

# How Negative Networks Are Forming and Changing in Time?

## Theoretical Overview and Empirical Analysis in Two High-school Classes<sup>1</sup>

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**ABSTRACT:** For a deeper understanding of how the conflicts between individuals and groups are forming, we have to examine the mechanism of negative social networks. Our basic idea is that we know a lot about the structure of positive, mainly friendship social networks – particularly about the phenomena of homophily, reciprocity and transitive triplets – but we do not know a lot about the similar properties of negative ties. The main question of our research is that compared to the positive networks, how the negative networks are working and what the consequences of the development of a closed community structure are. Our hypotheses were tested in two 9-grade high school classes (N=62). We managed to show that the positive and the negative networks were not mirror images, though among actors who were central in the positive network there were students who had a lot of positive ties in the negative social network as well. The results showed that in many cases similar properties resulted in negative ties, which did not become symmetrical, so that not all triadic relations became balanced. Our further conclusion is that the negative relations were more stable than the positive ones.

In our study, within the social network research we are putting the emphasis on examining the negative emotional aspects of the quality of ties and discovering the mechanisms of their inception, comparing it to the positive social network structure. The relevance of the topic is in the fact that social network analysis almost always focuses on the research and modeling of positive ties, and much less on discovering the negative relations. Although negative ties do appear in the network literature, mainly on a theoretical level – for example in the analysis of triadic ties –, but their framework of defining them is not yet clarified, neither empirical studies have been made in large numbers examining their operational mechanisms and dynamic

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changes. Negative ties are more interesting because their effect can be larger than that of the positive ones, as it was shown in connection with the efficiency of organizational operations. This is mainly because antipathy and hatred have significant effects on the operation of a community without emotional, verbal, and physical manifestations that can be noticeable for an outside observer. If someone is not liked by several people, he/she will be isolated and his/her motivation to participate in cooperative activities decreases (Labianca and Brass 2006). Hence, charting the negative ties can give answers to several relevant social questions like the various forms of discrimination and violent actions (Veenstra et al. 2010). Examining the network structure of high school communities and studying the mechanism of violent actions and social discrimination from a social network point of view are nowadays the main focus of sociological researches in the United States (e.g. Add Health project). Studying the negative ties among high school students is currently very important because violence committed in schools is on the rise, and this affects most the discriminated members of the given community (Aronson, 2000). This is one of the reasons why we decided on conducting our study in high school classes. Studying a school class from a network aspect is interesting also because while the school itself and the class in it are based on *formal ties* (Giddens 2003: 686), the in-class status position and the class structure are driven by *informal ties*. A specific characteristic of school communities is that in interpersonal relations significant changes can be observed, often in a short period of time. On top of this, studies on negative ties may contribute to prepare such prevention programs like the KiVA Program in Finland (Salmivalli et al. 2010).

The aim of our study is to collect and sort all theories in connection with the research on negative ties and the empirical test of a novelty approach by studying the adolescents' high school class structure, creating the basis for a larger, more comprehensive future study.

## Theoretical background

### *The Rules and Processes of Establishing the Different Types of Ties*

Establishing and maintaining negative and positive ties happens in similar dimensions, nonetheless in different ways. It is an important point in establishing ties that if people see each other a lot, then it will have higher probability of going to get connected and later become friends (Blau 1977). In creating friendship ties, sympathy is a long process which is formed on a mutual basis (Heider 1958) as a result of spending time together, homophily, similar characteristics, values, and acting modes (Feld and Carter 1992), the existence of attraction and closeness (Kadushin 2004). Friendships are slowly formed during their establishment, exist and then from time to time, are reassessed by the involved parties (Sachter 1959; Newcomb 1981), and – although they are relatively stable – in time they may end (Zeggelink 1993). The course of relations within communities is formed by the reciprocity of and constant interactions between the actors (Doreian–Stokman 1997). The main-

tenance of positive relations is helped by the fact that due to the time spent together, friends become more similar in their behavior, their opinions and values (Newcomb 1956), however costly their establishment and maintenance may be, requiring energy from the actors. The popularity effect affects the establishment of relations; i.e. individuals popular within the network (having high indegree value) are chosen as friends with above-average probability. An essential aspect of the establishment of the ties is if the given persons often see each other; getting connected with each other and later becoming friends has a higher probability (Blau 1977).

Other rules may be authoritative in the exfoliation of negative ties. The phenomenon of refusing the different ones (heterophobia<sup>3</sup>) is essential, but its extent is not necessarily as strong in the exfoliation of negative ties as the homophily is in the case of positive relations. Creating negative relations does not necessarily need longer time spent together or closeness; and those who live too far from each other will not necessarily become enemies. It is interesting that negative ties are established in a much shorter period of time (Wiseman and Duck 1985) than the positive ones, they are more rarely reassessed therefore they are very stable. While in case of positive relations, more complex events and characteristics are required for them to be established and maintained, in the case of negative ties only one characteristic or event is enough that triggers and maintains the unilateral or mutual antipathy or hatred (Labianca and Brass 2006).

Studying it from the dynamics side, a classic example of relations-based segregation is the analysis of the relations among the monks of a New England monastery in five different moments. In Sampson's famous study of the monks' relations toward each other, the monks were divided in cliques according to establishment, confrontation and termination (Sampson 1968).

The theory of structural balance (Heider 1958; Wasserman and Faust 1994) forms an important basis of the evolution of network relation systems, which theory is the basic model of, the quality, context and change of relations between multiple actors. The theory of *structural balance* manifests among three actors, the so-called triadic relations and their change. In the case of the structural balance, Heider's initial hypothesis is that in their strong relations, people are looking for balance. This means that they need people important for them to become friends with each other, but at the same time they disfavour their enemies. Therefore, the situation, where my friend's friend becomes my friend as well, can be considered a balanced situation (Heider 1958). According to Heider's theory, unbalanced networks cannot last long: the direction of one tie sooner or later will necessarily change, terminating the tension in the network. *Lack of balance* within three actors is created when the quality algebraic markers are multiplied and the result is negative. In case of studying negative ties, the theory of structural balance is important because it seems to be much more complex than the Heider model describes it. Its inception is determined by the fact that in an unbalanced situation tension arises among

3 Heterophobia means disliking dissimilar others, though "opposites repel each other." (Flache-Mäs 2008)

the actors, and exactly this is the reason why it is much more possible for them to get into a balanced situation than to remain in an unbalanced one (Taylor 1967; Szántó 2006). The existence of balance, the basis for generalization of the Heider theory is not classified by the mental processes in the actors' mind, but by group dynamics (Cartwright and Harary 1956, Szántó 2006). Negative ties can come into existence between two groups, while there must be positive relations among the group members (Wang and Thorngate 2003). The fact that not only two but even three hostile groups can exist also tends towards an unbalanced state. Heider considered this situation unbalanced as well. On the other hand, according to another hypothesis, if the ties between three groups are studied, not the ones between individuals, there is a balanced situation even if all three groups have negative ties towards each other (Davis 1967). In connection with changes in time, several studies showed that structural unbalance is constantly decreasing with time and tends towards a balanced state, and balance is reached as a result of mutually dissolving mechanisms (Hummon and Doreian 2003; Szántó 2006). The existence of balance or unbalance depends on several, more complex factors. It is a further question: what can be considered a balanced or unbalanced diad, triad, and graph system (Szántó 2006)?

The status position of individuals can also affect the development of both positive and negative network structures. Bonacich and Lloyd studied the status of individuals comparing them to negative ties. They studied the value of the eigenvector centrality measure and the exfoliation of the number of negative ties, and then on the basis of these values, they made a comparison between the existence of a balanced situation and the achievement of status (Bonacich and Llyod 2004). Their work is also not typical because they managed the relations in a multiplex manner, in connection with each other. Their hypothesis contradicts the one that was made from the result of transitive triads, supposing that triads negative on all sides are considered unbalanced. Their theory conflicts Davis's point of view, according to which three negative transitive triads can also mean a balanced situation (Davis 1967). The connection between structural balance and the reach of status is demonstrated in Table 1, created by Bonacich and Llyod.

Table 1: *Correspondence between structural balance theory and status achievement*

Structural balance theory	Status achievement
Friends of friends are friends.	A positive connection with high status individual increases one's status.
Friends of enemies are enemies.	A positive relation to a disvalued individual decreases one's status.
Enemies of friends are enemies.	A negative connection with a high status individual decreases one's status.
Enemies of enemies are friends.	A negative relation to a disvalued individual decreases one's status.

Source: Bonacich–Llyod (2004) pp. 332

Accordingly we tried to examine the positive and the negative network of ties separately in our study. Of course, in real relations, the operation of these is connected, but to understand their operation from the basics we separated them as it was done in previous studies describing friendship and sympathy ties. The main question of our study was, compared to phenomena observed in positive networks, how negative ties did develop, operate and change in time, and what their effect on closed, intensive community structures was. Whether negative ties work as the positive ones do?

### *Mapping the High School World from a Social Network Approach*

High school classes are those closed communities where the phenomena of status competition and discrimination can be studied best from a network aspect, since these are well-contained micro-networks where change in network actors is proportionally smaller, the time of the network's formation and dissolution is given, the actors spend a lot of time together and they have strong emotional ties to the other members of the community. The network of adolescents is interesting from a social politics aspect because this is the period where the group effect is intensive in the formation of individual and group identity (McNelles and Connolly 1999). As a result several studies were conducted to map the high school world and its relations which focused on the development of friendships and, in connection with this, on the phenomenon of in-school segregation observed from the aspect of friendship ties (Coleman et al. 1966; Holland and Harding 1978; Willis 2000; Quillian and Campbell 2003). In connection with the development of cliques within school classes, the relations between ethnic boundaries and personal choices have been studied as well (Baerveldt et al. 2007). Based on the data from the above-mentioned Add Health sample, Ted Mouw and Barbara Entwisle studied the effect of ethnic-based segregation in place of residence on the development of school friendships and showed that if segregation in the place of residence was to be decreased, then the ethnic segregation of school friendships would decrease as well (Mouw and Entwisle 2006). James Moody was working from the Add health sample as well, and studied ethnicity, school integration, and the segregations of friendships. He took the theory of homophily as a basis: people are more likely to make friends with those who are similar to them in various ways. In connection with this, in his study he concluded that there was a large amount of segregation in the schools even though they were integrated on a social level. In those schools where the school organizes events offering a chance to actors belonging to different ethnic and social groups to meet, there the students have much more positive attitude towards each other (Moody 2001). Newman and her colleagues studied the extreme manifestation of the segregation status, researching the social causes and factors of school shoot-outs. They tried to outline the social backgrounds of shooting kids by interviewing persons in the close surroundings of the culprits. During their studies they concluded that the attacks were carried out by well-off white boys in their middle class, which

was, nevertheless, a rather closed community. Their exact hypothesis is that the culprits do not necessarily have psychological, but – in a given case predictable – social factors, who are outcasts at the bottom of the social hierarchy in the school (Newman et al. 2005). The reasons for studying high school communities are part of the literature of both sociology as a whole, and of network analysis, enabling the measurement of different types of negative ties; therefore we put the study of sociological attributes in the focus of the research, supposing that hated actors always exist, and this has measurable, observable sociological and social network-based explanations.

## Research questions

The basic network hypothesis of our research is that positive and negative networks have asymmetric relations with each other, e.g. the negative network is *not* a mirror image, or in other words, it is *not* an inverse copy of the positive one. This means that the seemingly evident expectation that in the negative network the main actors of the positive network are on the periphery, the peripheral actors are in the center is not necessarily fulfilled. Furthermore, it is a question if this supposition is true, what kind of mechanisms drive the organization of negative ties, and what the relation of such mechanisms to the basic mechanisms is that define the development of the positive ties. Therefore, we tried to form such hypotheses that are “inside out” versions of the phenomena that form the networks of positive relations. To highlight these we came up with *static* (to highlight in any given moment of time) and *dynamic* (to highlight with the passing of time) explanations.

*Our static explanation* concerns the different structures of positive and negative networks. In the community, the number of negative ties will be significantly lower, i.e. the negative net will be less dense than the positive one. We suppose this may happen this way because it is possible that there are actors who are popular in one given group, but at the same time they are not very popular in any other group or groups, or others may have neutral emotions towards them.

*In our dynamic explanation*, the hypotheses revealing the causes of the differences between the two networks can be such what concern the causes for the exfoliation of the ties, and for the development and the dynamics of the ties. The explanation for the suspected causes of the development and the mechanisms can be possible to give by studying their change in time. We suppose that those mechanisms, which can be observed in positive networks – primarily *homophily*, *reciprocity*, and the phenomenon of *transitive triads* –, can prevail with different intensity and logic in the negative networks than what was observed in the case of positive networks.

### 1. Homophily – Heterophobia

In the case of homophily, according to the literature, those actors who have several similar characteristics may make friends with a higher probability (Burt 1982; Feld and Carter 1998). It raises the question whether it is true in the other way round in

the case of negative ties, i.e. would actors with very adverse attributes hate each other, and will the phenomenon of *heterophobia* appear in the development of hostility?

Those actors who are members of the same sex will be friends with a higher probability. It is a question whether the rival groups will be divided by sex. Is it typical that hatred arises between boys and girls?

Those students who have similar academic results will more likely be friends. Will they discriminate students with too good or too bad academic results with higher probability? Will it be observed that students with different academic results will hate each other?

Will students with similar social status be friends with higher probability? Will kids with different financial status hate each other?

Taste in music also determines the inception of friendships (Bryson 1996). Do high school communities repel those of certain musical subculture?

Smoking and drinking habits, the way of passing free time may also have a significant role in the birth of friendships: common activities and interests strengthen the development of friendships (Donohew et al. 1999). Do smokers have negative feelings towards their non-smoker classmates? Do those who attend social events together (for example, go out to bars together) mock those classmates who do not join them?

Those who are considered better looking will be more popular than those who are not considered as such by the community (Kreager–Staff 2009). In the case of homophily better looking actors make friends with other better looking actors, while those considered ugly are more likely to make friends with other ugly actors. In case of heterophobia, will the actors considered ugly hate the beautiful?

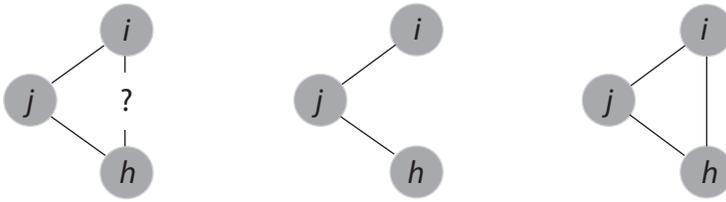
## 2. *Reciprocity*

In a positive network, reciprocity is when positive emotions become mutual in time (Heider 1958). In connection with negative relations, it is a question if two actors do not like each other and will this become mutual in time? Does heterophobia arise of the mechanism of reciprocity resulting in the fact that if we like somebody (or at least have neutral attitude towards), but they do not like us, will this set back our performance? The performance of an individual inside a company can be deteriorated by inter-department – or in-department – gossip. The individual can feel him/herself frustrated, and this tension can be dissolved by negative emotions towards the individual and can become mutual in time (Labianca–Brass 2006). It is a question though whether negative reciprocated relations work similarly in a not exclusively performance-oriented environment.

## 3. *Transitive Triads, Structural Balance*

The state of relations is called transitive triad, which, in case of three actors connects all three with one another, i.e. in a three-actor graph the density is exactly the same.

Figure 1: Potential transitive, non-transitive and transitive triads



$K_n = 1$ ,  
 where  $K$  is equal to a graph,  $n$  is the number of actors.  
 Source: Snijders (2008), pp.5

In the case of transitive triads, if the situation is at the first date that is that Actor I likes Actor J and Actor J likes Actor K, then, based on Heider's balance theory, Actor I will like Actor K (Heider 1958). The question is raised in the case of negative networks: the friend of my friend becomes my friend, but is it really true that the enemy of my enemy will become my enemy as well? This situation exists in those cases when three different groups are one another's rivals, and they have no such goals reaching which can make two groups come to an agreement and "the enemy of my enemy becomes my friend".

#### 4. The Effect of Popular Actors on the Network Structure

Based on the research made by Bonacich and Lloyd, we concluded that the reason why the positive and negative networks are not each other's mirror images may also be the fact that there may be such opinion leaders who have many ties in both the positive and the negative network. These actors have such influence and high status in the community's hierarchy which may affect the members of the network whether they like it or not.

#### 5. Summary of the Studied Hypotheses

The studied hypotheses are the following in brief:

1. *Hypothesis: (static hypothesis):* Positive and negative are not each other's mirror images, they are different in both their shapes and density values: those who are central figures in the positive network are not on the periphery in the negative network.
2. *Hypothesis: (dynamic hypothesis):* Mechanisms observed in negative networks (H2a: reciprocity, H2b: homophily, H2c: transitive triads) cannot be matched in an analogous manner with the mechanisms observed in positive networks.
3. *Hypothesis:* The difference between the positive and the negative networks can also be explained with popular actors having effect on the network structure: those who are not liked by them will not be liked by the actors having positive ties towards such popular actors.

## Data

Testing the research questions, we used data collection by self-administered questionnaires, which, on the one hand, is the most popular mode of data recording in network analysis (Kürtösi 2005). On the other hand we deemed it justified both because of the intimate nature of the topic, and because of the age of the youth. The method was also deemed better because we supposed that although the negative and positive ties are intimate relations, the interviewed persons will not decline answering them in the case of a self-administered questionnaire where they do not have to express their opinion publicly. A frequently used method for querying about relations is the social network matrix, which is often called list query in the relevant literature. In this case, all the group members are listed for the person questioned, and this person describes his/her relationships with all of them (Kürtösi 2005). This method is more suitable to map the whole network, because the person questioned must decide on his/her relationship to his/her fellows at a time. From the aspect of data, it is an interesting part of research that we did not query the youth one-by-one who they like, who they do not like, whom they consider a friend and whom an enemy; but they had to rate all their classmates on a scale of 1 to 5. It contained questions – among others – about the student's gender, age, school performance, subjective financial situation (i.e. how do they judge their family's financial situation compared to their classmates). We asked about smoking and drinking habits, the different types of free time spent together. Previous acquaintances are important and they affect the development of relations as well, so does the fact with whom makes the student their first contact. Starting on this assumption, we asked about previous acquaintances and about the one next to whom the student sits. The social network data are comprised of two parts: one part is the data concerning the network-forming ties; the other is data concerning the actors of the graph who are tied together by the above-mentioned ties. Assuming that a network contains  $n$  actors, the ties between them can be represented by an  $n \times n$  matrix, the  $X_{ij}$  element of which shows whether there is a relation which directs from Actor I to Actor J. In our case these variables are dichotomous, i.e.  $X_{ij}=1$  if there is a relation between Actor I and Actor J, or  $X_{ij}=0$  if there is none. After dismissing the diagonal elements ( $X_{ii}$ ), the whole network will be  $n(n-1)$ .

We made our questionnaire filled by two classes of 9 graders in Budapest, on two occasions each. We chose them because they were new, freshly brought together<sup>4</sup> in closed community forms, the members of which had strong, partly developed attributes that – so we assumed – can determine the exfoliation of both the sympathy-friendship ties and both the antipathy-hatred ties.

One school of the two was a public school, the other one was a private school run by a protestant church. The time difference between the two data recordings was four months. We timed the first wave to the moment when the classmates had known each other, but there were not any stabilized and strong relations as

<sup>4</sup> In Hungary, the high school generally starts at level 9 grade, and it is completed at level 12 grade.

yet. The second data collection was timed when they had a chance to get to know each other better and reevaluate their relationships after that period of time. One class (Class A) had 30 students, while the other (Class B) had 32 students, and the students were recorded by code numbers.

## Analysis

Our analysis is quantitative and descriptive at the same time. The status of the actors, the number of network ties were processed as numbers, while the dynamics of the various networks and the definition of the actors' status in the network was visualized by the help of involving the studied attributes; next we analyzed the resulting figures in a descriptive manner. The positive and the negative social networks were analyzed by questions according to the five-grade Likert-scale. All members of the class had to mark all the other members according to the following descriptions: hates them, considers rather unsympathetic, neutral, sympathetic or friend. For better demonstration and for a more accurate understanding of the governing mechanisms we dealt with and analyzed the positive and the negative networks separately as described in the literature (Labianca and Brass 1998). The comprehensive analysis of the social network was analyzed by an asymmetric network in the case of both classes, because it was common that students did not mutually consider each other as friends. The reason for this is twofold: one, the friendship-sympathy ties had not been consolidated yet; two, the students were not yet able to define what a friend meant to them. To compare the two classes and to conduct the analysis, the descriptive attributes were examined in the case of both of the classes (for example: gender, education of parents, financial situation, religion, etc.). Demographic data (sex, education of parents, financial situation, religion, etc.) were recorded only at  $t_1$  date because we deemed that there were not to be significant changes during the time (a little more than 3 months) between the two data recordings. Data encoding and descriptive statistical analysis were done in SPSS 15, the social network analysis was done in UCINET 6, and the network visualization was done in Netdraw. When making the social network matrix we created quadratic matrix in such a manner that its rows and columns were attributed to the same actors, the values of the matrix described the relation between them. The relation between the elements of the matrix moves from the row to the column.

The categories of the variables were encoded as follows. Sex: 0 is girl, 1 is boy. Education of parents: 1 = some elementary school, 2 = finished elementary school, 3 = finished vocational training school, 4 = finished high school, 5 = finished vocational high school, 6 = finished college, 7 = finished university, 8 = finished postgraduate studies, 9 = I do not know. The categories for the cohabitation status of the parents were the following: 1 = yes, they live together; 2 = no, they are separated and/or divorced; 3 = my mother or my father is not alive anymore. For school performance, the categories were as follows: 1 = under an average of 3 or 2 = average of 3-3.5, 3 = average of 3.5-4, 4 = average of 4-4.5, 5 = average of 4.5-5. Dummy variables were

used for “Did you know anyone previously?” and for “Do you go to church?” (0 = no, 1 = yes). For the financial situation the categories were the following: compared to the majority of my classmates: 1 = we are significantly poorer; 2 = we are somewhat poorer; 3 = we have similar lifestyle; 4 = we are somewhat more affluent; 5 = we are significantly more affluent. The social and demographic background variables of the two classes were considerably heterogeneous.

We studied the positive and negative network structure of Class A and B at the first time ( $t_1$ ) and at the second time ( $t_2$ ). We deemed the four-step separated two-level analysis important also in revealing the network structure of the two classes. On the other hand, we endeavored on studying the facet if the background variables involved in the study really gave an explanation of the causes of the establishment of negative or positive ties. But, during the course of the study, we had to face a situation in which the most and the least popular students in Class A at the time of the first data collection left the class by the time of the second one, and above all this a clique of 6 was missing also. Therefore the data from the two dates cannot be considered relevant for comparison, so we made a researcher decision not to include it in the dynamic analysis. If we have had the opportunity to make inquiries in the class for a longer period of time and in more waves it would have been worth it to keep Class A in to demonstrate how a shock of the community restructured the social network. Lacking this, the analysis only includes the class (Class B) that had useful samples at both times. In Class A, one student became home-schooled due to illness, the other chose another school due to poor academic performance.

## Testing the hypotheses

### *Testing the Static Explanation*

According to Hypothesis 1, negative networks are not mirror images of positive networks. To test this theory, network figures were compared; the main ego network indicators were calculated and compared.

Figure 2: Class B, positive network,  $t_2$  (black square = girl, white square = boy)

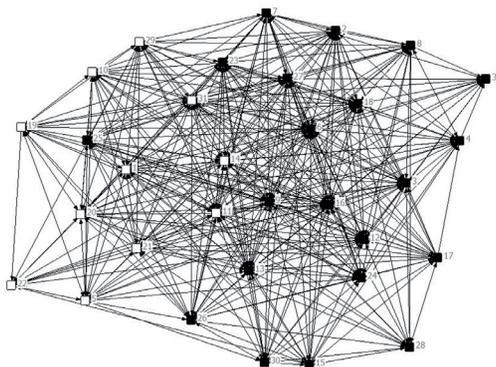
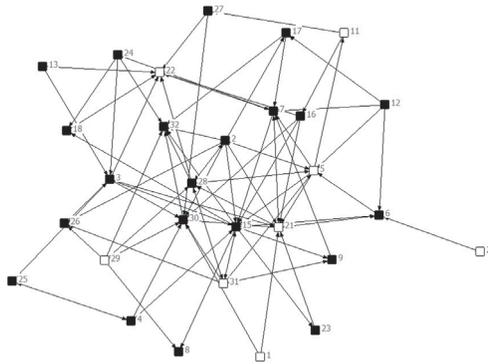


Figure 3: *Class B, negative network, t<sub>2</sub>* (black square = girl, white square = boy)

Our first two figures were created in Netdraw with “Spring enabled” method, which enables the central actor in the network to be in the center of the figure as well. The studied networks are asymmetric, not only the reciprocated indications were involved. On the basis of Labianca and Brass’s analysis (1998), we assumed that studying unilateral relations can play a part primarily in studying the development of status positions in the network (Labianca–Brass 1998). The results showed that the students of the positive network with high indegree are in the center of the visualized matrix, and the same applies to the negative network. The network figures show even at first sight that the positive and negative networks are not each other’s mirror images. On Figure 3, the ties representing positive and negative emotions are shown in one graph. Ties marked with a single line represent the positive networks, while the bold lines represent the negative networks. It is demonstrated well on the figure that if we analyze the two kinds of networks together, based on their quality, the relations are not situated conversely.

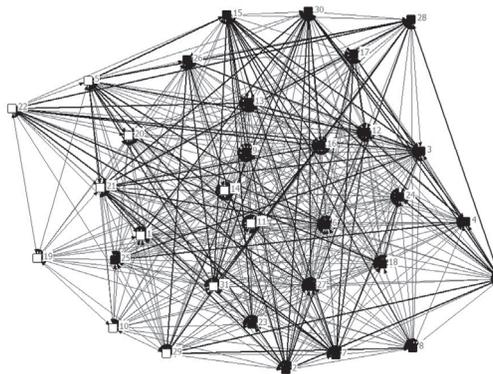
Figure 4: *Class B integrated figure of positive and negative networks, t<sub>1</sub>* (black square = girl, white square = boy; grey tie= positive ties, black tie= negative ties)

Table 2 contains the values of the density indicator of the two studied classes at both times.

Table 2: *Density measures in  $t_1$  and in  $t_2$  (Class A and Class B)*

Density/ network	Class A positive network ( $t_1$ )	Class A negative network ( $t_1$ )	Class B positive network ( $t_1$ )	Class B negative network ( $t_1$ )	Class B positive network ( $t_2$ )	Class B negative network ( $t_2$ )
Mean	0.86	0.13	0.81	0.11	0.74	0.12
Standard deviation	0.84	0.41	0.78	0.45	0.81	0.38

Yet, the density indicators show that the networks are not symmetrical<sup>5</sup>. Furthermore, we examined how many of the established ties the actors own both in the negative and positive networks. Table 3 contains the main centrality indicators of Class A and B's positive and negative networks at both times. Therefore, our results are in harmony with the assumptions of the scientific publications: positive networks are denser than negative networks (Labianca and Brass 2006). Although relations are denser in Class A than in Class B, the results are very similar. The densities of the two networks are different, i.e. people have much higher amount of positive opinions about their classmates than of negative ones. One can deduct from the high dispersive values that there are actors who have more negative relations, and there are others who have more positive ones than the average. We observed that the ties consolidate in time and tend towards mutual acceptance or refusal. It is interesting that as the classmates got to know each other better, although not to a significant degree, there were more negative ties.

Table 3: *Centrality measures of positive and negative networks (Class A and Class B)*

Centrality/network	Class A positive network ( $t_1$ )	Class A negative network ( $t_1$ )	Class B positive network ( $t_1$ )	Class B negative network ( $t_1$ )	Class B positive network ( $t_2$ )	Class B negative network ( $t_2$ )
Degree centrality (indegree mean)	25.1	3.7	25.0	3.4	22.9	3.6
Degree centrality (indegree standard deviation)	8.0	3.5	7.3	4,	8.9	5.4
Degree centrality (outdegree mean)	25.1	3.7	25.0	3.3	22.9	3.6
Degree centrality (outdegree standard deviation)	10.5	3.9	9.0	3.3	9.5	3.1
Network centralization (indegree)	26.6 %	20.1 %	20.0%	4.4 %	31.7%	27.2 %

<sup>5</sup> The ratio of progress of positive and negative ties among all the possible ties has not the same proportion.

Centrality/network	Class A positive network (t <sub>1</sub> )	Class A negative network (t <sub>1</sub> )	Class B positive network (t <sub>1</sub> )	Class B negative network (t <sub>1</sub> )	Class B positive network (t <sub>2</sub> )	Class B negative network (t <sub>2</sub> )
Network centralization (outdegree)	33.7 %	20.1 %	26.6 %	5.5 %	38.4 %	12.2%
Betweenness (mean)	1.3	3.3	1.3	2.7	1.4	1.3
Betweenness (standard deviation)	0.9	4. 519	0.9	4.2	1.2	3.7
Network centralization of betweenness	2. 4 %	13. 7 %	2.3 %	13. 8 %	4. 3 %	17. 5 %
Closeness centrality (mean)	30.5	7.5	42.8	7.3	30.0	8.0
Closeness centrality (standard deviation)	2.7	2.2	5.0	3.2	3.2	5.3

For further analysis and proof we examined the number of ties – in both negative and positive networks – attributed to the actors. Examining these helps to see who are liked and who are not, partly testing the second hypothesis. Examining the different numbers are important to reveal who the probably most popular actors are in the positive networks and who the least popular actors are, at least by the number of positive ties. We must describe the tie attribute of an actor to reveal who the important actors in the network are, who are those who have the most ties compared to the other actors, and who the most popular students are. The centrality degree primarily measures an ego network attribute, but it also contains information for the whole network. Central measuring numbers are those that help us show who occupies an important position and as what. The most important actors in the structural model are those who have the most ties, those who connect to the most actors within the network, and those who have the shortest route to their relations (Wasserman and Faust 1994). In Class A and B, we can reach the following conclusion on the basis of the centrality degree indicator: In both classes, lots of actors have outbound ties, in this there are no big differences between the two. On the other, in the case of the negative network, few actors have outbound tie and these ties reach few actors, and there are actors who have high values in both networks. These results do not contradict the theoretical hypotheses of the scientific discussion (Labianca and Brass 2006).

Table 5 shows that particular actors in the positive and the negative network are not situated as each other's mirror images.<sup>6</sup>

6 We got hardly similar results in time 2 of Class A and Class B.

Table 5: Class B in  $t_1$ 

Students possessing the least negative ties	Inverse of negative network	Students possessing the most positive ties
30	19	11
26	14	14
20	8	9
23	10	7
9	22	3
22	9	1
10	23	23
8	20	26
14	26	6
19	30	27

The first column of the Table represents the students with the least negative ties. In the second column, we reversed the order to compare to the actors of the negative network. It is clear that Actor 11, who has the most positive ties, does not belong among those who have a small number of negative ties. Actors 14 and 23 are those who have the same position both in the positive and the negative network, while this cannot be said about the other actors: they do not have reversed positions in the two networks. The figure strengthens the statement: positive and negative networks are not each other's mirror images.

Based on the various centrality degree indicators, one can say that Class B has more stable relations than Class A. The question occurred to us: could these numbers forecast the "disintegration" of Class A? I.e., if a class network is more stable according to the various indicators how will it change by time? Therefore, based on the different indicators, we concluded as follows: the positive and negative networks are not each other's mirror images and there are far fewer negative ties than positive ones, furthermore, we identified the important and the marginal actors in both classes.

### *Testing the Dynamic Explanation*

In our dynamic explanation we tested the phenomena of homophily, reciprocity and transitive triads, described mainly for positive networks. We made the following observations studying homophily and its analogous counterpart in negative networks which is heterophobia: separation along sex-lines was strong in both classes both times. It was clear that the most popular actors among girls were considered beautiful by more than 75 per cent of the class, while this same quality did not have such important role among the boys. In the negative network, sex has a less important role, but not beauty: there were several actors considered beautiful who were not liked. Although beauty is apparently one basis of popularity, it causes jealousy in others after all, and through the mechanism of jealousy it provokes negative feelings. This phenomenon is not typical among boys. This is also visible in the fact that

it can be observed in the negative network that there are three boys who are not hated by anybody, and furthermore, three of the four most hated actors are girls.

For the first time, we observed that the students considered their own financial situation average, and financial situation did not affect at all, or affected only the positive network structure only a little. For the second time, major changes cannot be observed from this aspect. First we observed in the negative network that there are no central actors in worse than average financial situation, therefore one can say that no one is hated because of the financial situation being worse than the average.<sup>7</sup> But there are several actors in the center of hatred whose financial situation is better than average. Although this must be treated carefully: on the one hand, only two students are not liked out of the five with a better than average financial situation; on the other hand, only one out of the four most hated actors has a financial situation that is better than the average.<sup>8</sup> For the second time, it was visible that two of the five students with the best financial situation managed to reach a more central position than previously – especially in the network containing strong (2) ties. Two of the other three students with better than average financial situation have a considerably peripheral situation. The situation remained the same in the negative network, but it could be observed as well that the least popular actors were concentrated more in the center.

In the case of academic performance, we found that the class has a considerably good academic average, there were not any students with an average lower than 3.5. Furthermore, we observed that there was only one student between averages 3.5 and 3.9. However, this person (9) is quite popular and – this is the most interesting part – is not friends with the students with 4 – 4.49 average, but rather with those with 4.5 – 5 average. In the network of strong positive ties we observed that boys with 4 – 4.49 averages have a rather separated group, to which two girls with similar academic performance are loosely connected (via Actor 31). For the first recording, we did not find any densification among any academic average. For the second time, averages had worsened, but there still were not any particularly bad students. The primary difference was that the majority of the students moved from the previous average above 4.5 to between 4 and 4.49. Those who maintained their excellent academic performance were somewhat excluded from the central positions, but were not isolated. For the second time, the excellent students formed a small, slightly separated group of 3–4 persons. The others clearly make friends rather according to their sex. The student with particularly bad academic average after the first semester managed to reach a central position in both strong and weak positive ties. In the case of the negative ties, it seemed that hatred was not fundamentally explained with academic average, although the really bad students were peripheral actors in the negative network. It is worth

7 There was no student in any of the given networks who was significantly worse than average or significantly better than would have considered the financial situation. Namely, in the Likert-scale, value 1 or 5 was not observed.

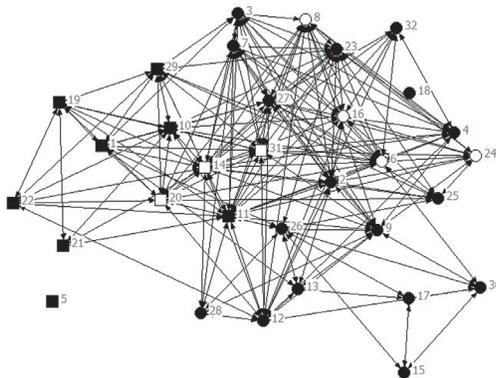
8 Unfortunately there is no information about the financial situation of these four actors, though there is no information about who holds positive financial information.

mentioning that while academic performance seemed definitive concerning the positive ties, i.e. students made friends with classmates with similar academic performances – especially from the same gender –; it seemingly did not have a strong effect on negative relations, there were the same average amount of 4 – 4.49 and 4.5 – 5 students among the least popular actors.

We examined the effect of smoking on the exfoliating ties, because, according to previous assumptions, it has a group-forming effect. But in the studied class only a very small portion of the students smoke, therefore this hypothesis cannot be well demonstrated, or proven. We had the same results with the musical network as well: contrary to preliminary expectations it did not have a strong effect on friendships. Next we switched to analyze those attributes that can only have meaning in the given community, like being a pointdexter, beauty and time spent together.

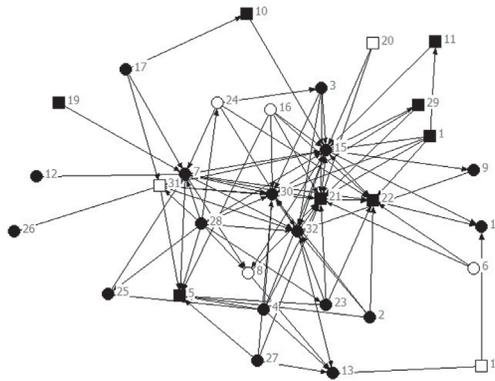
It is visible on our Figure, that four out of the seven most popular students were considered beautiful by the classmates for the first data recording. But this does not mean that every beautiful student is popular too: only 8 students were considered good-looking and only every second person among them was outstandingly popular<sup>9</sup>. Among gender-lines, we identified four beautiful girls and three handsome boys. Beautiful girls, who are not central actors of the positive network, form a visibly well-separated clique. In the negative network one beautiful female actor (32) has a relatively central role, although it is interesting that it is mainly girls who do not like her. This actor is member of the separated beautiful girl clique. Furthermore, we observed that very much hated Actors 15, 21, and 30 in the negative network were not considered beautiful by anyone. The situation of the beautiful actors in both the positive and the negative networks has not changed for the second data collection, except for the perception of the most hated girl, No. 32, who was not considered beautiful anymore by her classmates.

Figure 5: Class B, positive networks, sexes, beauty,  $t_1$  (circle = girl, square = boy; white = beautiful, black = not beautiful)



<sup>9</sup> It is only 3 beautiful girls whose roles are peripheral among the four highly popular actors. The handsome boy's popularity is slightly higher than the average.

Figure 6: Class B, negative network, sexes, beauty,  $t_2$  (circle = girl, square = boy; white = beautiful, black = not beautiful)



After this we examined the position of the students considered pointdexters in the different networks. It showed that the students considered pointdexter<sup>10</sup> have a relatively close and mutually positive relationship with each other. Maybe only Actor 21 is a bit of an exception from this rule, being connected through only one actor to the pointdexter group. It was also visible, that the pointdexter group was not on the periphery of the positive network, but was an integral part of it. It is especially true when it comes to friendship networks: it is well visible that although the pointdexter students are on very good terms with each other, they do not necessarily consider the others their best friends. In the negative network (at  $t_1$ ) it was clear that not every pointdexter of the class was hated. Four out of the six pointdexters had very peripheral positions in the negative network, i.e. they were not hated. Then why does the class hate two pointdexters and why does it not hate the other four? The answer to this may be the following: only the “teacher’s pet” pointdexter is stigmatized by the class (21). An interesting observation is worth mentioning: no point dexter student in the class is considered beautiful. At  $t_2$ , only four pointdexters could be identified (13, 15, 21, 30). They have a definitely marginal but not at all isolated position in the positive network. We also observed that Actor 21 of the four pointdexters was absolutely separated at  $t_2$ , the other pointdexters outcast him or her as well, although Actor 21 had a good relationship with one of the most popular actors, Actor 14. We can see in the  $t_2$  negative network that less persons are considered point dexters at  $t_1$  than at  $t_2$ , and these persons (except for Actor 13) are definitely not liked, one can say that these three actors (Actors 15, 21, and 30) are the least liked.

<sup>10</sup> In the Hungarian student language, point dexters are those who study a lot; mostly they are the best students within a class, but not necessarily seeking the favor of the teachers. The teachers’ pets are those who are trying to seek the favor of teachers in order to achieve good results.

Figure 7: Class B, negative network, poindexter, t1 (circle = girl, square = boy; white = beautiful, black = not beautiful)

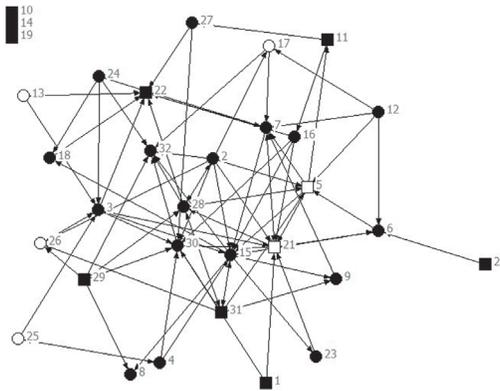
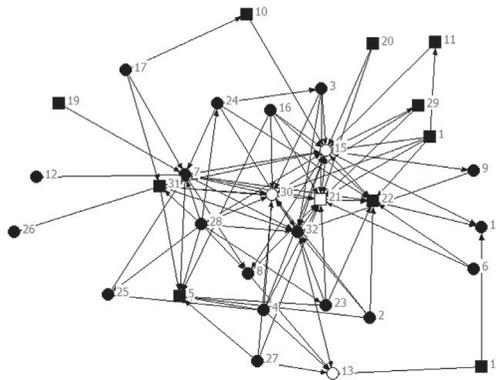


Figure 8: Class B, negative network, poindexter, t2 (circle = girl, square = boy; white = beautiful, black = not beautiful)



Partying is in the same situation as smoking: not a lot of them had been going out yet, therefore we cannot establish whether after school activities contribute or not to the establishment of both hostile and friendly relations. Table 6 contains the codes for popular and unpopular actors after the analysis of numbers and figures.

Table 6: Popular and unpopular actors in Class B

	Class B (t <sub>1</sub> )	Class B (t <sub>2</sub> )
Popular students	14, 11, 31, 6, 23	14, 11, 31, 6, 23
Unpopular students	15, 21, 30, 22, 28	15, 21, 30

In order to test the dynamic part of our hypothesis, we studied the developing cliques. Surprisingly we found so many cliques in both negative and positive networks that it was impossible to identify them. It would have been fortunate to study the cliques because then it would have been easier to study the changes in time between individuals and to describe the groups with their attributes that might separate them from each other. Therefore, we try to deduct from information the numbers. Table 7 contains the reciprocity values in the negative and the positive networks.

Table 7: Results of reciprocity

Measure/network	Class B positive network (t <sub>1</sub> )	Class B positive network (t <sub>2</sub> )	Class B negative network (t <sub>1</sub> )	Class B negative network (t <sub>2</sub> )
Reciprocity	56.1%	53.5%	8%	10%

In the positive, it is visible that the phenomenon, where Actors *i* and *j* marked each other as friends, manifested in 56 per cent of the existing ties. At t<sub>2</sub>, this value decreased. While in the positive network, reciprocity decreased with 4.7 percentage points compared to the previous data collection; in the negative network, the reciprocity proportion increased by 2 percentage points, i.e. by 25 per cent.

In the positive network, the percentage of ties that had become mutual decreased. On the other hand, in the negative network, there is an opposite result: the number of mutual ties has increased, i.e. unilateral hatred became mutual by time. This echoes Beethoven's famous line: "*Hate falls back by itself to those who feed him.*" If we think about Taylor's previously mentioned reciprocity theory, the proportion of a balance situation has not changed in the studied community, but has become opposite (Taylor 1967). But this fact that the shift becomes opposite must be looked for in the shift in proportion.

### *Transitivity – Transitive Triads*

In the case of transitive triads we studied the related indicating numbers as well.

Table 8: Values of transitive triplets

Measure/network	Class B positive network (t <sub>1</sub> )	Class B positive network (t <sub>2</sub> )	Class B negative network (t <sub>1</sub> )	Class B negative network (t <sub>2</sub> )
Number of one-directed transitive triads	10 168	8 258	205	329
Transitive networks	69.7 %	66.8 %	14.6 %	25.2 %

We found that with time the number of transitive triads in positive networks had surprisingly decreased, while it had increased in the negative networks: a 4.5 percentage point decrease appeared in the positive network, while the number of transitive triads increased by 72 per cent in the negative network, which is a significant growth, but there were still much more positive triads. This means, that some positive ties were broken, while negative ties became solid, and even strengthened. This may be the explanation for the development of Heider's unbalanced situations or Davis's negative balanced situations, which assumes that it may be worth it if actors hate each other, this way strengthening the group cohesion, the identifier power of their own group. But this would need a study with more time for data collections, which may help to identify all the cliques around, as Sampson's research demonstrated (Sampson 1968). We think that during a dynamic study with more occasions for data recording the in-class groups may have clearer outlines as the status of their own actors become more easily identifiable.

### *The Effect of Popular Actor on the Network Structure*

After the two hypotheses studied so far, let us switch to a possible reason referring to a suggested asymmetry both in the case of the tie proportions of the network and the density indicators. And this may be the suspected effect of popular actors on the network structure. We considered those popular who were marked popular by their classmates and those who had the highest number of positive ties.<sup>11</sup> The eigenvector centrality measure can be interpreted as the best in symmetrical networks; therefore, we made the positive and negative networks symmetrical at both  $t_1$  and  $t_2$ .

Table 9: The values of eigenvector centralities: the most popular and unpopular actors, Class B positive and negative network, in  $t_1$  and in  $t_2$

Student's code number	Class B positive network ( $t_1$ )	Class B positive network ( $t_2$ )	Class B negative network ( $t_1$ )	Class B negative network ( $t_2$ )
31	0.22	0.237	0.221	0.25
14	0.23	0	0.30	0.01
11	0.24	0.61	0.30	0.05
6	0.22	0.18	0.25	0.06
23	0.19	0.084	0.261	0.123
7	0.21	0.23	0.24	0.32
15	0.11	0.30	0.06	0.42
21	0.16	0.40	0.11	0.40

<sup>11</sup> Defining and measuring the popularity represents a highly complex and problematic phenomenon. Its conceptual framework includes the external manifestations (external appearance, in some communities the possession of material goods), a pleasant personality and the question of success (e.g. academic, financial) as well. In our study we attempted to identify the basis of the influence of popular actors by using the network-based approach, as Bonacich and Lloyd (2004) have done in their research.

Student's code number	Class B positive network ( $t_1$ )	Class B positive network ( $t_2$ )	Class B negative network ( $t_1$ )	Class B negative network ( $t_2$ )
32	0.11	0.21	0.11	0.26
28	0.11	0.22	0.07	0.22
22	0.10	0.15	0.09	0.25
30	0.07	0	0.04	0.22
Mean	0.17	0.14	0.15	0.14
Standard deviation	0.03	0.10	0.09	0.11

On the basis of the eigenvector centrality values it can be observed that there are three actors in the class who have a higher-than-average eigenvector centrality value in both the positive and negative networks. But the other popular actors have very low eigenvector centrality values in the negative network: it is possible that they did not want to harm their reputation by embracing their negative ties, assuming that there are none. We studied the relationship between these three actors at both  $t_1$  and  $t_2$ . It is clear that Actors 6, 7, and 31 have higher than average values in both networks at both times. However, it is also clear that, in the positive network they have the lowest eigenvector centrality values among the popular actors. This result may also demonstrate that owning negative ties may harm the status position measured by the number of owned ties in the positive network. During our analysis, we identified three divisive actors among the most and the least popular actors. The number of negative ties of these students increased, especially in case of Actor 31. At  $t_1$ , they did not like each with only three, but at  $t_2$  with five unpopular actors. Similar mechanisms can be observed in the case of Actor 7. Divisive actors did not have negative relations with each other. We found that they mutually liked each other in the positive network, even a whole clique gathered around them. Based on all this we concluded that there are divisive persons in the class, and it may be worth for them to maintain negative ties, even if it causes some loss in positive relations because, for example, this way they can decrease the cost of their friendship among each other. However, the presumption for the cost of ties needs further studies.

## Summary, future perspectives

The starting point of our paper was created by the works of network literature and by the questions regarding negativity. In our study we tried to examine how the positive and negative networks of ties – which work together in reality – work compared to each other. Several law-like operational modes were described in the network literature; therefore, we assumed that by comparing the positive and the negative networks we would have answers to how negative networks worked. The basis of the comparison was the basic mechanisms described in positive networks. We established that positive and negative networks are not each other's mirror images. This statement was well confirmed by the numbers concerning

the density of the tie networks and centrality. The second hypothesis said that the mechanisms of network dynamics do not have the same effect in negative networks as they do in the positive ones. Based on the analysis, it was shown that in certain cases the effect of *homophily* prevailed well in positive networks. For example, persons with the same gender make friends with higher possibility, so do pointdexters, as do beautiful girls and girls with good academic performance made friends with each other more willingly than with others. Regarding *heterophobia*, in the case of genders, it was clearly outlined that hostile emotions can be observed within the same gender as well. It is true especially about girls that they rather hated the other girls than the boys. We made an interesting observation too with pointdexters. Although pointdexters basically liked each other, they did not definitely hate those who were not pointdexters, students stigmatized as pointdexters even had more relations with not pointdexters than with those of similar type. And, in negative networks we saw that “non-pointdexters” refuse certain pointdexters, those who are “teacher’s pets”. We found an attribute in which the mechanism prevails where those with similar characteristics like each other and more likely do not like those who are different from them. This attribute was beauty. Beautiful actors often did not like those who were not considered beautiful at all by the majority of the class. Financial situation seemed to create neither friendship nor enemy ties. Musical taste did not concentrate actors either. When studying the academic performance we found that worse students took central positions in the positive networks, but students with 4.5 – 5 average were not all hated in the network showing negative ties at either times. Contrary to what was expected, we saw that transitive triads had not developed in the same proportion in the negative network as they had ceased to exist in the positive network. The same applies to reciprocity. Here, we must add the surprising result that the proportion of reciprocity decreased in the positive network, although we expected it to grow there as well. *Unilateral sympathy, if does not get affirmation, with time it loses its importance, while in negative relations unilateral negative emotions can frequently generate similar reactions.* It was a similar case with the hypothesis of heterophobia: those with very different attributes did not necessarily hate each other. This was confirmed by the fact that the dynamics of positive and negative networks show some differences; therefore, the two networks are not symmetrical. We managed to identify actors who probably were divisive actors, were considered popular, but who expressed whom they did not like. The results of our empirical study help to further think about the theory of structural balance in real environment, especially when the characteristics of relations are studied in the case of not three, but more actors. This may be especially suitable to model the relations or conflicts between work organizations (see Labianca et al. 2006), political parties, different countries and states.<sup>12</sup>

<sup>12</sup> Róbert Angelusz and Zoltán Szántó called our attention to the measurement and practical application of negative ties.

Our results draw attention to the problem to detect and to deeper understand negative ties; they draw attention to the necessity of not only studying the social operations of positive ties, but to analyzing the negative networks in more detail. These relations are not present only by themselves, but affect the operation of positive networks, therefore affecting the development, change and fruitful operation of the whole community's structure. Although negative ties can be measured with the querying method, the conclusions of our study show that to discover the internal conflicts of closed communities the approach of social network analysis – which is deeper than simple sociometric studies – is needed. Because, among others, people are not keen to openly confess their negative relations. Exception from this rule may be if the existence of negative ties strengthens the status position within a community based on positive relations. Our analysis also showed that both weak and strong ties can be present among negative relations – in positive networks, Granovetter drew attention to this for the first time (1983) – and these can have different roles (Granovetter 1983). A hate tie defined more characteristically the structural position within the network of any given actor. Apart from the strong and weak negative ties it is also important to further enhance their quality; which may be possible by measuring the malignant gossips based on dislike and hatred, and the physical violence arising out of conflicts. The more detailed analysis of the attribute of the relations between students and groups also serves this purpose. School violence, judging the receiving party and the aggressor depends on various external factors like gender (Veenstra et al 2010). Therefore elements dependent (for example who is considered beautiful) and independent (for example gender) of the network need a more thorough analysis. We think that further studies are required to understand the negative networks' development, change in time, and the network structure based on negative emotions and its mechanisms better. The role of the cost of relations may be the subject of further studies. It is possible that gain from positive ties is bigger than the maintenance of negative ties: this is why there are more positive than negative ties. The study of Espalage and her co-authors forms the basis of this hypothesis, who studied the cost of friendships. The authors concluded in their study that friendship was "expensive", i.e. it was only worth to make friends by the motivation of certain structural and behavioral factors. Maintaining friendships are more costly than to maintaining neutral ties. (Espalage et al. 2007) But the question occurs: why are there still negative relations? Maybe because under particular circumstances is it worth to maintain negative relations? The network analysis of negative relations helps to understand school aggression from a new angle, and creates the opportunity to become able to measure the violence creating or violence fending attribute of school communities – and community structures (i.e. Neal 2009). The phenomenon of discrimination may be worth to be measured also by studying the negative ties, as they did during the measuring of friendship ties in international studies. Classes may be worth to be analyzed during a longer period of time and on a larger sample to be able to make further and more complex conclusions about

the phenomenon of negativity and its importance. Therefore, as a next step, we are going to examine the structural relations of negative and positive times with three time data recordings and a four-year long study including several schools based on five times. The studies are conducted by RECENS, the Research Center for Educational and Network Studies at Corvinus University of Budapest. It is important to mention that during our research we faced several problems, for example, the fact that the various analysis and visualization applications are not suitable to a thorough analysis of negative networks. But we hope that our work also helps to draw attention to such an interesting question like the network study of antipathy-hatred relations.

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