Article

Levels of Governance in Policy Innovation Cycles in Community Education: The Cases of Education for Sustainable Development and Climate Change Education

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Abstract: While there is little doubt that social networks are essential for processes of implementing social innovations in community education such as Climate Change Education (CCE) or Education for Sustainable Development (ESD), scholars have neglected to analyze these processes in the multilevel governance system using Social Network Analysis. In this article, we contribute to closing this research gap by exploring the implementation of CCE and ESD in education at the regional and global levels. We compare the way CCE is negotiated and implemented within and through the global conferences of the UN Framework Convention on Climate Change (UNFCCC) with the way the UN Decade of ESD is put into practice through networks in five different German municipalities. We argue that the role of social networks is particularly strong in policy areas like CCE and ESD, which are best characterized as multi-level and multi-actor governance. Based on data derived from standardized surveys and from Twitter we analyze the complex interactions of public and private actors at different levels of governance in the two selected policy areas. We find, amongst others, that the implementation of CCE and ESD in community education depends in part on actors that had not been assumed to be influential at the outset. Furthermore, our analyses suggest the different levels of governance are not well integrated throughout the phases of the policy innovation cycle.

Keywords: Education for Sustainable Development (ESD); Climate Change Education (CCE); Social Network Analysis (SNA); multi-level governance

1. Introduction

In recent years, the issues of Climate Change Education (CCE) and Education for Sustainable Development (ESD) have become high-profile projects in education worldwide. School and non-school actors (e.g., educational organizations within communities, educational politicians, administrative staff, civil society actors, foundations or businesses) recognize that attaining sustainability objectives highly depends upon education and learning processes. Likewise, international organizations, such as the United Nations (UN), and international conventions, such as the United Nations Framework Convention on Climate Change (UNFCCC), aim to foster the implementation of CCE and ESD at the regional, national, and global levels. Stakeholders of these organizations highlight the essential role that education plays for the overall success of international agreements on issues around sustainable development [1]. Despite the international relevance of advancing sustainability in education, there is still a lack of studies that analyze the way (community) education is set on the sustainability agenda and explore the role that different stakeholders play in processes of CCE and ESD. Analyzing the role

of different actors in negotiating and advancing CCE and ESD can shed new light on the way these concepts are implemented in community education.

This article seeks to contribute to this emerging research agenda. It sets out to study the role of implementing CCE and ESD in education at the global and regional levels. We compare the way the UN Decade of ESD (UNDESD) is put into practice through networks in five different German municipalities with the way Article 6 of the UNFCCC, which aims at promoting climate change education, is negotiated and implemented at the global conferences of the UNFCCC. Specifically, we seek to answer the following research question: *how do different actors get involved in and influence the complex interactions of education-specific negotiations in the field of sustainable development and aim to foster the implementation of CCE and ESD?*

In analyzing this question, we do not only aim to provide new empirical insights into the mechanisms through which actors exert influence on the processes and outputs of CCE and ESD negotiations, but also to contribute to a better understanding of how global educational innovations are negotiated and taken forward at global and municipal levels.

To answer the research question, we draw on Social Network Theory (SNT) as well as Social Network Analysis (SNA). From this perspective, an actor's impact is inferred from its relative location in policy-specific communication flows [2] rather than from an actor's self-assessment or openly articulated intentions. Hence, an actor's role is determined by its action, behavior, and communication strategies, which are reflected in its position in issue-specific information networks [3]. Empirically, we extract data on the cooperation structures and behaviors of actors involved in the negotiations using information derived from participant observations and Twitter communications concerning the yearly UNFCCC treaty conferences over a period of six years.

With community education we refer to activities "which fall outside of formal school- or university-based programs" and "encompass a broad range of target audiences, topics, and approaches" [4] (p. 84). These initiatives and programs follow a participatory approach, i.e., they are realized by involving a wide range of individuals of all ages with the aim to improve education and quality of life over the life span. "Yet as diverse as community education programs are, most are bound by local context and directed by community knowledge and understanding" [4] (p. 84).

The article is divided into five sections. Section 2 provides a brief state of the art on the topics of CCE and ESD. Section 3 discusses the difficulties in measuring influence in complex governance settings involving multiple levels of policymaking and a wide range of public and private actors. Additionally, social network theory and social network analysis are introduced as alternative theoretical and methodological approaches. Theoretically based empirical findings are discussed in Section 4. Section 5 summarizes the major arguments and outlines prospects for future research.

2. State of the Art

2.1. Climate Change Education

In recent years, CCE has caught the attention of many scholars in educational and political science (e.g., [1,5]). In general, education is seen as an "essential element for mounting an adequate global response to climate change" [6] (p. 3). It helps to understand the impacts of climate change [6] and can increase public awareness and resilience by "helping populations understand and address the impacts of climate change, and [by] encouraging the changes in attitudes and behaviors needed to help them address the causes of climate change, adopt more sustainable lifestyles […] as well as to adapt to the impact of climate change" [6] (p. 3). While CCE forms part of ESD, in the UNFCCC a distinct vision of CCE as the empowerment of the individual to take climate action has been developed. Especially in the most recent negotiations between 2014 and 2016, this concept received considerable attention and political momentum.

In UNFCCC negotiations and events, CCE has frequently been placed on the agenda, and is increasingly regarded as obligatory for effective climate governance. Within the UNFCCC, education is mainly addressed in Article 6 of the Convention, which, since entering into force in 1994, lays the foundation for education in the global climate change regime. Article 6 highlights the importance of

education for combating climate change and calls for international cooperation on CCE [7] (p. 17). Several work programs, such as the New Delhi Work Programme on Article 6 of 2002 and the Doha Work Programme on Article 6 of 2012, have been established with the aim of implementing the Article and fostering a dialogue between different UNFCCC stakeholders.

At the 2015 climate summit, Article 12 of the Paris Agreement was adopted to further strengthen CCE in the UNFCCC. Article 12 highlights that "Parties shall cooperate […] to enhance CCE, training, public awareness, public participation and public access to information, recognizing the importance of these steps with respect to enhancing actions under this Agreement" [8] (p. 10).

2.2. Education for Sustainable Development (This Section Summarizes the Main Findings of [9])

Over the past decade and the half, Education for Sustainable Development (ESD) has been applied in different countries and educational systems. Schools all over the world have implemented ESD as an educational innovation in their curricula. At large, the goal of ESD refers to the incorporation of ecological, economic and environmental aspects into learning and teaching across the life span. The scholarly literature understands ESD as an education that enables persons to predict and answer the difficulties that constitute a threat to life on our earth [9]. To give an example, the implementation of ESD in schools has to include social, ecological and economic aspects, empowering students to modify their performance for sustainability.

Social innovations in education (i.e., educational innovations) can be defined as answers to difficulties in teaching and learning that are new to a particular political system or educational organization (e.g., [9–12]). In conformity with this characterization, ESD is often defined as an international normative concept of education policy enhancement that was established through the announcement of the UNDESD between 2005 and 2014 (e.g., [11,13]). The designated lead agency is the United Nations Educational, Scientific and Cultural Organization (UNESCO). Its main task is to apply and promote UNDESD in education systems at all levels of government, ranging from the global to the national, state, and regional levels. Whilst at the global level, the UNESCO Education Sector mandated the Secretariat of the UNDESD to promote the idea of ESD, its implementation and progress was assumed to happen at the level of the UN members. The UNDESD involves the obligation to undertake wide-ranging actions to include the notion of sustainability in education worldwide. Subsequently, numerous nations have effectively incorporated the idea into their educational systems [14]. Educational institutions have formed arrangements to apply ESD. Due to the multifaceted and interdisciplinary character of ESD, actors have pursued to form alliances, aspiring to operationalize the idea in practice. For instance, environmental NGOs are developing partnerships in further education by providing support or solutions for enhancing ESD activities in corporations.

With educational actors (e.g., schools) and international organizations (e.g., the UNDESD) supporting ESD, educational scientists and researchers have started to get interested in the ways this concept is implemented on the ground (e.g., [15,16]). Likewise, scholars in political science and public policy have started to analyze the impact of global values, norms and international as well as national processes of policy implementation and applications across diverse policy areas (e.g., [17–19]).

A second component of research considers organizations of formal education, such as schools or universities, as the most central organizations in supporting the implementation of international educational innovations [20]. From this perspective, formal education actors mostly drive the transfer of innovations, which were initiated at the global level. However, analysis on implementation processes of the social innovation of ESD are often focused on the formal education sector [21], overlooking the role played by other actors.

Similar to CCE, a multiplicity of actors located at different levels of government and operating at the intersection of two policy domains characterizes ESD. Systematic and comprehensive analyses of actors, interests, and institutions in CCE and ESD policy are, however, still scarce (for an exception, see [1]). While Uherek and Schüpbach [22] (p. 558) find that CCE "is very seldom a core part of the curricula in European schools", they do not analyze the factors that cause the weak implementation of this concept. Other studies focus only on the international organizations shaping CCE, thereby

ignoring the vast array of public and private actors at different levels that contribute to CCE and ESD implementation [23]. While analyses of actors and their relative influence abound in education and environmental policy (for education policy, see [24]; for environmental and climate policy, see the overview in [25]), we still know very little about the actor constellations in CCE and ESD and even less about the relative influence of different actors on their conception and implementation. We assume that this lacuna stems mostly from the difficulties of measuring influence in complex, multi-level and multi-actor policy settings with overlapping policy domains. In this setting, an actor's position in issue-specific communication networks becomes an important determinant of her or his real impact on policy outputs. Furthermore, an actor's material resources as well as its integration into formal decision-making hierarchies may no longer be a reliable indicator of influence. Social Network Theory (SNT) and Social Network Analysis (SNA) can better account for the changed structures and processes of educational policymaking than traditional approaches, as will be explained in the next section.

3. Theoretical and Methodological Orientation

3.1. Theoretical Orientation

Until recently, there has been no unified social network theory, but rather a wide range of network-theoretical perspectives (e.g., [26] (p. 189)). Synthesizing different theoretical constructs in the traditional social network theory, Borgatti and Lopez-Kidwell [27] develop an underlying generic theory: the network flow model [27] (p. 40). This model assumes that many variants of network theorizing, such as the seminal works by Granovetter [28], Burt [29], and Coleman [30], are all elaborations of the same underlying theory. Resting on this "conceptual universe" [27] (p. 44), the authors point out two kinds of relational phenomena: the backcloth and the traffic of a network. The backcloth provides the underlying infrastructure that enables or constrains the traffic, which again refers to what flows through the network (e.g., information on CCE or ESD). The underlying structure comprises similarities, social relations, or Twitter activities concerning CCE or ESD. As such, the backcloth serves as the conduit through which new information flows [27] (p. 44). For example, information exchange is possible based on regional cooperation on ESD implementation, which in turn can facilitate certain relations, such as trusting a cooperation partner, thereby potentially enhancing information exchange.

For the theoretical framework of this article, this perspective is important because it allows the researcher to distinguish between the structural conditions (e.g., network density), the actual flows (e.g., information exchange), and the resources that enable issue-specific negotiations (e.g., workshops, working groups, or standing committees). Moreover, the flow model is useful in examining latent influence because it is expected that authority and communication streams are seldom obvious and cannot be uncovered with direct interviews [27] (p. 45). Hence, influence is conceptualized in relational terms. Influence-seeking actors are, despite "different interests and perceptions of problem(s) and solution(s), [...] interdependent of each other" and thus need to interact in order to acquire resources [31] (pp. 1036–1037). The network flow model can explain variance in an individual or collective organization's performance or achieved rewards. From this perspective, a person or organization gains resources, opportunities, or defines its interests through its relationships, directly impacting on their social capital [27]—for instance, with respect to shaping debates on the implementation of CCE in the UNFCCC.

The advantage resulting from social relationships has been formalized in various ways. Whereas Granovetter [28] contends that the structure of social relationships surrounding a person or organization matters, other scholars point to the significance of the individual's role or position in social relationships. For instance, Burt [29] argues that individual or collective actors benefit from their position in social networks in gaining resources through social capital. In his analysis on structural holes (i.e., missing links between actors), Burt discovers that an actor expands its social capital by positioning itself in an exclusive role or position, permitting only this actor to establish a link between numerous groups in the network. By strategically using structural holes, this actor

benefits from the advantage to get first-hand information and the power to decide to whom and in what manner to share specific knowledge.

3.2. Measuring Influence in Complex Multi-Actor and Multi-Level Policy Settings

Analyzing "influence among individuals, groups and institutions" has been termed "one of the holy grails of the social science" [32] (p. 245). Dür [33] (p. 1223) identifies four major approaches for assessing the relative influence of actors: "process-tracing, measures of attributed influence, and assessments of the degree of preference attainment" as well as taking an actor's resources as a proxy for influence [33] (p. 1220). All of these approaches have their weaknesses. Process-tracing has difficulties in assessing the degree of actor influence [33] (p. 1224). The method of attributed influence, which asks actors to assess their own or other's influence, risks confounding influence with visibility. Finally, measures of preference attainment, which "assess the distance between actors' preferences and policy outcomes" [33] (p. 1224), are impaired by the fact that actors often do not publicly state precise preferences. If an actor's influence is based on his position in a policy network, measuring an actor's resources to assess influence may be misleading [34]. All four approaches run the risk of excluding potentially influential actors that operate at the margins or outside a given policy domain. In cross-cutting issue areas like CCE and ESD this may lead to an overstatement of educational organization's influence at the national and sub-national levels, such as schools, while at the same time underestimating the role of international environmental organizations, such as the United Nations Environment Programme (for the general argument see [35,36]). Overall, in multi-level and multi-actor issue areas that span different policy domains, such as CCE and ESD, the conventional methods for assessing actor influence reach their limits, since scholars tend to focus on highly visible and central actors, disposing of significant resources and openly articulating their policy preferences. Actors whose potential influence results from relational attributes, such as, for example, a bridging position between different, relatively unconnected actor groups and who maintain a low visibility in policy discourses, are easily overlooked.

Against this backdrop, we propose social network analysis (SNA) as a fifth approach for assessing actor influence. SNA is particularly well suited for studying the implementation of educational innovations in the fields of CCE and ESD and is also employed to analyze environmental governance processes [37,38]. This approach shifts the unit of analysis from the individual actors to the relations between groups of actors. In other words, it is the broader structure of social relationships within a policy network, rather than the interests, resources, and strategies of individual actors, that explains policy outcomes (see, for example [39]), or, as Slaughter [40] (p. 2) puts it: "Influence requires connection; the denser the web of relationships, the greater the influence".

Methodologically, we conducted two SNA case studies: the negotiations concerning CCE in the UNFCCC and the implementation of ESD in five different German communities. Combined, the case studies cover the entire policy cycle in environmental education, from agenda-setting and policy formulation (CCE) to implementation (ESD). (The final phase of the policy cycle, termination, is not an issue in the field of ESD and CCE.) This allows us to assess actors across all levels of government, ranging from the global level of the United Nations, where most of the agenda-setting and conception of policy innovations takes place, to the national and local levels, where these goals are specified and implemented in national programs. By conducting SNA in both cases, we are able to identify the most influential actors at different stages of the policy process and gain insight into the political division of tasks between actors operating at different governance levels.

3.3. SNA as a Tool for Studying CCE and ESD

To analyze global CCE negotiations, we analyze Twitter data directly related to selected UNFCCC conferences. On Twitter, information flows are represented by "tweets" (i.e., short messages), "retweets" (i.e., forwarding another user's tweet with or without additional comments), and "mentions" (i.e., naming another user). Retweets can be seen as the defining feature that distinguishes Twitter from other media and marks it as a new medium for broadcasting and spreading information [41]. Through Twitter's API (Application Program Interface), it is only

possible to obtain real time data; data from earlier points in time are inaccessible through the open streaming API. To remedy this, we purchased tweets from the data reseller "DiscoverText" for the period of 2009–2014, covering the entire duration of six Conferences of the Parties (COPs): COP15–COP20. We analyzed the Twitter data with quantitative SNA [42].

Concerning ESD, data was gathered using a snowball approach [43]. In a first step, available contact data from the UNDESD database was used to detect persons in the local communities responsible for implementing ESD at the communal level. We then constructed a survey which included name generators and interpreters according to Fischer [44] and Burt [29]. Name generators are questions aimed at obtaining names of pertinent contact persons in the field of ESD. The persons mentioned in name generators were requested to indicate their contacts regarding joint initiatives, collaboration, development of common ideas, and the elaboration of problem-solving approaches in ESD settings. Additionally, we applied name interpreters, i.e., supplementary queries on the characteristics and types of the social relations. More specifically, our questionnaire included name interpreters aimed at uncovering the degree of trust, the strength of the ties (as measured by contact frequency), and the closeness for each relation stated by the interviewees. In contrast to the process proposed by Burt [29], which addresses only five of the mentioned alters (i.e., the contact persons named by the interviewees), in our survey name interpreters were used for every contact to gain better knowledge about the features of all network members and the characteristics of the relationships between the actors involved. Correspondingly, the kind of relations among interviewees was grounded in the adaptation of ESD, the spreading of knowledge, collaboration, idea exchange, and the elaboration of problem-solving strategies. Data was gathered through online questionnaires, paper questionnaires, and telephone surveys (i.e., through a mixed-mode survey). The survey was directed to individuals involved in the implementation of ESD, not to institutions, with the intention to include every involved individual in the area of ESD. By performing diverse repetitions and distributing the questionnaire numerous times, we were able to identify virtually all network members [45] (p. 1087).

4. Results

4.1. Social Network Analysis in Climate Change Education (This Section Summarizes the Main Findings of [1])

NFCCC stakeholders use Twitter to discuss CCE. Figure 1 illustrates this finding and depicts the development of the education-specific negotiations over time, grouped in three sections. It shows both that actors increasingly discussed education in the UNFCCC and that they became more connected to each other over time.

To identify the actors with the highest centrality and influence in the Twitter communication networks, we applied the centrality measure called eigenvector centrality. Eigenvector centrality depicts how "influential" an actor is in a network: Twitter users are important if they are linked to other important Twitter users. In other words: An individual's eigenvector centrality is only high if the contacts of that actor also have a high eigenvector centrality. This actor may have few, but very important relations [46,47]. For the Twitter analyses presented in this article, we used eigenvector centrality instead of in-degree centrality as a main centrality measure to avoid overestimating the influence of those actors sending the largest number of tweets. In this way, we were able to uncover the most central Twitter users and hence those that have the greatest chance of exerting influence.

Figure 2 visualizes the Twitter information network covering all selected COPs. The "Fruchterman–Reingold" algorithm was used to outline the network. The thickness of the nodes represents their eigenvector centrality. The figure only labels vertices with an eigenvector centrality higher than 4000. Twitter users are represented by nodes; the links between the nodes show their relations; that is, @-mentions, tweets and retweets. For instance, the relation is directed from A to B if a Twitter user B retweets user A's tweet. If user D mentions user C, the direction of the relation goes from D to C. Finally, if user B mentions user A's retweeting a retweet, the direction of the relation goes from B to A (see [48]).

Figure 1. Development of the education-specific Twitter networks over time; (**left**) COP15–COP16; (**center**) COP15–COP18; and (**right**) COP18–COP20.
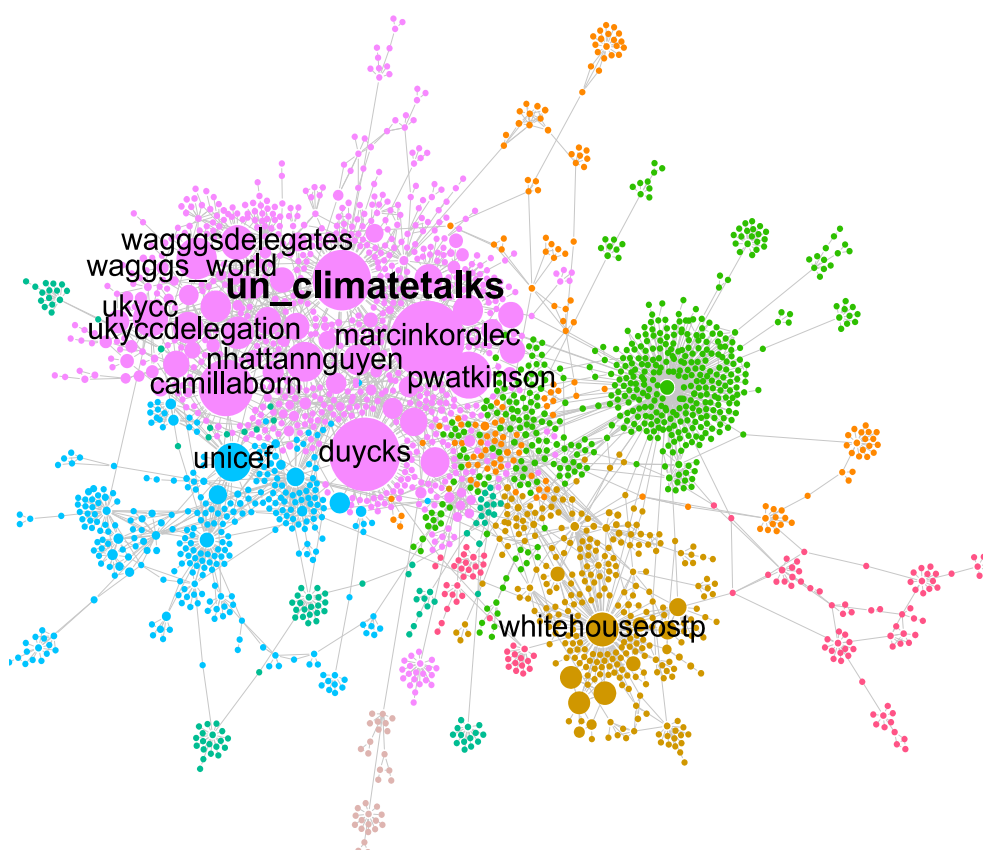

Figure 2. Education-specific twitter network of all selected COPs (colors in the figure represent modularity classes [49]).

The analysis of the whole education-specific dataset suggests that the UN Climate Secretariat with its account "un_climatetalks" is the dominant actor within the Twitter network, followed by other actors active in the debate on CCE (such as IOs, individuals, and youth associations). Figure 3 visualizes the development of eigenvector centrality over time (i.e., over the periodic COP meetings) and demonstrates the increasing eigenvector centrality of the UNFCCC ("un_climatetalks") and its former Executive Secretary Christiana Figueres ("cfigueres"), with the latter decreasing slightly subsequent to COP18.
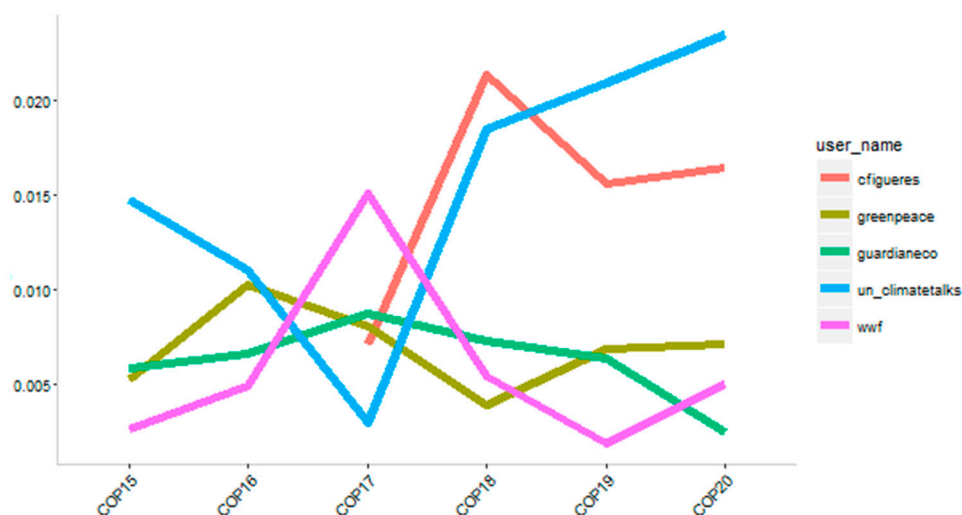
Figure 3. Development of eigenvector centrality over time with respect to education-specific ego.

In sum, the influential role of the climate secretariat in Twitter communications on CCE becomes apparent. Considering the formal mandate of the UNFCCC secretariat, which is limited to rather logistical, facilitative role, this is a surprising finding. Actively participating and acting on an own account in the public debates that accompany multilateral negotiations is not part of the formal "job description" of this administrative actor and yet, secretariat staff successfully carved out the leeway to become active in this way.

4.2. Social Network Analysis of Education for Sustainable Development (This Section Summarizes the Main Findings of [9])

For this article, we not only analyzed Twitter data, but also drew on data conducted with an own survey concerning the implementation of ESD in community education at the German municipal level. In total, our adjusted dataset consists of the individuals and their networks in five municipalities. Hence, the data of these five municipalities depict the whole networks concerning the implementation of ESD. In general, the dataset is made up of 1306 persons and 2195 connections. Data was conducted with a questionnaire using traditional techniques of social research and network analytical items. We applied QAP (Quadratic Assignment Procedure) correlations to test the validity of the collected data and the response behavior. QAP is a permutation test that keeps the dyadic data structure intact and can be applied to many kinds of models [50] (p. 564). In particular, QAP is used to test the statistical significance of observations obtained with SNA, which are not independent of one another. Results of QAP tests were used, for instance, to test the correlation of the name generators, i.e., questions to elicit the names of the persons responsible for implementing ESD. For instance, our analyses show that persons that are named as providers of problem-solving approaches are likewise often indicated as developers of new ideas. Influential network adherents in ESD realization further tend to play an important role in the distribution of ideas. In addition, good cooperation and trusting relationships correlate strongly.

Data representing the complete network of all five municipalities were visualized with the software packages "UCINET" and "Netdraw" (see Figure 4, where the nodes depict individuals dedicated to ESD).
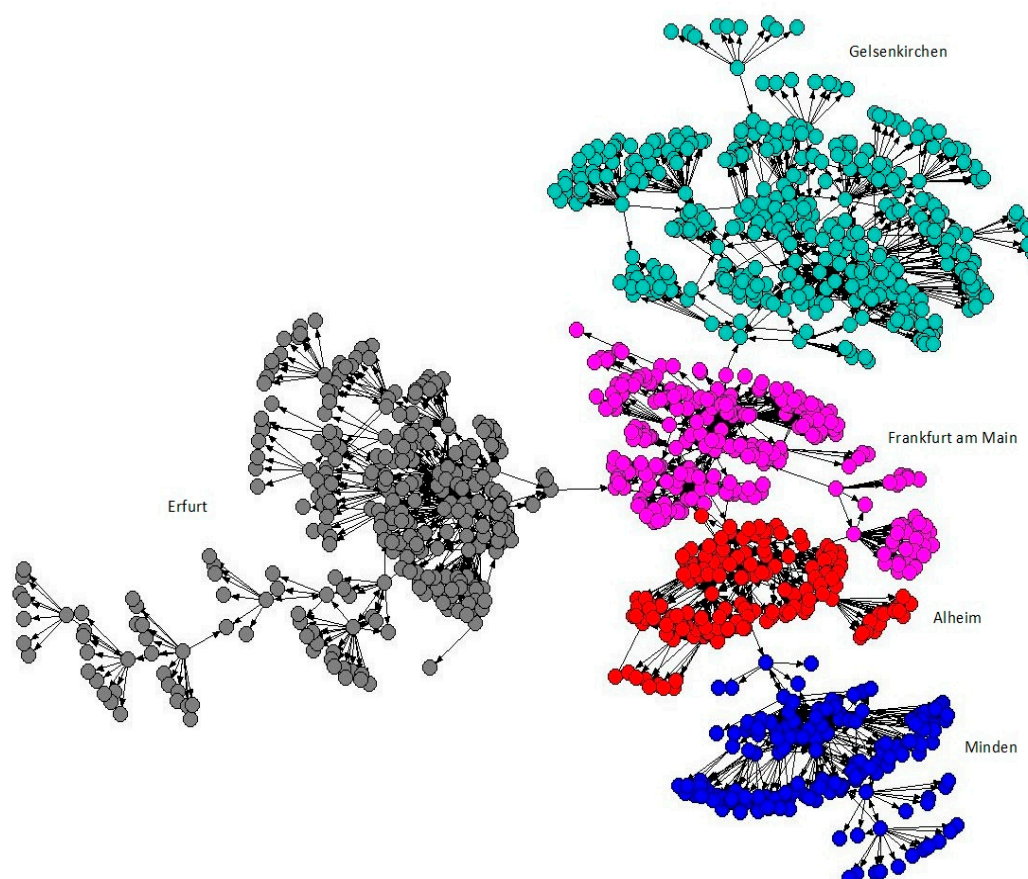
Figure 4. ESD network of five German municipalities, implementing ESD according to the UNDESD, generated with the program UCINET and the graph theoretical layout spring embedding. Source: own data.

Actors or nodes in Figure 4 represent persons (e.g., teachers, actors from non-formal education, universities, politicians, foundation staff or businesses) in the field of ESD. The links between the nodes are their relations (concerning aspects such as the exchange of information or the solving of problems in the context of ESD). All actors are involved in implementing ESD through cooperation. The majority of stakeholders stem from administrations or municipal governments, non-formal education (e.g., environmental education centers), NGOs, and formal education.

Unlike our preliminary expectations, the network comprises only few representatives of schools. Overall, only 7.5% of all network members in the five municipalities belong to schools. These school representatives have weak and only few connections to other actors. This is particularly true for relations with stakeholders from other organizations than schools. Hence, Figure 4 shows that despite the frequent trans-regional meetings organized by the UNDESD in Germany, the implementation of ESD is primarily concentrated in the municipalities. The overall network is characterized by structural holes (i.e., missing links between actors) between the five municipal networks.

At the same time, there are few brokers who bridge the municipal borders (i.e., actors who connect individuals that otherwise would remain unconnected). Brokers connecting two individuals or groups profit from their position as intermediaries between them [51] because this position enables them to potentially influence the flow and content of knowledge, provide or restrict other actors' access to new information, bring together ideas that have emerged within the network, and control benefits. Although the UNDESD provides a range of opportunities for cooperation such as trans-regional working groups or roundtables, the observed scarcity of brokers in the network must be interpreted as a lack of cooperation in implementing ESD in community education beyond municipal borders. Moreover, actors who are in a brokerage position all stem from educational or

environmental NGOs or from municipal government. No actors from formal education are in a position that bridges municipal borders.

We further analyzed single municipal networks in order to allow for deeper analyses and to produce readable visualizations of centrality measures. In contrast to Figure 4, which visualizes the whole network of the five municipalities, Figure 5 represents the selected municipality Erfurt.

We drew on centrality measures to detect the most relevant nodes in a graph. This enabled us to find those actors who are influential in communicating and framing problems and potential solutions and in setting priorities beyond established hierarchies. As already mentioned, SNA provides us with a diverse set of centrality measures based on different theoretical assumptions.

Eigenvector centrality, in contrast to other centrality measures, gives greater weight to those links that connect an actor to other influential nodes than to links that connect it with nodes at the periphery. Consequently, eigenvector centrality is particularly useful for identifying popular nodes in huge networks. Concerning the ESD network, a high eigenvector centrality means that this actor maintains connections to significant or influential actors with respect to a certain topic (e.g., the implementation of ESD).
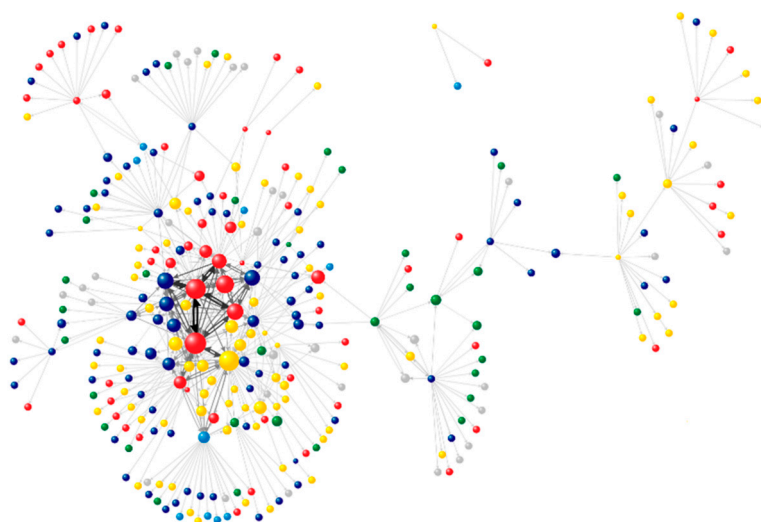

Figure 5. ESD network in Erfurt, node thickness according to eigenvector centrality, nodes are colored according to their area of activity (red: politics; yellow: NGOs; dark blue: non-formal education; light blue: formal education; orange: church; grey: other).

The most central node in this figure is a representative of non-formal education. Figure 5 shows the ESD network of Erfurt as an illustrative example of which actors are influential in ESD. The most central and influential nodes in the Erfurt network belong to non-formal education, government/political administration, or NGOs while no representative from formal education or schools occupies an influential role. Examples of crucial nodes in this network include German federal states' education secretaries, mayors, or representatives of nongovernmental organizations such as environmental social movements or societies. In contrast, none of the actors from formal education (especially schools) occupy influential positions. Consistent with eigenvector centrality, the most central node represents an organization from non-formal education in the local community or municipality of Erfurt.

While formal education was expected to show the most crucial position in implementing the educational innovation, centrality measures show that actors from other areas of activity such as governments, businesses, or NGOs are more influential in the process of implementing ESD than formal education actors and particularly schools. NGOs and governmental actors possess considerably more prestigious, central and influential network positions in the implementation of ESD in Germany than schools.

Overall, the network figures of the different municipal ESD networks show a mix of actors from different areas of activity. Hence, the findings create the impression that interviewees from different affiliations are highly connected. These findings support Shiroma's analysis of education networks in Brazil: "Individuals move between the public and private sectors, taking on multiple positions sequentially or simultaneously" [52] (p. 332), which enables them to increase their individual influence.

In a next step, we focused our attention on the qualities of the relationships—particularly regarding the degree of trust and the contact frequencies of the connections (see Figure 6 for strength of the ties as an illustrative example for both analyses)—to further check this finding and to go beyond the centrality results. To do so, we compared the observed with the expected number of strong ties (as defined by the contact frequency and the level of trust) between network actors from different areas of activity. We based our estimate of the expected number of strong ties on an assumption of uniform distribution of strong ties among the different groups of actors [28]. Survey respondents were requested to indicate their contact frequency with each of the persons mentioned in the survey, using a scale from one to four that included the following options: (1) never or less frequently than every three months; (2) every two to three months; (3) approximately once per month; or (4) more than one contact per month. For this article, we considered merely undirected links. Furthermore, we chose to dichotomize the data and to calculate ties with a contact frequency of at least once a month (values 3 and 4 on the scale) as strong ties (see Figure 6). We chose to calculate the higher value of contact frequency in case that the results of two interviewed persons considering their mutual contact frequency were not identical. Subsequently, each strong tie was set to the value 1 as UCINET does not allow researchers to analyze the value of the ratio with respect to the correlations.
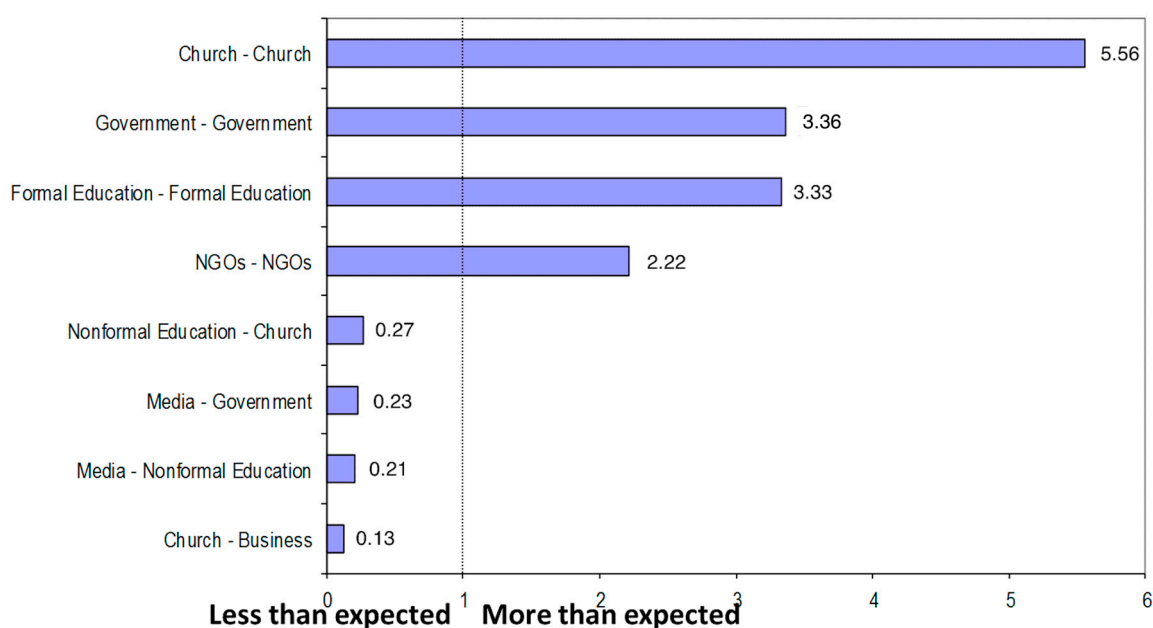

Figure 6. Quotient of observed and expected values (based on the assumption of independence from the field of activity).

Figure 6 presents the four highest and lowest values. Values of one or higher indicate that an actor possesses more strong ties than expected while values lower than one indicate that the actor possesses less strong ties than would have been assumed based on an assumption of uniform distribution. Therefore, it can be inferred from Figure 6 that there are more connections with a high contact frequency between actors with the same affiliation than between interviewees from dissimilar groups of stakeholders. The findings show that intensive cross-sectoral cooperation is still lacking in the area of ESD. While intra-group ties between members of the church, government/political

administration, formal education, and NGOs are strongest, relations between nodes relating to different groups of stakeholders are generally weak.

Thus, a major finding of our analysis of the municipal ESD network is that—despite their presence—neither the UNESCO nor the secretariat of the UNDESD was an influential actor in the local implementation of ESD. In particular, the UNDESD secretariat was not able to take on the role of an information broker and effectively coordinate the implementation of ESD across municipal borders despite its attempts to organize trans-regional working groups and round tables to bring together actors from municipal governments and from formal education. Thus, while international organizations—similar to the case of CCE—have been key actors in formulating the concept of ESD, they remain surprisingly weak in the implementation of this concept at the municipal level.

5. Discussion

In this article, we applied SNA to uncover influential actors in the negotiation and implementation of CCE and ESD at the global and the municipal levels. Our intention was to find answers to the research questions as to how different actors get involved in and influence the complex interactions of education-specific negotiations in the field of sustainable development and how they aim to foster the implementation of CCE and ESD. To answer these questions, we implemented measures of SNA and analyzed data derived from Twitter and an own questionnaire. We assumed that individual action and influence in educational contexts would depend on an actor's social relations and on the characteristics of the structural context.

We could demonstrate that international organizations and their bureaucracies are significantly involved in the processes of goal formulation and agenda-setting with respect to innovations in education, such as CCE and ESD. By analyzing Twitter data on the education-specific debates during UNFCCC conferences, we showed that the UN Climate Secretariat possesses a potentially influential role and broker position due to its relational position, connecting stakeholders from different sub-networks. The UNFCCC secretariat connected strategically with other actors and seemed to be able and willing to transcend its formally restricted mandate, attempting to frame debates in line with its policy preferences (see [1] for a more detailed analysis of this case). In the case of the education-specific negotiations, the secretariat fostered educational aspects in the UNFCCC through the social media platform Twitter, thereby increasing the relevance of education in the climate regime. The topic of CCE has provided the climate secretariat with opportunities to put forward its own values, problem perceptions, and policy preferences, thereby indirectly shaping in which way actors at the global and national levels approach the climate crisis.

In contrast, the factual implementation of sustainability innovations in education is mainly conducted by local actors. This finding was illustrated by results of network analyses we conducted on the implementation of ESD in German municipalities. These analyses show that even though the UNDESD has highlighted transregional collaboration and has reinforced many activities to promote cooperation between different municipalities, connections beyond municipalities are still rare. Actors dedicated to implementing ESD tend to cooperate more with actors from within their municipality than with actors from other municipalities. International and transnational actors—who are leading actors in the process of agenda-setting and concept-formulation—are conspicuously absent from the implementation of education on the ground. This is surprising since during the UNDESD, which took place when we conducted the data, the UNDESD secretariat organized regular trans-regional working groups, roundtables, and other opportunities for cooperation with the aim of fostering trans-regional cooperation and international collaboration in the context of ESD. Social network analysis showed that these efforts by the UNDESD secretariat were—at least in the municipalities analyzed—largely unsuccessful. The secretariat did not manage to take on the role of an information broker who would have been able to coordinate ESD implementation across municipalities. In addition, the ESD networks consist of only a few school actors, who demonstrate only few and weak relations.

While earlier studies have expected actors from formal education (e.g., schools) to be the most influential concerning the application of social innovations such as ESD, our results demonstrate that schools have considerably less influential, prestigious, and central roles within the innovation

networks than actors belonging to NGOs or government. In reality, schools still play an insignificant role in the process of adopting ESD. In the five municipalities only 7.5% of the network members work in schools, possessing only few and weak connections to other actors.

We further analyzed the degree of cooperation beyond areas of activity by comparing the observed with the expected number of links with a high contact frequency between network actors with different affiliations. On that basis, we discovered that actors from the same area of activity show stronger ties than actors from different areas of activity. The latter, however, are essential for the implementation of educational innovations, such as ESD, which are mainly realized through collaboration between different areas of formal and non-formal education (e.g., [36]). In fact, the notion of ESD, which originated at the international level, has diffused to local levels primarily via non-school actors. The chance of innovation adoption increases significantly if it is promoted not only by single actors, but also by interconnected individuals [53]. Therefore, intensive collaboration and influential actors from schools are essential for educational innovation such as CCE and ESD in community education.

Our analysis highlights two trends of implementing educational innovations: On the one hand, international organizations and their bureaucracies mainly shape agenda-setting and goal formulation. On the other hand, they do not play an important role in substantiating and implementing the policy contents within the communities. Instead, implementation is mainly driven by local actors. It is striking that the municipalities are involved in the implementation in a highly isolated manner, i.e., they are neither in close contact with international organizations, nor with other communities.

For policymakers, the results of our study suggest that actors operating at different levels of government that are involved in sustainability innovations in education need to be better linked, allowing for an effective implementation of these innovations. Innovations in education cannot be implemented effectively beyond the minds of the people involved; they must be accepted and actively put into practice.

While we have provided first empirical results regarding the role of different actors and levels in implementing educational innovations, there are still many open questions. For example, it would be interesting to complement the findings of our study with an analysis of the perceptions of education administrations, teachers and the recipients of education. Do they have possibilities to better interact with actors at the global level? More generally, there is a need to explore the ways in which the different levels of governance can be better integrated throughout all phases of the policy cycle. Here, a first step would be to analyze the reasons why international and transnational actors—who are decisive in the formulation of policy innovations—are nearly absent when it comes to their implementation at the local level. Why is implementation carried out within relatively closed policy communities and how can this closure of policy networks at the municipal level be overcome? Another closely related question is whether sustainability has gained weight in education at all over the past two decades. One possible—albeit very pessimistic—interpretation of our data could be that the global discourse on sustainability goals has not yet been effectively translated into consequential action at the local level. To better understand whether and how sustainability is integrated into education, further systematic empirical studies are needed.

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