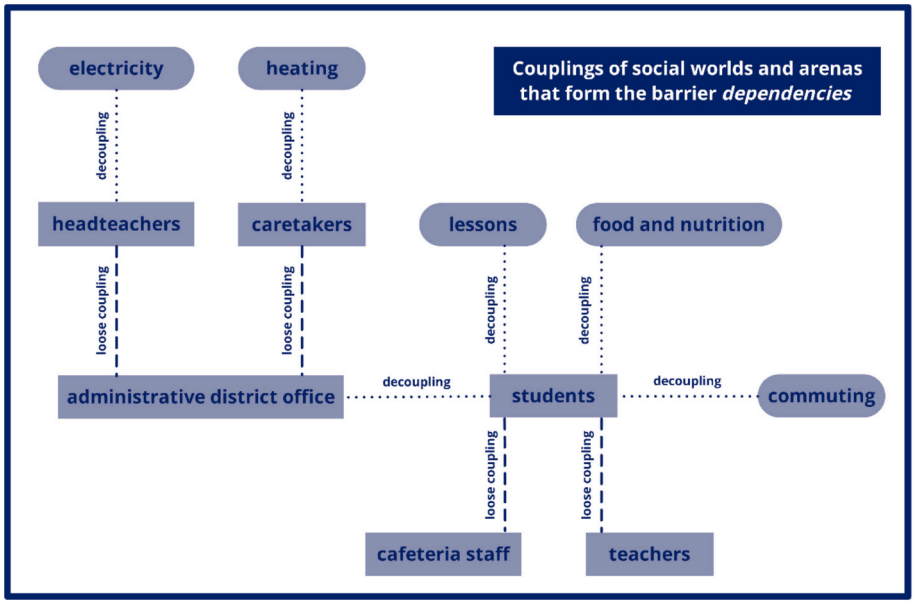

Fig. 6. Identified couplings in connection to the barrier of many changes depending on authorities' decisions inside and outside the schools. The dashed lines represent instances of loose coupling; the dotted lines represent instances of decoupling.

choices. Participating students suggested, for instance, creating more climate-friendly menus, taking measurements with thermal imaging cameras or installing LED light bulbs. However, decision-makers involved in the project were often unwilling to provide the necessary money, time or other resources, or simply ignored the students' wishes. For instance, active support from the administrative staff would have been necessary to bring more plants into the schools and on the school ground to realise the students' visions of creating greener schools. Another group of students reported they could not turn down their heating even if it was too warm in the classrooms because it was centrally regulated by an administrative body which was over 300 km away. Further analysis of the role of school governance is required in determining concrete options for successful transformative measures by high school students. **Getting frustrated about the likelihood of change** was mainly connected to the fact that the young people did not feel supported by others and therefore, lost faith in the possibility of creating a more climate-friendly school. First, this frustration stemmed from students' not believing that their peers would be willing to refrain from certain actions and change their habits in the long run. Many believed that neither information strategies nor incentives would change students' commuting habits or tendencies to forget to switch off the lights in the classrooms. One group of students stated that their peers

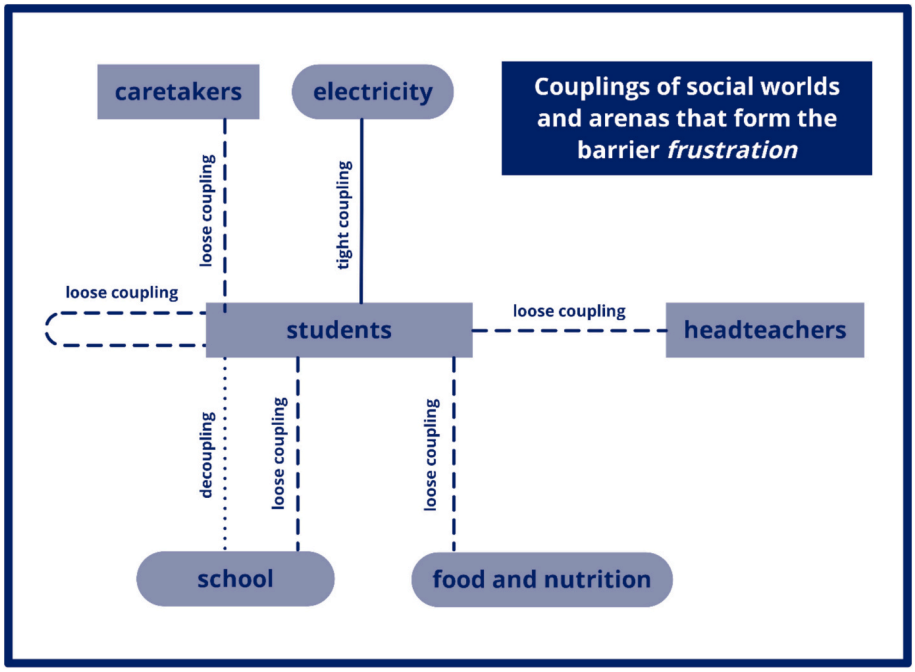

Fig. 7. Identified couplings in connection to the barrier of the students lacking reassurance that their efforts will lead to real changes when confronting the complexity and scale of the transformation required. The solid lines represent instances of tight coupling; the dashed lines represent instances of loose coupling; the dotted lines represent instances of decoupling. Some elements are coupled in different ways depending on the specific situation.

did not care enough or would not be willing to grapple with climate change. In other cases, the frustration appeared during or after the assessment of the school's CO_2 emissions. For instance, some students calculated how much their school's carbon emissions could be reduced by always switching off the electronic boards and were frustrated that it would have a relatively small impact. In other cases, they got the impression that their proposals would not be implemented anyway. At one school, the caretaker refused to even consider the students' proposals, suggesting that nobody would like to buy climate-friendly food. The frustration about the likelihood of change is also interconnected with other barriers. For instance, it has been partly exacerbated by others' discouraging statements or actions.

Swift changes of mindsets or plans mainly characterised the students' reaction to the various barriers. Although some barriers certainly would have been challenging to overcome for them (e.g. bad public transportation systems), other barriers were more permeable and could have been utilised as sensitising concepts for creating strategies towards overcoming barriers. Facing, for example, involved stakeholders' frustration, indifference or lacking motivation, they could have tried to convince these groups or contribute to changing their attitudes. Being referred from one person to another or being denied important information, the students could have insisted on the importance of their projects and the aim of a more climate-friendly school. Instead, in most cases, they lacked assertiveness and accepted that their idea was not feasible or that change, in general, was not an option. The process of change was often immediately interrupted – while some groups could be encouraged to fight for their ideas or find ways around the barriers, others lost motivation and limited their further engagement to a minimum.

4.3. *Situatedness of barriers at the interstices of social worlds and arenas*

To understand the context and development of each barrier, we identified connections of social worlds and arenas which were relevant to the respective barrier (see step 3 of Fig. 2). These pairs were coded as instances of, loose coupling (38), decoupling (24) and tight coupling (12). Before looking more closely at examples of coupling processes in relation to the most prevalent barriers, the general distribution of the forms of coupling has to be considered. Despite a prevalence of loose coupling, barriers were shown to develop in relation to all three types of coupling. While this precludes simple ways of preventing barriers by aiming at changing coupling processes, it also provides further insights into the development of barriers. As becomes apparent in Fig. 4, there are two barriers which only appeared in cases of decoupling: being confronted with others' indifference and situations shaped by uncertainties. For the other barriers, decoupling and loose coupling are relatively evenly represented. About half of the identified barriers appear in relation to all three forms of coupling. Since six barriers where not associated with tight couplings, tightening the coupling in these contexts might be considered.

In order to scrutinise the interrelations from which barriers to climate action arose, we focus on the coupling processes which were relevant to the three most prevalent barriers (see Figs. 5, 6 and 7). Since the analysis builds on the students' perspectives and experiences, the assessments centre around the social world of the students. Some connections reappear repeatedly, such as 'students' and 'caretakers' (Figs. 5 & 7), or 'students' and 'commuting' (Figs. 5 & 6). Some social worlds and arenas are not coupled in the same manner in the context of different barriers. For example, 'students' and 'commuting' were found to be decoupled in the situation of dependencies becoming a barrier to climate-friendly transformation (Fig. 6). This was the case when the students proposed to provide job bikes for teachers and found that their dependency on others' decisions decoupled them from the arena of commuting. In the instance of infrastructures becoming a barrier, however, 'students' and 'commuting' were often loosely coupled (Fig. 5). There were not enough school buses at one school or older students had to pay for the buses at another school, leaving the students loosely coupled to the arena of commuting as they were affected by and could to some extent still affect the arena of commuting.

The connection between 'students' and 'school' is of particular interest as it portrays to which extent the students can affect their schools – cases of both decoupling and loose coupling have been identified between students and schools (Fig. 7). The decoupling was characterised by the students not believing in the possibility of change and not having

access to either relevant information or decision-making processes.

The analyses revealed a tendency of some social worlds to present themselves as decoupled from a specific arena, while the collaborative work showed that these were rather tightly coupled. As previous research has shown, people (or social worlds) may decide to decouple themselves from decisions (or arenas) (Lutz, 1982). For instance, although it was clearly part of some caretakers' job to organise the school's waste system and provide respective bins, they partly refused to take responsibility in this regard. This also applies to the students, who suggested their decoupling of the arenas of waste and commuting in specific situations (Figs. 5 & 6). However, in these cases, they would have had options to separate waste or to use climate-friendly transportation.

5. Discussion: Identifying and tackling barriers in different organising processes

With this study, we sought to create a detailed account of the situations in which barriers to school's climate-friendly transformation arise. Combining our findings with previous studies, this discussion elaborates how barriers to creating more climate-friendly schools could be addressed in different organising processes. As the precondition to the exploration of possibilities of overcoming barriers, we deem it crucial to connect them to their related organising processes. By locating the barriers between involved social worlds and arenas, we analysed how the barriers developed in concomitant organising processes. Reconsidering each form of coupling, we discuss aspects which should be considered in future studies and similar initiatives.

Although we acknowledge the limited generalisability of this study given its focus on Austrian and German schools, we expect that similar examples could be found in schools in other contexts. Many of the identified barriers are connected to general complexities and difficulties of adopting more climate-friendly practices and motivating transformation. The situation-specific conditions created by the availability of infrastructures, funding and other resources greatly influenced the possibilities of climate-friendly transformations. Nevertheless, the prevalent barriers in this study, rigid infrastructures, dependencies on others and frustrations about the possibilities of change, are likely to appear in different organisations which seek to reduce their emissions. More generally, barriers to change can arise wherever the social worlds and arenas involved, and their respective interests, collide.

5.1. On barriers between decoupled elements

Barriers in connection to *decoupled elements* might be most difficult to overcome, as the involved social worlds could not affect the other social worlds or arenas. Since change is thereby almost rendered impossible, recoupling seems crucial. Only a few studies deal with the possibility of changing coupling, particularly in dealing with decoupled elements. However, Hallett's study (Hallett, 2010) on recoupling processes in an elementary school provides some ideas on potential approaches and a detailed account of the fundamental changes as well as disruption that deliberate recoupling can cause. In relation to the schools participating in *k.i.d.Z.21_aCtiOn2*, for instance, the decoupling between students and heating and even more so between students and their school could be changed by headteachers' and teachers' committed action or even by their openness to communicating with the students. If students were empowered to influence these arenas in a certain way, the current coupling would change, increasing the possibility of climate-friendly transformation. Frequently, the students were decoupled from other social worlds, such as the caretakers, headteachers or the administrative district office, as these stakeholders refused to communicate with the young people. Targeted steps towards more open and fruitful communication and effective collaboration on climate-friendly transformations could also prevent the students from decoupling themselves from certain arenas.

5.2. On barriers between tightly coupled elements

As has been elaborated (see 2.5), *tight coupling* could be described as beneficial to achieve rapid and fundamental changes that are critical in the face of climate change. Coordination and control are difficult in the context of loose coupling with the different parts interacting in complex and variable ways (Weick, 1982a). Thus, previous studies highlighted possible strategies for tightening a loose system, elaborating the potentials of enhanced leadership, focused effort and shared values (Burke, 2014; Orton and Weick, 1990). In relation to the practical examples of this study, this might comprise strict guidelines for schools, students being tasked to create bus schedules, or caretakers having to implement climate-friendly measures. However, this study has revealed that tight coupling does not necessarily lead to strengthened or accelerated climate-friendly transformations. Hence, we argue that despite theoretical possibilities of tightening existing couplings, it is neither realistic nor efficient or even favourable in the case of schools' climate-friendly transformation. Since schools are complex and climate-friendly measures are not their primary objective, tightening would take too long and certain educational aims might be neglected in extremely tightly coupled systems. Within k.i.d.Z.21_aCtiOn2, barriers in connection to tightly coupled elements involved social worlds that could have changed something but decided not to. Possible solutions to this deadlock might comprise convincing the social worlds to contribute to climate-friendly transformation and overcoming the barriers. For instance, although students were at least partly found to be tightly coupled to the arena of waste, and teachers were found to be tightly coupled to the arena of electricity, the respective actors did not use their possibilities to contribute to climate-friendly transformation in these cases.

5.3. On barriers between loosely coupled elements

Instances of *loose coupling* prevailed in relation to the barriers of schools' climate-friendly transformation – more than half of the identified couplings were loose. In these cases, the social worlds were somehow related to other social worlds or participating in the respective arenas. Thus, change would be possible but complex and difficult to predict. For instance, the *k.i.d.Z.21_aCtiOn2* project revealed the loose coupling of the social worlds of students and cafeteria staff. The students' suggestions for creating climate-friendly menus with less meat, more regional and seasonal vegetables and reduced food waste were only marginally or not at all implemented.

In general, targeted and concerted climate-friendly measures might be challenging in loosely coupled systems, as their change processes are "continuous rather than episodic, small scale rather than large, improvisational rather than planned, accommodative rather than constrained, and local rather than cosmopolitan" (Weick, 1982a, p. 390). When change processes are initiated or supported by external interventions (in this study, researchers engaging in transdisciplinary collaborations with schools), further challenges may arise in relation to the specification of their skills, tasks and positions (Kaplan, 1982). Confronting the urgency of extensive climate action, the characterisations of change in loosely coupled systems might seem insufficient or even alarming. But they also provide an answer to why assessments and predictions of loosely coupled systems may be vague or inaccurate (Weick, 1982a, p. 381). Since centralised changes rarely affect and alter the components of loosely coupled systems (Weick, 1982a, p. 398), other approaches to creating more climate-friendly schools should be explored. Thus, it is crucial to elaborate possibilities and to gather experiences of change inside and with loosely coupled systems, and to work "with, rather than against, loose coupling" (Shen et al., 2017, p. 672). This comprises refraining from coercion and instead building on connections, practices, open-ended inquiries, attunement and change (Taptiklis, 2012, pp. 563–566).

First of all, it is vital to recognise that a "loosely coupled system is not a flawed system. It is a social and cognitive solution to constant

environmental change […] and to limited information processing capacities" (Weick, 1982a, p. 405). Hence, loose coupling does not only bear disadvantages, but also advantages. Concurrent loose and tight coupling can be beneficial as it is associated with "commitment, enthusiasm and loyalty to school" (Sergiovanni, 1983, p. 13). While we might be inclined to propose transforming loosely coupled into tightly coupled systems to achieve climate-friendly transformation, the benefits of loose coupling should not be forgotten. As loose coupling creates flexibility, adaptability and the capability of acting on future changes (Weick, 1982a, p. 387), it might be essential to being able to react to consequences of global warming in the future. Rather than trying to change the coupling processes in loosely coupled systems, they could also be used as a foundation for change that is created by multiple stimuli out of the centre of organising (Goldspink, 2007, p. 45). In particular, external change agents should acknowledge existing couplings and enable the involved people to build on them (Kahn, 1982, p. 415). Building on other studies, climate-friendly transformation could be facilitated by adopting an approach of distributed leadership (see e. g. Hatcher, 2005), or fostering "key process factors, such as participation, communication, and coordination" (Beycioglu and Kondakci, 2021). Moreover, the localisation of problems, reliance on self-determination and low coordination costs are only some potential benefits of loosely coupled systems which should be further scrutinised regarding possibilities of building the base for climate-friendly transformations (Weick, 1976)

5.4. Implications for practitioners and policy makers

The analysis of climate-friendly transformations in educational institutions links to broader discussions on barriers to climate action in others contexts and institutions. Even though this research is bound by its focus on German-speaking schools, the presented results can be transferred to both other educational institutions and, beyond that, to organisations that inherit similar structures. Because of the intentionally broad descriptions of barriers (see Table 3), they may be found in a range of institutions in different contexts which try to achieve climate-friendly transformations. For instance, the three most prevalent barriers (being tied to rigid infrastructures, being dependent on others' actions, getting frustrated about the likelihood of change) could be equally relevant in businesses, local administrations or schools in other countries. Researchers and practitioners from other contexts could use them as a starting point for studying and fostering transformative steps.

Instead of perceiving barriers as immovable walls, this study presents the processual development of barriers and thus provides a starting point for addressing them in new ways. Particularly when barriers stem from complex entanglements, uncovering their causes and development is the first necessary step towards fostering effective climate action. This can be a difficult process in which learners, educators and other practitioners might get frustrated or struggle with defining the next steps. The learnings from this study can help policy makers and practitioners to understand and address the origins of barriers they encounter in relation to transformative processes in educational institutions. To successfully overcome challenges that hinder climate-friendly transformations, we recommend to (a) assess barriers' situated specifics, (b) identify relevant actors and aspects in the context of these barriers, (c) get a clearer understanding of how these actors and aspects influence, and possibly disagree with, each other and (d) identify next steps depending on this relationship. The last step is arguably the most difficult in this process as it requires context-specific assessments and decision-making. Bringing together chapters 5.1 to 5.3, we can conclude that,

- when barriers arise from decoupled actors or elements, recoupling these elements is necessary for effective transformation.
- when barriers arise from tightly coupled actors or elements, transformation efforts will need to involve those in power to make the required changes. In practice, this can include different ways of convincing and motivating such as lobbying, petitions, public discussions etc.
- when barriers arise from loosely coupled actors or elements, it must be considered if stronger ties and interrelations could be formed so that concerted action becomes possible. There might be options of encouraging stronger collaborations and couplings. As this study however shows that barriers also arise from strongly coupled elements, we particularly recommend approaches that utilise the flexibility and adaptability of loosely coupled systems. Because of their fluid character, transformations might be implemented faster and smoother in loosely coupled systems.

6. Conclusion

Through the close collaboration with high school students and their insider perspectives in schools, it has been possible to not only identify barriers but also analyse their processual development. Various barriers have been shown to arise at the interstices of social worlds and arenas, ranging from structural to collective and personal aspects. By analysing the barriers' origins within broader organising processes, they can be conceptualised as sensitising concepts that can be used to point out possibilities for climate-friendly measures. Since this study showed that barriers to climate-friendly transformation arise in various forms of decoupling, loose and also tight coupling, attempts to overcome these barriers have to consider how to work within their respective coupling types. This includes taking related advantages and disadvantages into account. Future research should thus engage more closely with questions such as: Why are tightly coupled systems struggling with implementing change despite their clearer hierarchies and responsiveness? How can general and effective climate-friendly measures be implemented in loosely coupled systems despite their openness and fluidity? How are relevant social worlds and arenas coupled in other institutions trying to reduce their carbon emissions? How can we involve young people in experiments and inquiries of addressing barriers in line with the organisational background? Despite these remaining open questions, future attempts to foster climate-friendly organisational change are hopefully inspired to engage more closely with emerging barriers and pay particular attention to the involved actors and their interrelations.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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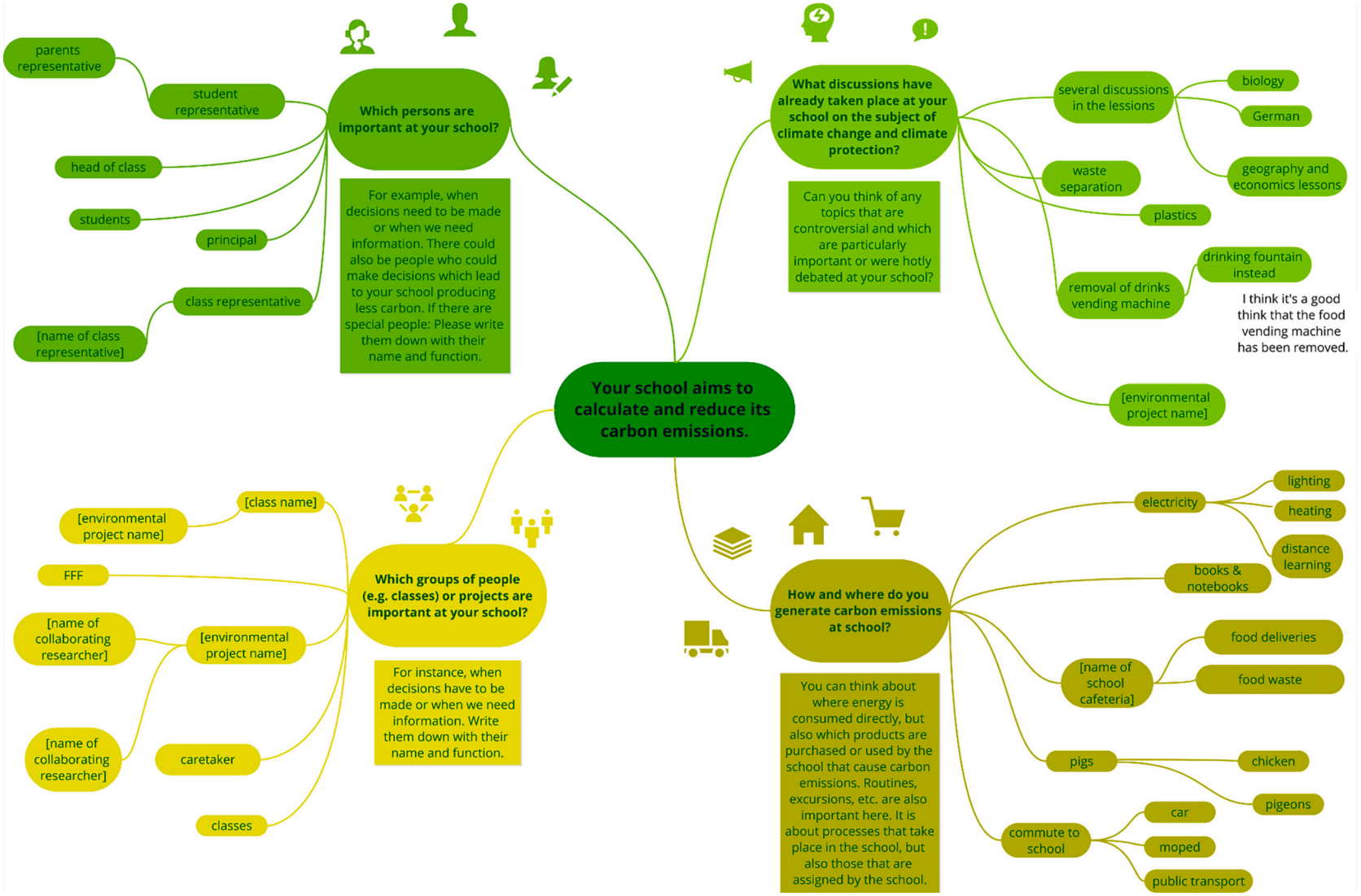
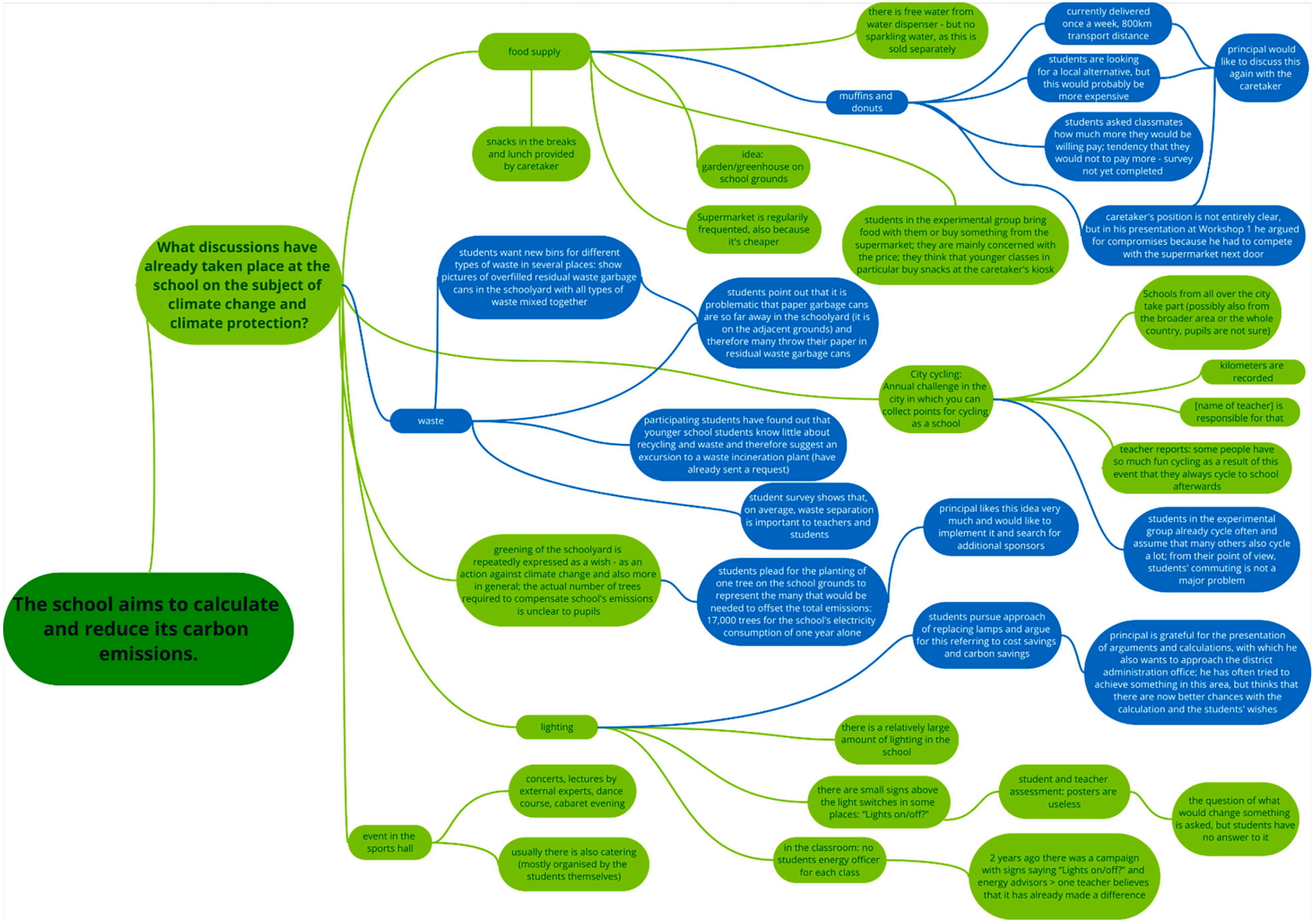
Appendix 1: Example of a messy map created by the participating students



Appendix 2: Exemplary snippet of one of the maps on students' projects



Data availability

The data that has been used is confidential.

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