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ONLINE EDUCATIONAL WORKING GROUPS.WHAT CAN STUDENTS' "FACEBOOK" REVEAL?

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ABSTRACT

Social media are now affecting all sectors of modern societies. We tried to investigate, how critically these networks are affecting education and furthermore, which is the relevant number of an effective online group of students. We know that, within a classroom a group of 4-5 students is the most effective, for a well performing project. But, which is the relevant number of students working online, from their homes? How many students can simultaneously collaborate online on the same project? In order to find the answer, we focused on students' social media. The main objects of our investigation were "Facebook" type networks, of students aged 14 to 18 years old. We inquired on the number of friends, number of active connections and "network density". We found that, for networks, counting 200-1000 members, there is a linear dependence of the "network density", to the number of members. For smaller networks, the relevant "network density" seems to increase asymptotically, mainly because members know each other very well, while for larger networks, the consistency is very low. We focused on networks, counting 300-600 student members finding that, the ideal size of a functional and strongly interactive online working group is about 20 members.

KEYWORDS: Social Networks, Socio Cultural Method, Education, Internet, Pedagogy, Online Research, Network Density, Communication

INTRODUCTION

Social networks have gathered interest over the last few years (Christakis & Fowler, 2009), (Marsden, 1987), (McPherson et. al. 2006), (Kristensen & Bjerkedal 2007), (Dodds et.al. 2003), play an important role in all aspects of our lives. Health issues, e.g. How quickly a virus is spreading (Rothenberg et. al. 1998), (Helleringer & Kohler 2007), (Potterat et. al. 2002), economic issues, such as the capitals stream (Kelly & Gráda 2000), (Salganik et. al. 2006), (Watts & Strogatz 1998), the preparation and organization of election campaigns and election procedures (Huckfeldt & Sprague 1995), (Huckfeldt 1984), (Zuckerman 2005), (Nickerson 2008), even in interpersonal relationships and the love life of people (http://qz.com/140357/what-your-facebook-friends-list-reveals-about-your-love-life/#140357/what-your-facebook-friends-list-reveals-about-your-love-life/) (McEwan 2012), (Boomsma et. al. 2005). However, especially in education the influence of social networks is high. Many researchers have investigated the strong relationship between social networks and education (Calvó-Armengol et. al. 2009), (Yuen & Yuen 2008), (Chuang & Ku 2010), (Goodman2010), (Doering et. al. 2009), (Ozkan& McKenzie 2008). L. Vygotsky, Doise, Mugny, and E. Wenger introduced a new pedagogical approach, called sociocultural (Cowie et. al. 2000), (Smaldinoet. Al. 2008), (Newby et. al. 2006), (Armstrong 2004), (Artigue et. al. 2006), (Avouris et. al. 2003), (Scardamalia & Bereiter 1994), (Johnson & Johnson 1994), (Palloff& Pratt 1999), (Turkle 1996), (Dagdilelis 2006), (Wenger 1998) relying on social networks and their impact on education.

We tried to investigate, how "thick" are these networks, focusing on networks of students aged between 14 and 18 years old. Our research is mainly students' "Facebook", a social network with great penetration, at these specific ages. We looked at the number of truly active friends, i.e. how "thick" are Facebook type networks. Inquiring the actual number of active interfaces on a network could reach the size of a correspondingly effective workgroup of students. We know that in a class the maximum number for an effective and productive collaboration is 5 students (Driver et. al. 1996), (Springer et. al. 1999), (French &Kottke 2013), (Herrmann 2013). However, in an online group of students this number may vary. We are looking for the number of students, who can work together in a social network efficiently. Technology provides the means so that, more than five students to interact directly, to exchange opinions, to discuss and search. On the basis of the predominant number of friends in the proposed social networks of students, we can assume the corresponding number of students, in online project teams.

EXPERIMENTAL SECTION

Research Field

We focused our study on the social networks of students, studying their friends' grid at Facebook (https://www.facebook.com/?stype=lo&jlou=Affu0G3gZc9dEBNP_ve8V3yyhh7nN2Iw7nuYnYOYZZdEnkOTDpATsO5 QBBYraZ6toh5ThrGroTilD6HBdIDM0zXv&smuh=35099&lh=Ac8lfeGVbhAgDC5-). For processing information, that arises from these networks, we used the Touch Graph (http://www.touchgraph.com/facebook) application that provides the ability to create and to analyze the nexus friends on Facebook. In addition, Touch Graph offers us significant information about the number of friends and about intra-network connections, between all friends. You can see a Touch Graph worksheet in Figure 1. We asked our online students, to create their corresponding personal grids using Touch Graph. Accordingly, we asked them to record the number of friends and to aggregate the number of reciprocal links. Summing all the internal links of a lattice, we can disclose important information about the density of the network (Hanneman & Riddle 2005), (Wasserman & Faust 1994), (Carrington et. al. 2005), (Wasserman & Galaskiewicz 1994). We recorded the number of connections between all friends and compared them, with the number of members of the network (network size). We tried to find a relationship in a form of power-law, between the number of network members and network density.

Network Characteristics

We have focused our research on a certain type of networks. We are totaly interested in school networks built gradually and solely by students (Barabási & Bert-László, 2002), (Wu & Tsai, 2006). We chose urban schools with average number of pupils among 150-200. We focused mainly on social networks and not onto professional networks. Professional networks, such as those created through LinkedIn.

(http://www.linkedin.com/uas/logout?session_full_logout=&csrfToken=ajax%3A6629634475227999452 & trk=nav_account_sub_nav_signout) is not as coherent (dense), as those composed by students. As shown in Figure 2, there are very few reciprocal links in a professional network, in comparison to a private network. Important requirement for our research are social networks of students to have developed gradually (and not in a short time), so they are "mature and tested» Thus they can representatively reflect the relations between students from the same school in an urban or semirural area. For comparison purposes we collected data from three different schools by extending the survey to students aged 14 to 19 years in various regions.

As the Touch Graph application enables us to aggregate all the connections between members of a network, we collected and processed relevant data. We asked all owners of networks to aggregate numbers of interconnections and to communicate the results to us. In addition, all pupils-owners of networks sent us the overall list of friends and the number of connections per friend. Thus we were able to uncover the extent of active and dynamic interfaces within a social network. Knowledge of active interfaces is of high interest, while it specifies the really active participants in a network (Barthelemyet. al. 2003), (Laughlin & Sejnowski, 2003), (Wagner & Leydesdorff, 2005), (Powell, et. al. 2005). We need to know this number, in order to organize the equivalent size of the web-working groups of students that will work effectively, on a research project.

RESULTS AND DISCUSSIONS

Table 1, shows all the data collected. We can see the number of friends, number of links that actually exist (active) in each grid, the theoretically predicted maximum connections value, the percentage and the average number of connections per friend. The theoretically predicted maximum connections are calculated from the following statistics formula:

$$\binom{n}{k} = \frac{n!}{k!\,(n-k)!}$$

Where n is the number of friends (provided by Facebook), while k is the minimum number of friends connected, here k=2. The number of actual connections is calculated by summing all the connections, friend to friend (provided by Touch Graph). Network density (French & Kottke 2013), (Freeman 2004), (Easley & Kleinberg 2010), (Scott, 2000) is determined by dividing the number of actual connections to the theoretically predicted connections.

$$\text{network density} = \frac{\text{actual connections}}{\text{theoretically predicted connections}}$$

This factor mightily concerns us, as it provides us with information about how dense is a network, essentially reflecting the interactions within the range. A highly interactive network provides rapid dissemination of information, thus allowing students to exchange their data rapidly.

Additionally, the average number of friends is obtained by dividing the actual number of connections to the total number of friends:

$$\text{average number of friends} = \frac{\text{actual number of connections}}{\text{total number of friends}}$$

This factor indicates the average functional connections per network member. Due to the large number of network members is often difficult to capture all intra-network connections and the analysis thereof. We are overcoming this specific difficulty with the assistance of the average number of connections per member. This factor is not representative of the actual amount of connections per member, as a very popular member may exceed this number, while a less popular hardly can gain only few connections.

Thus, we tried to identify the "true" popularity. To achieve this we have focused on the number of closer friends of each network member (top friends). This factor can be derived from Touch Graph, as shown in Figure 3. We limited our search to the top 100 friends for each social network owner and we calculated the average number of top connections per member. We excluded members with extremely high connectivity and members with very low, i.e. until one single friend. In the last column of table 1 we can see the popularity factor for the networks that we studied. Our main goal is to simulate the schools as online social networks, and to "identify" the size of a functional social network as the size of a corresponding school.

In Figure 4, the density of networks in relation to the number of members is shown. We can clearly see the almost linear dependence of network density to the network's size (number of members). We limited our study within networks consisting of 200 to 1000 members about, i.e. medium-sized networks. Such networks can precisely simulate schools consisting of 200 up to 1000 pupils and draw important conclusions about data exchange rates (speed). Simulating linearly these points we depict the following equation:

$$y=-0.0003x+0.4535$$

With extremely satisfactory simulation value (approach) $R^2 = 0.98017$. Network density is denoted by y the, while x the number of friends. This equation represents the linear dependency between the network density and the number of members of the network for medium-sized networks. As the member’s number increases, the density decreases, revealing that if we want to achieve an operating school network we must exclusively rely on a respectively sized digital network.

Additionally, we analyzed a few smaller networks (above 200 members), as well as larger ones (over 1000 members). In Figure 5 we present the corresponding data that are satisfactorily simulated by a sigmoid curve. We observe an asymptotic behavior for very small networks and a quick rundown for larger ones. These comments are rather expected as well. Small networks appear to be denser and all friends know each other quite well, while on the other hand, huge networks are characterized by loose connectivity and look more like professional networks. Above 1500 network members network connectivity seems to “collapse”, while single (one by one) connections dominated over multi-connectivity. Finally, the best fit to our experimental data turned to be a sigmoid curve, which equation given below:

$$y=-1E\text{-}09x^3+3E\text{-}06x^2-0.002x+0.7837$$

(Simulation Value: $R^2=0.95336$), by y we denote the density of the network and by x the number of friends. We can see a third power dependence law between the network density and number of friends.

In addition, it seems that popularity is related to the density of the network. In Figure 6 we can see this association. Touch Graph application provides us with the necessary information about the popularity of the network members. We can confirm what we really expect: for high-density networks a common friend can be found for every 3-6 members, while for low-density networks a common friend can be found for every 25-30 members. This can be illustrated by the following math equation resulting from the simulation of the respective data:

$$y=2,\ 0113x^{-1,003}$$

With simulation value (precision value): $R^2 = 0.9986$. We denote by y the network density, while x is the popularity factor that shows "how often" a mutual friend is being spotted or derived in a network. According to our information, we believe that networks with an average of 300-600 members are ideal for the exchange of information, because of their interconnections, their densities and internal interfaces.

Finally, we searched all networks with a different number of members. We looked for the most common number of connections. We assume that statistically, members with large number of connections are scarce, while the majority of the members of a network are characterized by a medium number of connections. Each member of a network is developing a series of ties with other members. But which is the most common number of network connections throughout all networks we have studied?

We recorded all the correlations, searching for the most common number of connections. Figure 7 shows the corresponding recordings revealing that the size of most effective and possible links to a network is from five to twenty members. Knowing that a research project within a classroom can ideally be conducted by a group of maximum five students, we expanded our findings into their respective groups on the net. Usually, a team at an online social network can be as big as we wish, but an optimal online workgroup for school research projects seem to be subject to some limitations. We assume that about twenty pupils is the ceiling of a well-functioning online research group.

CONCLUSIONS

Initially, we concluded that for medium-sized networks (200-1000 members) we have a linear dependence between the network density and the number of its constituent members. Secondly, for small networks under 200 members the network density seems to increases asymptotically, mainly because the members of a small network know each other very well, so they develop many online connections and build thus dynamic "relations". For larger networks, (over 1200 members) consistency is very low, and it seems that in approximately 1500 members the network "collapses", with almost zero network density. Furthermore, taking under consideration that according to Dunbar number (Lachance, 2011), (Dunbar, 1997) we are hardly able to know and communicate with more than 200 people; it is obvious that, such big networks are very loose. Obviously, it is easier to find a mutual friend in networks with high density, than in networks with low density.

Searching for mutual friends in a dense network, we can easily find one between 5-10 network members. On contrast, searching for mutual friends in a loose network we can hardly find one just among 25-30 members of the respective network. As regards school networks, the optimal number of members per network we believe that it's around 300-600, from which we concluded to the optimal number of about 20 students per online research project. The required number of 300-600 members is critical in order to have the proper "tank" for "feeding" constructively the online working groups.

The average number of 20 students per online "beehive" is crucial information for us, so that we can build our future school online working groups in "the cloud" and moreover to create potentially productive groups. Finally, school social networks are definitely denser than the professional ones, thus we chose to focus on them in order to tailor our findings directly to schools. The closer to the ages of the students we are the more realistic our conclusions are.

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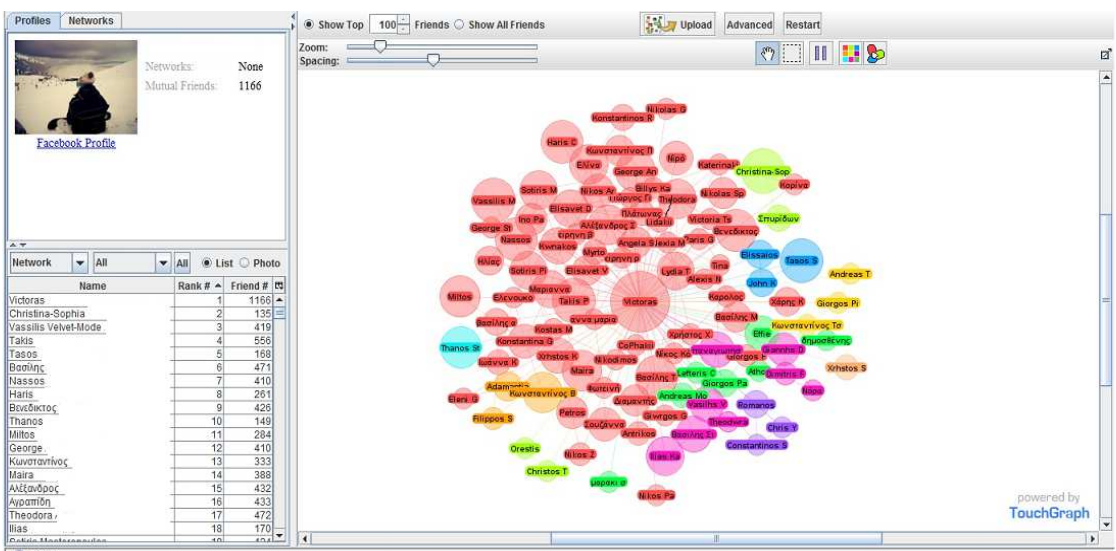

Figure 1

Figure1: Student's Facebook grid, as it's depicted from Touch Graph. The network is characterized by different colored areas that reveal different meeting resources (friendship development period). In the lower left side all friends were presented and the number of reciprocal interconnections is referred.

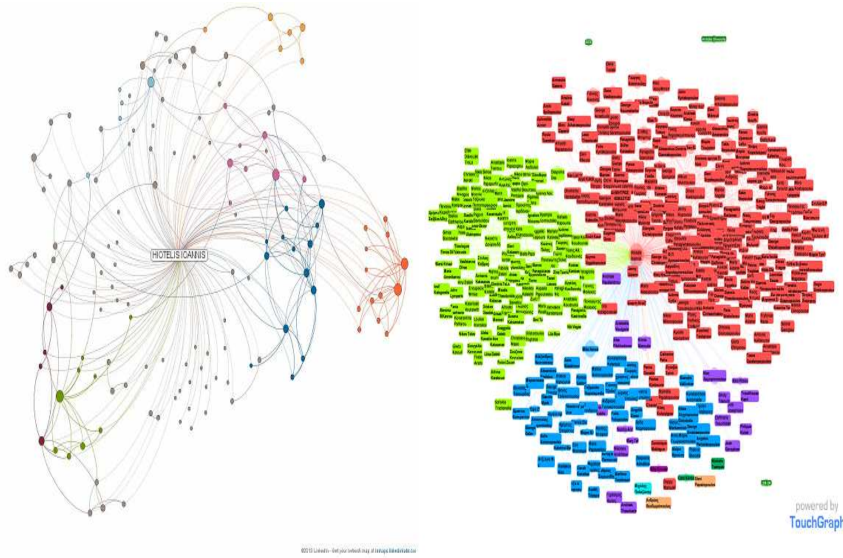

Figure 2

Figure2: Comparison between two different networks of the same person. The left network represents a professional network, while the network on the right shows a private network. We can see that the private network is by far denser than the professional one. The number of mutual friends is greater in a social network and reflects the real social life. On the other hand a professional network with few common friends resembles the professional status.

Table 1

Network Owner	Number Of Friends	Actual (Real) Connections	Theoretically Predicted Connections	Network Density	Average	Popularit Factor
1st	435	30925	94395	0.33	71	6,1
2nd	914	90340	417241	0.22	99	9,2
3rd	1347	68933	906531	0.08	51	26,4
4th	229	10020	26106	0.38	43,8	5,2
5th	665	66541	220780	0.30	100	6,6
6th	685	17533	234270	0.07	25,6	26,8
7th	773	124713	298378	0.42	161	4,8
8th	82	2218	3321	0.67	27	3,0
9th	331	38942	54615	0.71	118	2,8
10th	188	6103	17578	0.34	32,5	5,8
11th	96	2332	4560	0.51	24,3	4,0

Table1: Number of friends, number of actual connections, theoretically predicted connections, network density, average number and popularity factor per friend.

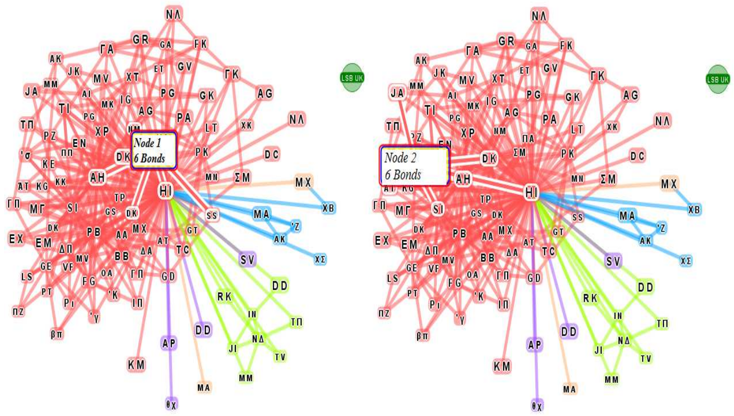

Figure 3

Figure3: Two separate nodes with the relevant connections within each network. In both two images we used the grid of the first owner of the network. We can see that the average number of connections per node is around six. For clarity we present only the top 100 friends on the grid in these graphs.

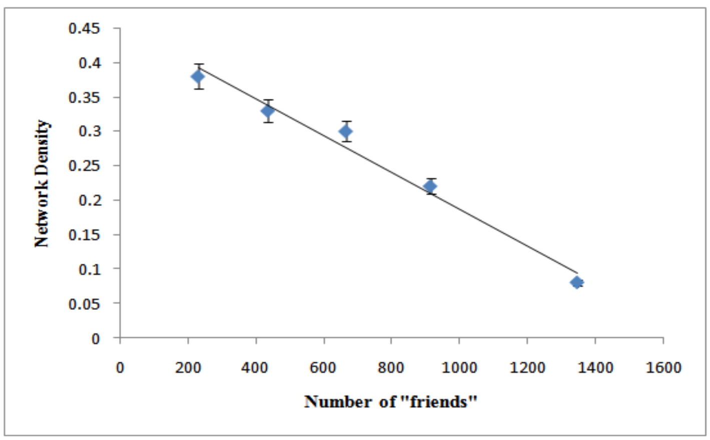

Figure 4: The network's Density, Relative to the Number of "Friends"

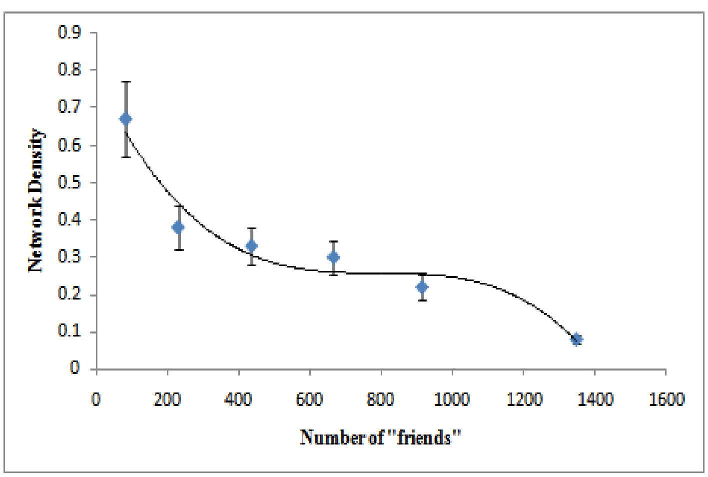

Figure 5

Figure5: Network density in comparison with the number of members of a network (friends). We can see the asymptotic behavior for small networks and the rapid decline in large networks.

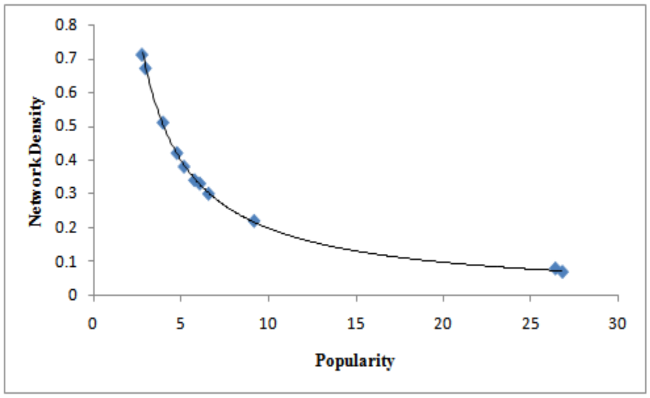

Figure 6

Figure6: Network density in relation to the popularity factor, i.e. the number of closer friends per member of the network.

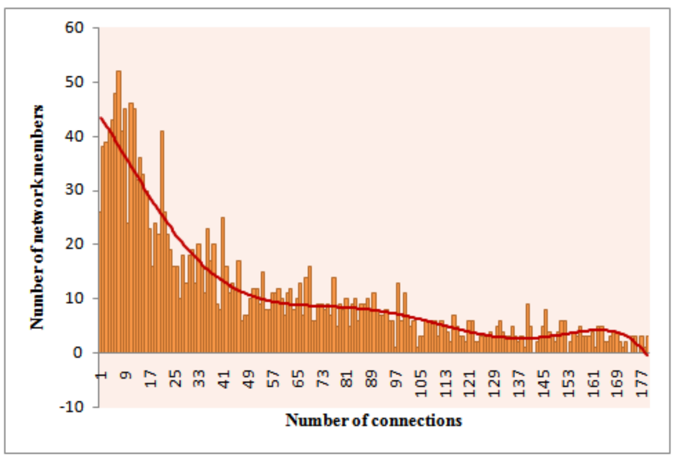

Figure 7

Figure7: Number of connections per member in a network. We can see that the optimal range of online connections is 5-20 links.