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Research Articles

Adolescents' Environmental Attitudes and Behaviors: Analyzing the Opportunities and Constraints of Their Friendship Network Structure*

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ABSTRACT

In this paper, I profile the attitude, belief, and behavior of adolescents with regard to environmental issues via a nationwide survey to illustrate the extent to which our younger generation practices environmentalism. The opportunities and constraints of their friendship networks on disseminating the New Ecological Paradigm (NEP) are further discussed. This discussion is based upon Simmel's sociation theory, the degree to which one's social interactions shape and reshape his/her values and actions, which results in opportunities and constraints for developing environmental education. The data collection is based on the nationwide in-school adolescent population in three age cohorts

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(first-year students of junior high school, high school, and college students, respectively) in 2015. The total sample size is 1,320, but the college respondens were too few to be included in the discussion here. By using social network analysis (SNA), I am able to place the following key network features of sociation: multi-dimensional friendship structures, eigenvector centrality, network constraint, network closeness, and susceptibility into the model. The findings show that adolescents had a low level of environmental engagement (only approximately five percent of our respondents displayed high environmental awareness, and even fewer had ever participated in environmental movements). Besides, the link between social and environmental engagement was of high network constraint and low eigenvector centrality, which indicates that environmental education in junior high must be highly peer-centered to spread. Moreover, popular high school students with higher levels of environmental engagement might have more influence among their peer networks, since they have stronger links to others and greater chances to help their peers become more sympathetic towards environmental problems.

Keywords: New Ecological Paradigm, social network analysis, friendship, network features, social influence

青少年的環境意識與行動：社會影響網絡的機會與限制

張志堯*

摘要

在本研究中，我以臺灣地區青少年抽樣調查的資料，剖析青少年對於環境議題的了解與參與環境保護運動的程度，並探討友誼網絡與

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新生態典範主義之間的關係。社會網絡的觀點乃是基於 Georg Simmel 的 sociation 理論，探討友誼網絡特性對青少年養成環境保護認知的影響。資料蒐集的方式是利用一項臺灣青少年生活現況調查計畫，於 2015 年抽樣調查當時國一新生、高一新生以及大學一新生共 1,320 名的資料，進行臺灣青少年環境意識與友誼網絡分析，但由於大學一新生樣本數不足，故在分析上，僅以國高中生的結果進行討論。友誼網絡分析部分，我著重於探討多重友誼關係以及中心性、連結限制性、臨近性和易感性等結構特徵。研究發現臺灣青少年普遍環境意識皆不高並缺乏環保行動力。國中生友誼網絡是扁平，訊息傳遞或資訊分享有較高的效率，故環境意識培養應以其內部社群影響力推動較適當。高中生則是有較高環境意識的一群人在同儕之間扮演功能性的友誼角色，有助於向同儕推廣環境教育的知識與實踐。

關鍵詞：新生態典範，網絡分析，友誼關係，網絡特徵，社會影響

I. Introduction

Environmentalism is a broad philosophy, ideology and social movement regarding concerns for environmental protection and improvement of the health of the environment. Due to the popularity and yet the politically correct nature of this social movement, it is difficult to determine the genuine level of commitment to this cause. In fact, in a 2013 *Taiwan Social Change Survey* poll, 63.1 percent of respondents disagreed with the statement that there is nothing we can do to solve environmental problems; however, 75.5 of respondents had never directly participated in environmental improvements (Fu et al. 2014). This poll, which was conducted with 2,005 adults throughout Taiwan, clearly shows the gap between attitude and action with regard to the environment. It seems that, in this case,

words speak louder than actions.

Environmental education has been firmly rooted in Taiwan for decades, in the formal education system and "annual required course credits of environmental education" for all governmental employees and those working in related institutions. One would think that concern for the environment would be universal; however, the above-mentioned poll shows that we still have a long way to go. We must ask ourselves, "How long will it take?" and "How do we get there?"

A central challenge of environmental education is to encourage and develop in children a sense of respect for and harmony with the environment. This will contribute to pro-environmental behaviors that extend into adulthood. In the past decades, studies have shown that peer influence is one of the keys to determine youths' attitudes and behaviors (Allen and Antonishak 2008; Brechwald and Prinstein 2011; Burk et al. 2007; Hallinan and Williams 1990; Kandel 1978; Moody 2001). To find out the opportunities and constraints of peer friendship networks on dissemination of environmentalism among adolescents is the major work in this study. This is why I chose to mainly focus on the younger generation, and the goal of the study is to ask a core question: To what extent is peer social interaction associated with youths' environmentalism?

In order to measure the impact of environmentalism on our younger generation, four dimensions of this philosophy should be taken into consideration: environmental awareness, attitude, belief, and behavior, based upon the theoretical perspective of the New Ecological Paradigm (NEP). Next, the association between environmentalism and peer influence via friendship networks will be discussed in depth. Empirical data processing and programming will be presented in the following sections. Last, key findings and

discussion are presented at the end in response to my research question.

II. Environmentalism as a Way of Thinking: New Ecological Paradigm

Environmental problems have been important since the publication of Rachel Carson's *Silent Spring* (1962), describing the social and environmental effects of air and water pollution, waste management, land exploitation, and the depletion of natural resources. As environmental threats increase, so does the awareness of the public, and scholars have been devoted to finding what factors could raise people's environmental awareness and behaviors. However, when sociologists analyze the causes and effects of these problems, they emphasize the social factors, concentrating on social phenomena, but ignore the environmental factors. The core thesis of sociology is to discuss the world outside the laws of nature, the world that human beings have created on their own. This traditional sociological focus has been criticized by modern environmental sociologists (Catton and Dunlap 1978, 1980, 1994, Dunlap and Catton 1979, Dunlap et al. 2002). Dunlap (1997) criticizes Durkheim's view that social facts must be explained by other social facts, and argues that it is wrong to draw the boundaries of sociological concern around human social phenomena as though social facts are independent from natural rules and facts, and free of natural domination. Catton and Dunlap (1978) call this way of thinking about social phenomena the Human Exceptionalism Paradigm (HEP). In the HEP view, human dominance is justified by the uniqueness of the "grand civilization", and human culture has the capacity of trial and error, making us believe that we can solve all natural problems. Therefore, humans, the HEP contends,

are not constrained by natural conditions; instead, human beings can control their destiny and triumph over nature (Catton and Dunlap 1978).

As a means of correcting the traditional sociological bias against the role of the natural world, Catton and Dunlap (1978) propose the New Ecological Paradigm (NEP). In the NEP, human beings are merely one species of many, and interdependently linked in the global system. Human beings are not supreme and cannot monopolize natural resources. In fact, human beings must understand that natural resources are finite, and after we have depleted our natural resources, the environment will collapse, and human lives will be in danger. Therefore, the purpose of the NEP is to urge people to see the natural environment as an intrinsic part of human society.

To reinforce this point, environmental sociologists contend that NEP should include the following concepts: (1) although human beings have exceptional characteristics and a civilization, we are still one of many interdependent species in the global ecosystem; (2) the social world is influenced not only by cultures and societies, but also by intricate linkages of causes, effects, and feedback from nature; and (3) human inventions and creativities cannot produce something without exploiting natural resources (Buttel 1987: 470). Decades after Buttel's conceptualization of environmentalism, the extent to which the NEP inspires us to practice environmentalism is still unclear. To measure the effect of the NEP on people's thinking about and practicing environmentalism, four levels of environmental engagement should be uncovered: environmental awareness, attitude, belief, and behavior. By doing so, we can see if the NEP has replaced the HEP and built a new relationship between society and the environment. Below I explain why the four levels of environmental engagement are essential to practice environmentalism.

A. Environmental awareness

Environmental awareness is about knowing and understanding the reason for environmental problems. A central challenge of environmental education, therefore, is how to teach environmental awareness, which will follow children into adulthood. Environmental awareness instills a love of and respect for nature along with a sense of the interdependence between people and the environment. It can instill a sense of responsibility and commitment to environmental protection (Gatens-Robinson and Gilligan 1986).

In practice, environmental awareness is the knowledge of the vulnerability of the environment and of the importance of environmental protection. To promote environmental awareness, it is necessary to ensure that we have a thorough understanding of environmental issues. Watching environmental news, reading about environmental threats and attending environmental seminars are all worthwhile activities. Environmental awareness can be cultivated by studying an environmental issue that strikes us as urgent, such as sanitation, health, housing, water supply, or food security. In addition, population growth is putting pressure on the environment, leading to lower quality of life and imbalance in the ecological order. With environmental awareness in mind, we can be involved our community, friends, and family. Promoting environmental awareness is a crucial part of being a responsible environmental steward.

B. Environmental attitude

Environmental attitude is the way we think about and act in response to environmental problems. The word "attitude" in this context implies the critical factors of motivating emotional concern to determine whether we

will act or not. Ajzen and Fishbein (1980) called it the "theory of reasoned action". The central idea of this theory is that people have their own values that are weighted by giving them ranks through rational calculation. For example, a staunch environmentalist will act in a more environmentally friendly way than someone who is not. This difference of weighted environmental attitude results in distinct levels of practicing environmentalism (Kotchen and Reiling 2000).

The theory of reasoned action emphasizes attitude as a crucial predictor of the variance in individual behaviors (e.g., Ajzen 1988, Mohai 1992, Weaver 1996). Leeming and his colleagues argue that the importance of environmental attitude among children is significant because "early attitude and knowledge shape the later thinking and action of adolescents and adults" (Leeming et al. 1995: 23). Although the theory of reasoned action is commonly applied to explain economic activities, environmental scholars have applied it to understanding environmental attitude–behavior relationships with alternative ways to combine individual rationalizations with environmental altruism.

C. Environmental belief

Environmental belief is a feeling of trust in environmentalism. The study of values understands environmental behavior as an expression of the forms of relationship established between the environment and the cultural context (Gray and Weigel 1985). Belief is a preconception; we trust what we believe, then do what we believe emotionally. For example, Thompson and Stoutemyer (1991) study how a biased belief guided people's decision about water consumption. This is an example of a social dilemma under which the decision-making process is based upon incomplete and biased information.

As a result, if the preconceived information one trusts is good for the environment, then one will engage in environmental behavior; otherwise, the environment will be harmed when one's preconception of the environment is harmful but unconscious (e.g., Taylor and Todd 1995).

D. Environmental behavior

Environmental behavior is a way of protecting the environment. Compared to environmental awareness, attitudes, and beliefs, environmental behavior has a direct positive or negative effect. When respondents are asked about their environmental awareness, only information about their expressions of concern is collected; they provide little or no indication of a commitment to improving environmental quality. In other words, the significant difference between awareness, attitude, belief and behavior is that the first three are words, but the last is action. The difference is between what people say they are willing to do, and what they actually do (O'Riordan 1973).

III. Social Network: The Opportunities for and Constraints of Change

Practicing environmentalism is observable through individuals' awareness, attitudes, beliefs, and behaviors. The key point is to understand how society perceives the significance of the environment to themselves —in other words, in what way we can deliver the concept of NEP to the public. Here I emphasize the importance of social interaction to achieving this goal.

Simmel's sociological imagination is not the Durkheimian treatment of social facts as "things", but rather the protection of individuality, a core

value and a product of social interaction. Simmel's conception of society emphasizes its interaction: society exists where individuals interact based on certain drives or for the sake of certain purposes. Society is not a static entity, but a dynamic organism as "sociation": the patterns and forms in which human beings relate to each other and interact (Wolff 1950). That is, society is the name for individuals who are connected by interaction. Society is a fluid reality composed of conscious individuals who act themselves by imposing a scheme of interpretation on others' actions and engagements. Hence, Simmel argues that the concept of interaction implies individual action is a product of reciprocal effects from interpersonal interaction (Simmel 1909).

To apply Simmel's sociation to exploring the mechanism of the social networks on spreading of the NEP, social network theorists suggest that engagement and interaction of individuals with others in their social group can enrich their knowledge of environmental issues, pro-environmental attitudes and perceived personal capability of environmental actions (Castaneda et al. 2015). In addition, social capital theory argues that people may adopt certain attitudes or actions consistent with their significant others to justify their behaviors because people may find reference groups and individuals (like close friends or important others) significant and influential in their opinions and behaviors (Gupta and Ogden 2009). Therefore, sociation shapes human behaviors and attitudes. Sherif (1936) argues that when a group of people find themselves in an uncertain situation, they tend to seek consensus from other members of the group about how to respond. Roper (1940) finds that individuals' attitudes about certain issues depend on the views of others who are close to them. Festinger (1950) develops the social comparison theory by integrating these traditional social psycho-

logical perspectives regarding group influence on individuals. These theoretical perspectives of social interaction explain what features of social network structure could facilitate social cohesion for social norms or even pro-environmental attitudes and behaviors, and why they could do so. To illustrate such "what and why" questions about network structure, I introduce several network features from social network analysis (SNA) in response to Simmel's social interaction theory: eigenvector centrality, network constraint, network closeness, and network susceptibility. These network features are used to profile each individual's position in a social network where their interconnection is built through their subjective interaction with others.

A. Eigenvector centrality

In SNA, centrality refers to one's position at the center of the network: the ego itself has the most direct connections (or degrees, in SNA terms) to alters. The original degree centrality approach argues that egos that have more connections are more likely to be influential because they directly affect more alters. This makes sense, but this does not necessarily make egos equally important (Freeman 1978–1979). Bonacich (1987) extends this concept of degree-centrality and illustrates that an ego is likely to be more influential when it connects to central alters because it can quickly reach more alters through them. If these central alters cannot connect between themselves directly but do so through a given ego, then then that ego becomes an influential node. On the other hand, if these central alters interconnect well between themselves, it means this ego is not influential at all. Therefore, a natural extension of this degree of? centrality is eigenvector centrality. Here Bonacich emphasizes that eigenvector centrality

differs from degree centrality: an ego having many links does not necessarily have a high eigenvector centrality, while an ego with high eigenvector centrality is not necessarily highly linked, because it might have few but important alters (Bonacich 1987). Bonacich proposes that both centrality and power are the function of the connections of the ego in its neighborhood (a subgraph where a node has direct ties to others). The more connections an ego in its neighborhood has, the more central it is; the fewer the connections an ego in its neighborhood has, the more powerful it is.

In short, ego's eigenvector centrality scores correspond to the values of the rest of the alters it connects directly. The centrality of each ego is proportional to the sum of the centralities of those alters in its neighborhood. Egos with a high value of eigenvector centrality are those connected to others who also have a high value of degree centrality. This means the egos are at the very center of the network and are thus powerful in the network.

B. Network constraint

A network constraint explains the extent to which egos can connect to other subgraphs indirectly. Burt (2004: 349–350) argues that a high constraint means that strong group cohesion constrains members' opinions and behaviors to maintain consistency within groups. In contrast, members of a group with low network constraint are receptive to alternative ways of thinking and behaving; they bring in new ideas or information to other group members. This concept is powerful and useful for applying to the study of social capital: social capital exists where people have an advantageous position to link to a variety of nodes from outside. These nodes can cross the boundary of the network, accessing a broader diversity of information and translating information across groups.

C. Network closeness

Network closeness is another concept of centrality. The purpose of this index is to find out what characterizes an important node. The word "importance" has many meanings. Here, it can be conceived in relation to a niche of transmitting information across the network. That is, network closeness is based upon proximity of a node to all others in the network. When an ego has the minimum value of the shortest path to all alters, it is the closest node in the network. This concept of closeness is related to control of communication (Bavelas 1950) and reduction of information loss by multi-level transmission.

D. Network susceptibility

Network susceptibility is used to examine an ego's susceptibility to alters in a network. Friedkin (1998) developed this concept to assess one's vulnerability to influence by other group members. He proposes the social influence model to predict individuals' attitude change based on their positions in a network structure. His methodological approach of network influence explores the power of the network over individuals within a group setting. Here, the effect occurs only on the structure of the network itself. This model was based on Festinger's (1954) social comparison theory, in which any individual attitude in a group converges into a shared value system through the process of "comparing" an individual's attitude with those of others. Friedkin's social influence network theory emphasizes that one's "susceptibility to interpersonal influence" is based on the number of in-degrees (social connections to the group) of the members. That is, an ego is more susceptible to influence by alters when it has few

sources of information. Conversely, when an ego has more sources of information, it can assess the correctness and validity of information received from alters by comparing various sources.

As discussed at the beginning of this section, spreading of the NEP through a social network occurs by the functions of eigenvector centrality, network constraint, network closeness and network susceptibility. These selected functions assist us in assessing whether the NEP can be rooted in and disseminated among the younger generation through the social interaction perspective.

IV. Methods

A. Data setting

The research setting is designed for investigating a series of questions about teenagers' life experiences, delinquency, parenting and family relationships, consumption behaviors, community relationships, NEP measures, and friendships. We recruited adolescent participants who were in the first year of junior high school, high school, or college. These students were asked to participate in a project called "Birds of A Feather Flock Together: An Investigation of Homophilies among Friendship and Antipathy in Adolescence", for three years in a row for our longitudinal data collection from early adolescence to late adolescence (Wu 2014). This project was initiated and implemented by the Institute of Sociology, Academia Sinica, and funded by the Ministry of Science and Technology (August 2014-July 2017). The grant proposal was reviewed and approved by the IRB on Humanities & Social Science Research, Academia Sinica (AS-IRB-HS07-104009) to protect all participants' confidentiality.

Implementation of this project is ongoing at the time of writing this

paper, but for this study, I only selected the first wave of data to analyze (data collection was in September 2015). In this dataset, there were 1441 total cases. Among them, 106 cases were faked or testing accounts, and eight respondents were from three classes in which their total peer participants numbered less than 10. Seven did not answer the questions about friendship, so I did not have their network data for comparison. Therefore, a total of 1,320 participants were included in my analysis. Among them, there were 501 junior high school students from 24 classes in 12 schools, 730 high school students from 27 classes in 10 schools, and 89 college students from three classes in three schools. Through stratified systematic random sampling, we were able to sample valid responses from adolescents by covering four regions of Taiwan (northern, southern, western, and eastern) to represent the enrolled young population in Taiwan statistically.

B. Measures

To conceptualize environmentalism in the NEP and for social network analysis, I operationalized environmental awareness, attitude, belief, and behavior by consulting the NEP scale developed by Catton and Dunlap (1980) and Albrecht et al. (1982). I propose five friendship network structures to depict adolescent social networks in school.

The NEP scale has been modified several times by environmental scholars around the world to increase its reliability and validity in a variety of cultural contexts (Catton and Dunlap 1980, Cordano 2003, Corral-Verdugo and Armendáriz 2000, Dalton et al. 1999, Dunlap et al. 2000, Edgell and Nowell 1989, Lalonde and Jackson 2002, Lundmark 2007, Nepal 2008, Rauwald and Moore 2002, Stern et al. 1995). For this study, I categorize the NEP scale into "awareness", "attitude" and "belief" groups and measure their environmental behavior to analyze the extent to which

Taiwan adolescents practice environmentalism.

(A) Environmental awareness:

Two questions were used to measure adolescent environmental awareness:

1. How much do you know about the causes of the environmental problems you are concerned about most above?
2. How much do you know about the solutions to the environmental problems you are concerned about most above?

I used a five-point Likert scale with items from 1 (do not understand at all) to 5 (understand fully). Adding their responses, the scores of environmental awareness were from 2 to 10. I grouped the lowest score (2) as "low environmental awareness", the highest score (10) as "high environmental awareness", and the rest were as "medium environmental awareness".

(B) Environmental attitude:

Three statements were used to measure adolescent environmental attitude:

1. It's too difficult to do something for the environment.
2. News and statements about environmental crises are exaggerated.
3. It's hard to know how our way of living benefits or hinders environmental protection.

The responses to these statements were scored along a five-point Likert scale from 1 (completely disagree) to 5 (completely agree). I grouped those whose response to all three questions were 4 or 5 as "passive environmental attitude", those whose response to all three questions were 1 or 2 as "active environmental attitude", and the rest as "medium environmental attitude".

(C) Environmental belief:

Two statements were used to measure adolescent environmental belief:

1. In modern life, we do things which severely harm the environment.
2. Economic growth always harms the environment.

The responses were scored along a five-point Likert scale from 1 (completely disagree) to 5 (completely agree). I grouped those whose response to these two questions were 1 or 2 as "weak environmental belief", those whose response to all three questions were 4 or 5 as "strong environmental belief", and the rest as medium environmental belief.

(D) Environmental behavior:

Here, I measured adolescent environmental behavior by asking respondents whether they had ever participated in any civil environmental movement and if so, how many times. I grouped those with responses of 0 as "inactive environmental behavior" and those with responses of at least once as "active environmental behavior", since participating in civil environmental movements is an objective measurement of practicing environmentalism.

(E) Friendship network:

To capture the friendship network structure among in-school adolescents, I asked participants to nominate their best friends in five situations. To answer these questions, participants could nominate all their friends.

1. Please name your best friends in class. (F1: Best friends)
2. When looking up teamwork for class assignments, whom do you like to be with? (F2: Teammates)
3. Whom do you chat with during class breaks? (F3: Hangout buddies)
4. Whom do you have lunch with at school? (F4: Lunchmates)
5. Whom do you often share your private stories with? (F5: Affective supporters)

Friendships should have a variety of meanings to adolescents. Asking

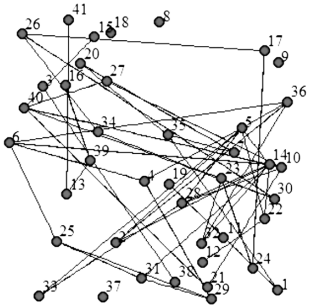
"who are your best friends?" would be biased because of the individual affective definition of "friend". Therefore, the friendship network structure is profiled within a class boundary in about five situations to reveal several aspects of friendship networks. Figure 1 presents the network structures from a given class as an example. It shows that those in a class nominated their "friends" by approximation in relationship and by affective and instrumental functions: the network of best friends had the highest density (.040), and the lowest density was in the network of hangout buddies (.013). The definition of personal friendship networks varies on purpose: For example, node 1 nominated two nodes as best friends, four as favorite teammates, and no hangout buddies, lunchmates, or affective supports; however, node 1's best friends were not her favorite teammates in her definition. In this paper, I present different network structures of friendship to identify the respondents' different positions through a variety of dimensions of friendship networks and their opportunities to and constraints upon interacting with others.

C. Models

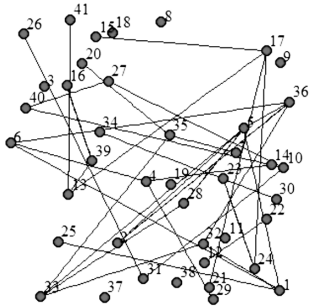
To explore the extent to which the NEP affects the young generation in terms of four dimensions of environmentalism, I present a series of descriptive statistics to profile the respondents' environmental awareness, attitudes, beliefs, and behaviors by age cohort, and compare their differences with a robust statistical test. Furthermore, I construct the network structures based upon five measures of friendship and then calculate a series of network attributes to assess the extent to which network features contribute to the dissemination of the NEP among adolescents. The algorisms of eigenvector centrality, network constraint, network closeness, and network susceptibility are from Bonacich (1987), Burt (2004), Freeman

Figure 1 Example of Network Graphs by Friendship

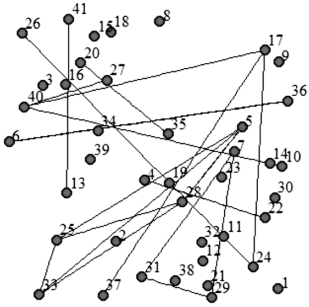
F1: Best Friends (density = .040)



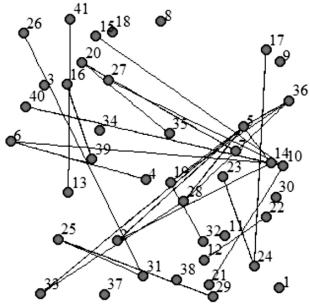
F2: Teammates (density = .024)



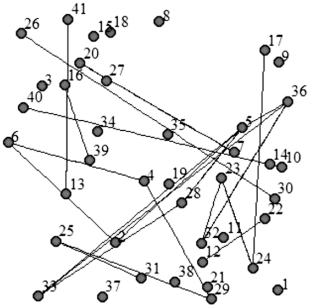
F3: Hangout Buddies (density = .013)



F4: Lunchmates (density = .024)



F5: Affective Supporters (density = .015)



N = 41

(1978-1979) and Friedkin (2001), respectively.

Eigenvector centrality is a measure of centrality in which a node *i*'s "centrality is its summed connections to others, weighted by their centralities" (Bonacich 1987). Let N_f be a matrix of a friendship network (*f* denotes F1, F2, F3, F4 and, F5, respectively). The eigenvector centrality of node *i* in N_f ($N_{f\cdot\lambda e_i}$) is given by the following expression:

$$N_{f\cdot\lambda e_i}=\sum_j N_{f\cdot ij}e_j \tag{1}$$

where *J* is the subset of node *j*'s neighbors, $J\in(1, 2, \ldots, j)$ λ is an eigenvalue of N_f, and *e* is its associated eigenvector. Eigenvalue λ should satisfy the characteristic equation of the matrix N_f for

$$\det(Nf-\lambda I)=0 \tag{2}$$

where *I* is the identity matrix of N_f, and to solve the determinate of Eq. (2), we can get the value of λ (here we only look for the possible integer valued solutions for the best solutions of eigenvectors later). Once the eigenvalue of a matrix N_f has been found, we can find the eigenvectors by Gaussian elimination. For each eigenvector *e*, we have

$$(Nf-\lambda I)e=0 \tag{3}$$

that is, convert the augmented matrix

$$(Nf-\lambda I)e\,\vdots\,0 \tag{4}$$

to row echelon form, and solve the resulting linear system by back substitution. We find the eigenvectors associated with the best solution of eigenvalue. The largest of eigenvector centrality is 1 (Bonacich1987). Eigenvector centrality 0 means a node does not connect to any node in a given net-

work. Eigenvector centrality 1 denotes a node who connects to all nodes with the highest value of degree-centrality in a given network.

The index of network constraint is proposed by Burt (2004). The index of network constraint measures the extent to which a node is concentrated in a single network of nodes:

$$C_i = \sum_j C_{ij},\ i \neq j \tag{4}$$

where C_i is the network constraint on node i, and C_{ij} is a measure of node i's dependence on contact j:

$$C_{ij} = (P_{ij} + \sum_q P_{iq} P_{qi})^2,\ q\ in\ N_f[i],\ and\ i \neq q \neq j \tag{5}$$

where P denotes the proportional tie strengths, defined as $P_{ij} =$

$$\frac{(N_{f \cdot ij} + N_{f \cdot ji})}{\sum_m (N_{f \cdot im} + N_{f \cdot mi})},\ m\ in\ N_f[i],\ and\ i \neq m \tag{6}$$

for isolated nodes, the network constraint is undefined.

The score of the network constraint is a positive rational number. The network constraint varies, depending on network size, density, and hierarchy. Constraint on a node is high when that node has few contacts but is strongly connected to another, either directly, or through a central, mutual contact (as in a hierarchical network). Hence, the larger the value is, the more constrained a node is by its neighbors.

Network closeness is another measure of centrality. It is defined by the inverse of node i's average length of the geodesic distance (shortest paths) to/from all the other nodes in the matrix N_f (Freeman 1978–1979):

$$G_i = \frac{N-1}{\sum_{j=1}^{N} d_{ij}}, j \neq i \tag{7}$$

where G_i denotes network closeness of $N_{f\cdot i}$, and d_{ij} denotes the geodesic distance between nodes i and j. For an isolated node i, the total number of nodes in a matrix N_f is used in the formula, instead of the geodesic distance. It shows that the higher the value of network closeness a node has, the shorter are its paths to other nodes in a network.

Last, a node's susceptibility is measured based upon its in-degrees (Friedkin 2001: 174). The formula is as follows:

$$a_i = [1 - (1 / (1 + e^{-(d_i - 2\bar{d})})]^{1/2}$$

where a_i denotes node i's susceptibility to the influence of matrix N_f, d_i denotes the in-degree of node i, and $\bar{d}$ denotes the average of in-degree for $N_f[i]$. It shows that the lower the susceptibility, the higher the in-degree. The node could have more sources of information from different nodes for reference, and then it would not be constrained by single or oligopolistic information sources.

These network features are then used to analyze the network positions of adolescents by different levels of environmental awareness, attitude, belief, and behavior, and their opportunities and constraints in network structure in terms of disseminating the NEP to their peers. The statistical operation and analysis are programmed and processed under the R environment (R version 3.2.1) (R Core Team 2015).

V. Analysis

The research question is the extent to which the students appreciated the NEP. Table 1 shows that about five to seven percent of the students had high environmental awareness and there was no statistically significant difference between school types in a chi-squared test. In terms of environmental atti-

Table 1 Descriptive Statistics of NEP by School Type

NEP	Junior High School	High School	College
Env. Awareness			
Low	6.122 (30)	4.978 (35)	.000 (0)
Medium	88.367 (433)	89.900 (632)	92.771 (77)
High	5.510 (27)	5.210 (36)	7.228 (6)
χ^2(p-value)	.852 (.653)		
Env. Attitude			
Passive	6.326 (31)	4.694 (33)	4.819 (4)
Medium	80.816 (396)	77.667 (546)	66.265 (55)
Active	12.857 (63)	17.638 (124)	28.915 (24)
χ^2(p-value)	6.008 (.049)		
Env. Belief			
Weak	21.428 (105)	26.742 (188)	46.987 (39)
Medium	63.673 (312)	61.024 (429)	45.783 (38)
Strong	14.897 (73)	12.233 (86)	72.289 (6)
χ^2(p-value)	25.675 (.000)		
Env. Behavior1	.171 (.925)	.182 (.859)	.301 (1.217)
Missing	11	27	6
Total	501	730	89

* Percentages with raw number in parentheses were in cells.

1. The values for environmental behavior were average times with standard deviation.

tude, the result shows that high schools had a higher percentage of respondents with an active environmental attitude. Junior high schools had more respondents with a passive environmental attitude than expected ($\chi^2 = 6.008$, $p < .05$). In terms of environmental belief, students in junior high school and college had a significantly higher percentage of being in the weak environmental belief category ($\chi^2 = 25.675$, $p < .001$). As to participating in civil environmental movements (environmental behavior), college students on average participated more, but after an ANOVA test, there is no statistically significant difference between school types (part of the reason is the larger standard deviation in the college group).

To profile the relationship among the four dimensions of the NEP, a cross-table with chi-squared test is presented to examine their statistical robustness (Table 2). The sub-cross-table of environmental awareness and environmental attitude shows that the number of respondents who had low awareness but reflected an active attitude was more than expected. Similarly, those who had high awareness also had an active attitude, while more respondents than expected took intermediate positions on these two ($\chi^2 = 33.155$, $p < .001$). Another cross-table of environmental attitude and environmental belief shows similar results ($\chi^2 = 137.050$, $p < .001$). That is, there was a positive relationship between attitude and belief: respondents who had a passive attitude also had weak belief, while those who had an active attitude also had strong belief. Here again, a surprising number of respondents took an intermediate position on attitude and belief. In the last sub-cross-table of environmental belief and environmental awareness, the number of respondents who had low awareness but showed strong belief was more than expected, but still high awareness corresponded to strong belief ($\chi^2 = 19.400$, $p < .001$). In short, environmental attitude and environmental belief were

Table 2 Three-Way Frequency Table of Environmental Awareness, Attitude, and Belief

Awareness	Attitude	Belief		
		Weak	Medium	Strong
Low	Passive	2	1	0
	Medium	6	35	2
	Active	0	3	16
Medium	Passive	32	24	3
	Medium	219	612	85
	Active	52	68	47
High	Passive	4	1	1
	Medium	9	25	4
	Active	8	10	7
Missing	44			
Total	1,320			

* Chi-squared test is not applicable on the whole table due to the case number in some cells being less than 5. Instead, the statistical tests are implemented by pairs of these three variables.

positively correlated, but it does not show that those who had active attitude and strong belief also had high environmental awareness.

Would the diffusion of the NEP be overwhelming among the young generation? In this study, I do not find significant evidence to support this statement, since most of the respondents were at the intermediate level on measures of environmentalism. Few respondents had been engaged in civil environmental movements. This shows that environmentalists need to expend more effort on environmental education and practice. One education strategy is to influence individuals' intention to carry out environmentally friendly behavior through sociation, where engagement and interac-

tion with others in their social group can enrich their knowledge about environmental issues and pro-environment values and actions. Hence, the structure of sociation is the second research topic I discuss in this paper. Network positions bring us the opportunities and constraints of information flow, knowledge innovation, and economic development (Burt 1976, Burt 2004, Granovetter 1973, Lin 1999a, 1999b, Marsden and Lin 1982), as well as influence on values, attitudes, beliefs, and behaviors through group cohesion and micro social interaction (Festinger 1950, 1954; Simmel 1949). In the next section, I adopt the theoretical approach of sociation and SNA to profile the network positions of our adolescent respondents with different degrees of environmentalism, and illustrate the opportunities and constraints of acquiring network resources to influence or be influenced by others.

To do so, I adopt multiple dimensions of measuring friendship networks. I show a variety of network features in terms of adolescents' network positions from where the opportunities and constraints of their network characteristics on disseminating the NEP could be examined in this study. Network features were calculated based upon the measures of the five friendship questions. Their correlations are presented in Table 3. The network features were measured based on five friendship networks. The correlations between networks were moderate to weak (between .299 and .633) in relation to each other. These correlations show that the results of measuring an individual's positions in network features depend on types of interaction with friends. One exception is network closeness. Interestingly, the measures of network closeness in different friendship interactions were highly correlated, showing that the number of social ties in a given network was consistent, so that the total amount of one's geodesic distance

Table 3 Correlations of Network Features by Friendship Network

Friendship	Eigenvector centrality					Network Constraint				
	1	2	3	4	5	1	2	3	4	5
1	1.000					1.000				
2	.459	1.000				.592	1.000			
3	.513	.402	1.000			.540	.521	1.000		
4	.633	.423	.483	1.000		.601	.522	.524	1.000	
5	.551	.486	.377	.536	1.000	.612	.530	.549	.556	1.000
Size	1,007					1,243				

Friendship	Network Closeness					Susceptibility				
	1	2	3	4	5	1	2	3	4	5
1	1.000					1.000				
2	.803	1.000				.369	1.000			
3	.813	.870	1.000			.299	.306	1.000		
4	.819	.819	.866	1.000		.352	.344	.339	1.000	
5	.781	.817	.844	.817	1.000	.443	.469	.339	.483	1.000
Size	1,320					1,320				

*all $p < .001$

(i.e., the shortest path) to all others was similar across different types of interaction.

In addition, the score of one's eigenvector centrality in a certain interaction with friends was high, while it became low in another one. Similar results were found in network constraint, and susceptibility. This implies that one's positions in network features vary in different measures of social interactions (i.e., best friends, teammates, hangout buddies, lunchmates, and affective supporters). Obviously, friendship is a general concept of social

relation in which individuals interact to form a close social network, providing essential affective and instrumental functions. However, not all affective and instrumental needs can be satisfied from a single type of interaction. That is why we need different types of friends. This diversity influences one's network positions, which then determine the opportunities and constraints of information flow and resource availability, as well as value and behavior change (Festinger 1950, Granovetter 1973, Lin 2002).

I also look for multicollinearity among the four network features. The matrices of correlations between them by friendship network are presented in Table 4. The results show that each network feature was nearly uncorrelated or even negatively correlated to one another. This implies that these four network features can measure an individual's different positions in a network structure. This finding corresponds to the theoretical arguments that eigenvector centrality detects the proportionality of one's connecting to others with high centrality, network constraint for measuring the degree of one's neighbors' interconnection, network closeness for understanding the geodesic distance to all other group members, and susceptibility for measuring the extent to which a node is influenced by its connected nodes at both individual and global levels. Therefore, these four network features can be used to examine the opportunities and constraints of one's network positions in terms of the sociation perspective.

Next, I examine adolescents' network positions in the selected network features by their levels of environmentalism (awareness, attitude, belief, and behavior) in order to demonstrate the opportunities and constraints of network positions for dissemination of NEP. Tables 5–7 show the selected statistical results of the distribution of network feature measures by school type. Only the results with statistical significance are shown, because of

Table 4 Correlations between Network Features by Friendship Network

	Friendship 1: Best Friends				Friendship 2: Teammates			
	E-C	CON	CLO	SUS	E-C	CON	CLO	SUS
E-C	1.000				1.000			
CON	−.102	1.000			−.118	1.000		
CLO	.085	.129	1.000		.091	.083	1.000	
SUS	−.242	−.035	−.072	1.000	−.155	.097	.000	1.000
Size	1,320				1,320			

	Friendship 3: Hangout Buddies				Friendship 4: Lunchmates			
	E-C	CON	CLO	SUS	E-C	CON	CLO	SUS
E-C	1.000				1.000			
CON	−.099	1.000			−.049	1.000		
CLO	.060	.159	1.000		.102	.099	1.000	
SUS	−.290	.057	.032	1.000	−.184	.005	−.014	1.000
Size	1,320				1,320			

	Friendship 5: Affective Supporters			
	E-C	CON	CLO	SUS
E-C	1.000			
CON	−.072	1.000		
CLO	.052	.174	1.000	
SUS	−.147	−.040	.004	1.000
Size	1,320			

E-C: Eigenvector centrality; CON: Constraint; CLO: Closeness; SUS: Susceptibility.

*all $p < .001$

space constraints.

Table 5 is for all adolescent participants. Three types of network features from three friendship measures had significant difference in terms of environmental belief and behavior. Among them, the score of susceptibility measured from F2 (teammates) in weak environmental belief was significantly lower than that in medium and strong groups. It implies that adolescents with weak environmental belief had received more friendship ties and had acquired more information from various sources; as a result, they were less susceptible to individual points of view. However, when the result

Table 5 Statistical Tests between NEP and Network Features for All School Types (Selected)

Network Features	Environmental Belief				Environmental Behavior		
	Weak	Medium	Strong	F-test	No	1 or more	t-test (*df*)
Susceptibility (F2)[1]	.987 (.054)	.994 (.028)	.994 (.027)	4.220*			
Constraint (F5)	.578 (.232)	.534 (.210)	.506 (.199)	7.182***			
Eigenvector centrality (F1)					.243 (.346)	.177 (.308)	2.030* (121.24)
Eigenvector centrality (F5)					.201 (.323)	.142 (.259)	1.885† (97.523)
Size	332	779	165		1,175	100	
Missing	44				45		

Note: means and standard deviations are presented in cells.

F-number: this means which friendship network was used to calculate the network feature. For example, F2 is the friendship network created by respondents' nominating their favorite teammates for completing class assignments.

†: $p<.10$; *: $p<.05$; **: $p<.01$; ***: $p<.001$

shows that the scores of network constraint measured from F5 (affective supporters) in the weak environmental belief group were significantly higher than scores in the other two groups, it implies that adolescents with weak environmental belief were in a more cohesive, dense network. That is, adolescents with weak environmental belief tended to form a more cohesive network. The opportunities and constraints of such a network structure are determined by the degree of network heterogeneity: when the network is perfectly dissimilar, then the group members receive diverse points of view to compare with individual attitudes or opinions via direct communication and interaction with other members (because they highly connect with one another). In this situation, belief change is more possible than change occurring in a homogeneous network. However, when the network is perfectly similar (homophily), the group members will hardly change their standpoints, since all of them believe in a certain social fact.

As to the distribution of eigenvector centrality in environmental behavior for all participants, it shows that participants in environmental activism had lower scores than non-participants, implying that environmental participants were less likely to be connected to those who had higher degree centrality, and thus were less? influential in spreading the NEP to their peers. Among networks of best friends (F1) and affective supporters (F5), young environmental participants were less likely to be in the center of a network, thus making it more difficult to influence their friends to participate in environmental activism.

After discussing the results of network features and environmentalism from all adolescent respondents, I explore the relationship between network features and environmentalism by separating different age cohorts to elaborate the similarity and dissimilarity of their positions in friendship networks

that would bring up different opportunities and constraints for disseminating the NEP among adolescents. Here, I only examine junior high and high school samples but excluded the college sample because in certain categories the college sample did not meet the minimum requirement for statistical testing. Tables 6 and 7 are the results obtained from the junior high and high school samples, respectively. Table 6 shows that among the junior high school sample, respondents with low environmental awareness were slightly less susceptible to influence by their peers. This implies that their friendship network structure was less hierarchical, so that information exchange could have multiple channels. Besides, junior high school respondents with a passive environmental attitude had lower scores of eigenvector centrality than active respondents did. In addition, measures of network constraint from F1, F2, F3, and F5 show that non-participants in environmental activism tended to form more highly interconnected network groups in which their friendship networks were significantly more overlapped than those of environmental participants. This means that junior high school respondents with a low level of environmentalism were in more highly interconnected friendship networks. Hence, by understanding the dense network structure of these low-environmental-engagement adolescents, we can educate them on the importance of environmentalism by distributing knowledge and information through multiple channels (nodes) so that these have good opportunities to be noticed and exchanged.

Table 7 presents the statistical results for the high school sample. High school respondents with high environmental awareness are less susceptible in the network, which means this group had more access to various information sources to make decisions or choose what to believe when their network was heterogeneous in terms of environmental awareness. Simi-

Table 6 Statistical Tests between NEP and Network Features for Junior High School (Selected)

Network Feature	Environmental Awareness				Environmental Attitude			
	Low	Medium	High	F-test	Passive	Medium	Active	F-test
Susceptibility (F1)[1]	.989 (.046)	.996 (.011)	.998 (.002)	2.933†				
Eigenvector centrality (F1)					.112 (.204)	.260 (.349)	.281 (.384)	2.846†
Size	30	433	27		31	396	63	
Missing	11				11			

	Environmental Behavior		
	No	1 or more	t-test (df)
Constraint (F1)	.539 (.206)	.475 (.184)	1.947† (39.506)
Constraint (F2)	.546 (.212)	.466 (.194)	2.297* (39.195)
Constraint (F3)	.535 (.220)	.451 (.165)	2.799** (42.295)
Constraint (F5)	.547 (.207)	.484 (.171)	2.037* (40.686)
Size	455	34	
Missing	12		

Note: means and standard deviations are presented in cells.

F-number: this means which friendship network was used to calculate the network feature.

†: $p < .10$; *: $p < .05$; **: $p < .01$; ***: $p < .001$

Table 7 Statistical Tests between NEP and Network Features for High School (Selected)

Network Feature	Environmental Awareness				Environmental Attitude			
	Low	Medium	High	F-test	Passive	Medium	Active	F-test
Susceptibility (F1)1	.998 (.003)	.996 (.011)	.987 (.057)	5.685**				
Susceptibility (F3)					.960 (.168)	.993 (.028)	.992 (.023)	8.059***
Size	35	632	36		33	546	124	
Missing	27				27			
Network Feature	Environmental Belief				Environmental Behavior			
	Weak	Medium	Strong	F-test	No	1 or more		t-test
Constraint (F5)	.562 (.220)	.521 (.210)	.497 (.194)	3.469*				
Susceptibility (F2)	.991 (.033)	.995 (.020)	.998 (.004)	2.384†				
Eigenvector centrality (F1)					.237 (.346)	.138 (.286)		2.434* (69.71)
Eigenvector centrality (F2)					.202 (.323)	.105 (.210)		2.894** (66.647)
Size	188	429	86		647	56		
Missing	27				27			

Note: means and standard deviations are presented in cells.

F-number: this means which friendship network was used to calculate the network feature.

†: $p<.10$; *: $p<.05$; **: $p<.01$; ***: $p<.001$

larly, respondents with passive environmental attitudes were the least susceptible, specifically within the "lunchmate" network. This preliminary finding shows that high-environmental-awareness adolescents and passive-environmental-attitude adolescents had similar network patterns of the susceptibility in different dimensions of friendship. What we learn here is that understanding adolescents' environmental engagement along with their friendship network structure helps us to communicate well with them through their social networks.

As to environmental belief, we can see that adolescents with strong environmental belief had lower network constraints (in terms of "affective supporters") and higher susceptible to others (in terms of "teammates"), implying that they were in less dense and interconnected neighborhoods of "affective supporters" but had more friends relying on them for help with their class assignments. In other words, these adolescents with strong environmental belief were more reliable study partners (Nelms et al. 2017). Last, adolescents with different levels of environmental behavior had different network positions in eigenvector centrality: environmental activists were less likely to connect with those with high degree-centrality in terms of best friends (F1) and teammates (F2), implying they were less likely to influence others to spread their standpoint about environmentalism if desired. This could be a constraint upon these environmental activists.

Junior high school respondents with low levels of environmentalism were in a more highly interconnected friendship networks, while high school teenagers with a higher level of environmental engagement tended to be in network positions that are supportive and reliable. Hence, to educate junior high school students on the importance of environmentalism, peer influence would be more effective than top-down communication. At

the same time, for high school teenagers with higher environmental engagement, their positions in network features were seen to be instrumental and functional. These environmental adherents were reliable and dependable. They would be more influential within their peer networks if they could have more affective linkages to others so that those with a lower level of environmental engagement would become more sympathetic toward environmental problems.

VI. Conclusion and Discussion

The New Ecological Paradigm (NEP) has challenged the Human Exceptionalism Paradigm (HEP) as an alternative way of thinking about the relationship between society and nature for decades. The goal in this paper is to review the extent to which the NEP has affected the young generation in promoting environmental engagement through sociation and social capital embedded in social network features. I focus on the opportunities and constraints of their positions in friendship networks to raise adolescents' environmental engagement.

Environmentalism is a belief or procedure followed as the basis of action to protect our living world. I focused on four dimensions that measure how environmentalism can be practiced. Environmental awareness is an understanding of the fragility of the environment and the importance of environmental protection. Environmental attitude pertains to the ways in which we think about environmental problems. Our attitudes affect our behaviors. Environmental belief is our preconceptions about things, and since we trust what we believe, we do what we believe emotionally. Our environmental behavior is how we protect the natural environment. These four dimensions of practicing environmentalism illustrate the influence of

the NEP. In this study, I do not find significant evidence to support this statement. Most of the respondents were moderately environmentalist, and few of the respondents had engaged in environmental activism. This shows that environmentalists need to put more effort into environmental education and practice. We need a better way of teaching the NEP to them.

Since we would like to see the influence of the NEP spread from individuals to groups, to the community and then to society, I emphasize that the influential effect of the NEP on individuals can be spread through social networks. My argument is based on George Simmel's social interaction theory. Simmel's conception of society emphasizes social interaction. To explore the association between social networks and adolescents' acknowledgement of the NEP, I examine the opportunities and constraints of the positions which the adolescents occupied within their friendship networks.

Four network features from social network analysis (SNA) in response to Simmel's social interaction theory are introduced and discussed here. I profile the network positions of the adolescent respondents with different degrees of environmentalist beliefs, and depict their opportunities and constraints for acquiring network resources to influence or be influenced by others.

The findings show that network positions had a variety of effects on information flow and communication. One of the mechanisms causing such effects is our measurement of different dimensions of friendship networks. Friendship is a social relation in which individuals interact to form a close social network, performing essential affective and instrumental functions. To capture the diversity of friendship network structure among in-school adolescents, participants were asked to nominate their best friends, teammates, hangout buddies, lunchmates, and affective supporters, demonstrating

that adolescents have many kinds of friendship. I find that not all affective and instrumental functions can be satisfied from a single dimension of friendship. For example, among networks of best friends (F1) and affective supporters (F5), young environmentalists were less likely to be in the center of the network, but were identified as reliable teammates (F2). "Reliable teammate" implies one is seen as a person with good self-esteem, self-confidence, and perceived influence (Hogg et al. 2004; Ritchie et al. 2013). It corresponds with the empirical evidence that adolescent environmentalists fit in well at school and are relatively influential among their peers (Nelms et al. 2017). They are expected to be good citizens, taking action that reflects their values and volunteering in their community (Nelms et al. 2017: 547). Hence, adolescent environmentalists have an important reference role in terms of civic duty for their friends. Measures of network constraint from best friends (F1), teammates (F2), hangout buddies (F3), and affective supporters (F5), however, showed that adolescents who had not engaged in environmental activism tended to form more highly interconnected network groups in which their friendship networks overlapped significantly more than did those of environmentalists.

I also examine the correlations among the four selected network features and found that these four network features can measure individual's different positions in network structure. This finding corresponds to the theoretical arguments discussed in the literature review section that each of them is for detecting individual's network positions and providing insights into their opportunities and constraints (Burt 1976; Friedkin 2001). For example, adolescents with little environmental engagement had more interconnected friendship ties (less susceptible but stronger constraint) while adolescent environmental participants were less likely to be con-

nected to those who had higher degree-centrality to make themselves more influential in spreading the NEP to their peers. Hence, understanding adolescents' environmental engagement along with their friendship network structure helps us to adopt better ways of teaching them about the meaning and importance of environmentalism.

As to adolescents' network positions in the selected network in terms of their environmental engagement, the results shows that junior high school respondents with a low level of environmentalism were in a more highly interconnected friendship network in which their individual awareness, attitude, and behavior were more noticeable, exchangeable, or even changeable and influenced, as long as seeds of environmentalism can be planted into their network structure. And, for environmentally engaged high school teenagers, their network positions were shown to have an instrumental and functional orientation. Compared with different age cohorts in terms of the influential effect of the NEP on these adolescents which spread through the social network mechanism, this study suggests that to educate junior high school students on the importance of environmentalism, peer influence needs to be more effective. Environmentally engaged students should be more influential among their peer networks if they have more affective linkages to others.

In this paper, I have preliminarily explored the opportunities and constraints of network positions in terms of several network features on adolescent social interaction. Social network theories contend that network connections facilitate social interaction and enhance social relationships from which individual actors shape their values, attitudes and behaviors by referring to significant others. Therefore, two possible issues merit elaboration. The first is about position in a multidimensional friendship net-

work. In this study, I base adolescent positions on multidimensional friendship networks. Adolescent friendships have a variety of meanings and functions. Mapping these aspects of friendship should provide insights into the characteristics of network actors. It will facilitate our understanding of the effect of sociation on individual values and behavior. The second point is about homophily in adolescent friendships. In this paper, I do not explore the proportion of attitude or behavior similarity within one's subgroup which might produce different levels of cohesive pressure on peer group similarities. Literature has indicated that people have strong physical and emotional ties with their society because they share a value system and social norms (Hirschi 2002 [1969]). Such social embeddedness encourages greater intimacy and further sharing of values which then foster group homophily. Therefore, the mechanism of group homophily and the multilevel network structure functioning on individual values, attitudes, and behaviors need further clarification so that the opportunities and constraints of network structure can be applied to environmental education and other social issues.

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