

# A Social Network Approach for Student's School Performance Measurement

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**Abstract:** This article brings to light analyses of student's social networks in order to comprehend how social interactions occur in schools. Furthermore, the present research intents on verifying if social groups affect student's performance. In view of this reality, this work presents the analysis of 40 social network students with the objective of measuring the degrees of interrelationship between groups to provide means of implementing the process of building Collective Knowledge in the classroom. One of the main challenges encountered at work is the understanding between native psychic and somesthetic students. From the data collection of the experiment, it was evidenced that there is a strong correlation between the networks of friendships and grades, which allowed to verify that repeating students do not fit in with students of the grade in which they are and that students with good grades have many friendship bonds, however these bonds are weak since they are only bonds with interest in the notes. The Collective Knowledge applied by the teacher must collaborate for the interrelation of the students and, consequently, in the strengthening of bonds and grades.

## 1 INTRODUCTION

This article brings to light analyses of student's social networks in order to comprehend how social interactions occur in schools. Furthermore, the present research intents on verifying if social groups affect student's performance. Its goal is to help teachers better comprehend different student's groups and support the development of cooperative work inside the classroom.

The formation of groups to develop collaborative work within the classroom is a rich tool that can provide the development of Collective Knowledge effectively, provided there is planning. For this reason, understanding how social interactions and school performance influence the formation of these

interactions is something relevant.

The difficulties of inter-relationship between students and problems of implementation and use of technology as pedagogical and social tools, is the reason behind the current research. The literature chosen for this research, comes from Professor Xavier's psychogenetics, with origin in Piaget's psychogenetic study which is directed at the fundamentals of intelligence. The main focus of the chosen research, is the thorough comprehension of the human behaviour, cognition and the interactions of metacognition.

Inter-relationship is fundamental, as explained by Delbem (2014), because within it, students are able to develop connections, have existential exchanges, establish dialogue, be interested in cooperative work and feel rewarded by reciprocity.

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Our proposal, as a possible solution towards this research problem, is to, it is the tangent between students' native and non-native competences for integral development that occurs through the awareness of the individual to the collective, that is, the awareness that not only should personal and comfortable factors be considered, but also external objective characters, common objectives that require the collaboration of two or more individuals with divergent native capacities.

As a main result we found after the experiment that the higher the number of the entry grade, the higher the student's grade. That is, in this experiment we can see that the more friends the student has, the greater his chance of getting a grade. We also noticed that there is a strong correlation between the networks of friendships and grades, which allowed to verify that repeating students do not fit in with students of the grade in which they are and that students with good grades have many friendship bonds, however these bonds are weak since they are only bonds with interest in the notes

In order to organize the discussion and proposals described in this article, it is divided into the following sections: section 2 presents the conceptual foundations (metrification of complex networks, and theoretical framework of the research). Section 3 presents the related papers. Section 4 describes the methodology used to conduct the study presented in this article. Section 5 displays the data analysis and its results. And finally, section 6 presents the conclusions and future work of this research.

## 2 CONCEPTUAL FOUNDATIONS

### 2.1 Collaborative Work

For the development of this article, we utilized the following concept of Social Network. Social networks are an essential part of humanity (Bezerra 2014). These networks are based on the interrelationships between humans seeking a common goal, between entities and can be mediated and metrified using technologies, as we can see in Bastos (Bastos, Queiroz 2015). The observation and research to raise patterns of connection between social groups and how connections are established between individuals is something already found in current research, however there is no metric that makes it possible to see how social interactions within certain networks interfere in academic development.

The formation of networks in school, operate in the same manner as other networks, as explained by

the concept cited above. This means that, the results of the two enturmentations, we can say that the productivity considered in the different objectives can differentiate in relation to collaborative work and its production. Based on the 3C model<sup>7</sup> (Fuks; Pimentel, 2011) we proposed some of the main differences that we believe to be distinct in both groupings:

In strictly hedonistic groups we emphasize communication and cooperation, because the members of this group are associated not only with a view of an objective and its development, but especially by common affinities and tastes, which creates a strong interactional bond between the members, but disregards productive capacity specifically. Therefore, these groups have strong interactional and collaborative bonds, but with exceptions such as a football match, for example, they do not tend to be organized by skills, and there are exclusions of weaker members.

Conversely, utilitarian groupings - although they may occur as practical communities - tend to occur in the face of a specific activity, challenge or need. In this case, the communication between the members already has a character of commitment to the objective, the coordination is a fundamental characteristic, because the objective is the focus through which the groups will organize and divide and, therefore, the skills of each member are considered.

<sup>7</sup> It is the model that classifies into three dimensions the systems that support group work: communication, coordination and collaboration. This classification gave rise to the 3C Collaboration model, later formulated. In this model, cooperation strictly refers to the action of operating together, while collaboration refers to the action of doing all the work together, which involves communication, coordination and cooperation.

The main difference highlighted for the differentiation of these groupings is the planned coordination, that is, while in the hedonite grouping this coordination takes place naturally or not, in the utility grouping it is fundamental, because the primary objective of this grouping is to achieve a pre-established objective that requires the action of ordering the grouping in tasks and resources according to the capacities of each member.

To understand the scenario of the problem proposed in this research, we start from the hypothesis that its solution is to create a means for mapping students' social networks to formulate a metrification that enables an intervention that potentializes the tangent of young people's interrelated capabilities through collective knowledge. We consider that the methods of work and of potentiation of collective knowledge are sufficient, but we also recognize that their application does not favour the means for mapping the social networks of the participants nor potentiates the ideal enturmentation that aims at the real inter-relational tangency.

Even though social networks are apparently similar to others. When it comes to complex social network analysis among students, the concerns become greater, since metrifying their personal interrelationships and their individual performance is not a trivial task. Thus, this metrification should develop sufficient data for the verification of utilitarian and hedonistic relationships, so that through this data, teachers can intervene and form groups in which students with low school performance and more difficulty in interacting feel involved and motivated in the learning process.

## 2.2 Psychogenetics

In creating the metrics for mapping the tangency (Xavier 2004) of these social networks, our attention was focused on observing the relationships of students within the school, both in class and at intervals, for analyses, Xavier's psychogenetics was used.

According to psychogenetics (Xavier 2004), psychism and somesthesis are propositional concepts. Thus, psychism groups the competencies for the so-called "superior" activities, while somesthesis groups the bodily functions correlated to the so-called "human" activities. Both definitions refer, according to Delbem (Delbem 2014), to the difference of energy to action, that is, psychism is the pattern of innovation dosed with somesthesis, and somesthesis is the pattern of somatic repetition accelerated by the psychism.

The tangency is the articulation of these two instances, and it is understood as articulation, the evolutionary structure, measurable by seasonal diachrony. As Xavier explains (Xavier 2004) articulation is the meeting of these two energies which, according to him, can be understood as hybridization<sup>8</sup>, this is because the energies coexist in a process of complementing one with the other, they do not merge into another.

Therefore, it can be understood that a higher density in one instance does not require damage to the other, because one instance has no quota to the detriment of another. Therefore, articulation is summed up as the regulation between somesthesis, psychism and tangency as the balance between all.

This is understood as "native", the predominant energy in the individual that can also be called as a pioneer competence, that is, it is the individual's strong point.

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<sup>8</sup> Hybridization is the acquisition of new properties by combination with the other energy (somesthesis or psychism).

## 3 RELATED WORKS

One of the aspects that marks the 2.0 generation of the Internet is the idea of co-authorship, that is, collaborative production. This is because, as cyberspace is an environment of production and consumption in an expanded way, collaborative production is achieved through co-authoring, which we can call cyber culture (Fuks; Pimentel, 2011).

This incorporation of the digital into our daily lives has resulted in what the artist and researcher Domingues calls biohybrids, that is, a biological, cybernetic and hybrid subject; and this reality allows the generation of biohybrid narratives of life in a mixed way (Domingues, 2004).

The concept of network, according to Deroy-Pineau (Deroy 1994) can be recognized through its effectiveness, both as the static point of use and the dynamic point of use. The static point of use exploits the structure of the network, while the dynamic point exploits the system that constitutes the network.

The analysis of social networks establishes a new paradigm, since the study of the behaviour or opinions of individuals depends on the structures in which they are inserted. Thus, the unit of analysis is not individual - sex, class, age, gender, etc. - but the whole built through the interpellation of the whole. This structure is illustrated and apprehended concretely by the network of relationships and limitations that weighs on the choices, orientations, behaviours and opinions of individuals as Bastos explains (Bastos et al. 2014).

The analysis of networks is not an end in itself. It is the means to carry out a structural analysis whose objective is to show in which form the network explains the analysed phenomena. The objective is to demonstrate that the analysis of a diode (interaction between two people) only makes sense in relation to the set of other diodes of the network, because its structural position necessarily has an effect on its form, its content and its function (Marteletto 2001).

The basic premise of information technology is management through the epistemic-ethical posture of the individual in the exercise of his autonomy in social media as Delbem states (Delbem 2014). Its starting point is the 'Inter-relationship' as a marker of cognitive development. Thus, interaction precedes and determines knowledge. Therefore, one investigates doing, living together, collaborating, producing, knowing, reciprocating, finally, inter-relationship.

Marinho also used the Technology Acceptance Model (TAM) to identify different motivational factors of the use of a Virtual Teaching Platform

(Marinho et al., 2015).

One important characteristic of social network analysis is the capacity of describing mathematically the characteristics of a node in a network. The positions of nodes in networks are frequently described in terms of centrality. The three main points of centrality are the degree of centrality, intermediation centrality and proximity centrality (Degenne e Forse 1999).

For example, Liu et al., Use these concepts and analyze the dynamic characteristics of the network structures and, in fact, found that the structure of the students' social network varies dynamically with the progress of the course. In the same article, they concluded that "in the interactions of the course forum, the positions of students in the network are partially correlated to learning results" (Liu et al., 2018).

Still in a school environment, social networks allow the prediction of learning success in education with their tools offering results that can direct the attention of teachers to their teaching practice, that is, through analysis in this environment, tools for modification are added in the physical environment in which the research actors are inserted (Souza et. al, 2018).

So the operations of the academic subjects carried out in virtual spaces by adolescents maintain the concreteness of proprioception coming from the instantiated functioning in 'somessthesis'. The virtual space aggregates the conceptual data, but without losing the bodily reality. It only changes the state from real to virtual, preserving the experience of contact with the real object (Delbem 2014).

#### 4 METHODOLOGY USED

The problem that permeates this research is understanding how school social interactions are formed. As well as verify how school performance is influenced by social groups. To understand how these networks are developed, might help teachers to map and comprehend the main difficulties students face during group work. With this, a strategy can be crafted for the development of the student within groups, since low levels of cooperation results in lower rates of interactions (relationships).

The formations of these networks work in the same way as the networks of practical communities, that is, they are made up of informal groups that have a shared practice and a clear and defined objective. Therefore, for the metrification of the students' social networks a questionnaire, which is found in table 1,

was first elaborated, individually made for 40 previously selected students (considering that all of them studied together since the sixth grade of elementary school II). In this questionnaire the preferences of the students in various psychic and motor activities were considered, as well as a previous spontaneous survey of their networks of friends, where they highlighted the friends they have for specific activities (in sports, collaborative digital games - like RPG, for example -, school work, proximity to home, etc). As seen in table 1.

Table 1: Questionnaire applied during the survey.

Application questionnaire template			
Student:			
Age:			
Friend of:			
Applied questions	Yes	No	Which one
Do you practice any sport?			
Do any friends play on your team?			
Do you play video games or online games?			
Do you usually play alone or in a group?			
Do any classmates live near your home?			
Like to read? If so, what genre?			
Do you do any kind of artistic activity?			
Social media you use:			

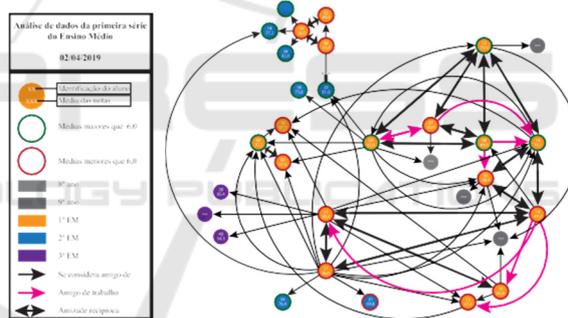


Figure 1: A Detailed analysis of the social networks of first grade high school students.

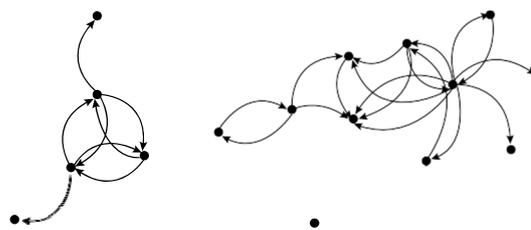


Figure 2: Social network graph of High School 1st Grade students.

After the interview, an observation was initiated with the teachers, where some of them were previously instructed (those who considered the data collected in the interview). This observation was intended to confirm, or refute, the data previously provided and tabulated by the interview.

Based on the reports of teachers who have followed the development of students since the sixth grade of elementary school II, it was possible to see how interactions between them take place. These reports provided data that confirm much of the information gathered in the interview, reinforcing the informed social networks.

After this return of comparative data between the interview and the observation, the data was analysed within Cytoscape<sup>9</sup>, which is an open-source software platform for viewing complex networks. After the construction of the graphs of the social networks (built with the help of the software), the following metric was analysed and calculated: In-degree (which is the degree of entry of the vertex). It was calculated based on the number of friends of each student and based on their relationships. For example, a student 'x' can have a number 'y' of friends and a number 'z' of work friends only. So, first the total entry grade was raised and then subdivided between work friends and personal friends.

To establish a correlation between the in-degree metric and the average score (which corresponds to the student's performance in the subjects), we use the CCP which measures the degree of linear correlation between these two quantitative variables. The CCP is a dimensional index with values between -1.0 and 1.0 that reflects the intensity of a linear relationship between two data sets.

In our analysis, this coefficient is represented below the graphs by the letter "r" and assumes only values between -1 and 1, being that 1 means a perfect positive correlation between the two variables and -1 a perfect negative correlation between the two variables - that is, if one increases, the other always decreases. This way, we consider that  $r=0$  means that the two variables do not depend linearly on each other. Therefore, based on the metrics of social network analysis and the CCP calculation, we propose a formal system that has rules for the analysis of interactions and their representations.

After the interrelationships were found, the data collected was strengthened. The notes of each student were collected from the coordination of the College, thus generating a general individual performance average, and with this data, cross-references of information between the analysis of the social network and the averages were made.

## 5 DATA AND ANALYSIS RESULTS

The experiment was developed on April 2, 2019 targeting students in 1st, 2nd and 3rd grades. The age of the participants was between 15 and 17 years, and the number of participants was 40 students. The method used to collect and analyze the data was through the empirical sieve, that is, a prior interview was developed with 40 students regularly enrolled in the first to third grades of a high school in a private network and of teacher's reports.

In this first graph that represents the interrelationships of the first-grade students (Figure 2), we can see how the networks between them are structured and with this we can conclude that I - the student number 13, located in the right median corner, has the highest average in the class. We can also observe the large number of entries he has, however, although he considers all the entries as reciprocal friendship, the vast majority of the entries consider him only as a work friend and not as a personal friend, as can be observed by the pink arrows. Another important data that we can observe in this graph is the list of student's numbers 05, 06 and 03 that are located in the upper left corner. As can be seen, the grades of the trio are below average and they do not relate to anyone in their class. After these findings, we sought more information about these students and found that the three are repeat students.

We highlight here, that as mentioned earlier, these were considered for this deeper analysis in the first year of high school because it is a class where students have lived together since the sixth year of elementary school II. In other words, they have maintained the same group as the previous year and have maintained the interrelationships with the friends who were approved. This leads us to consider that there may be a cause-and-effect relationship between poor performance because they do not interact with peers in the current grade.

In this detailed chart we can consider a way of approach to improve student performance, being the implementation of a model of induced collaborative work, where the teacher should naturally include student number 13 to work with students' number 05, 06 and 03. This way, the network of interest for his grade is broken and failed students have the opportunity to produce and be approved. The other two series (Figure 5 and Figure 6) are presented here only in their simplified form to highlight the issues discussed in this article.

<sup>9</sup> <https://cytoscape.org/> - Accessed 20/09/2019

Table 2: Analysis input degree x grade 1<sup>st</sup> series High School.

Student	Input degree	Grade	Student	Input degree	Grade
1	6	58,9	9	4	62,6
2	6	70,5	10	5	65,9
3	2	49,0	11	5	58,4
4	4	57,5	12	6	73,9
5	2	56,9	13	9	76,1
6	1	35,0	14	4	49,2
7	4	50,0	15	4	57,3
8	4	64,8	16	5	37,7
			17	3	56,6

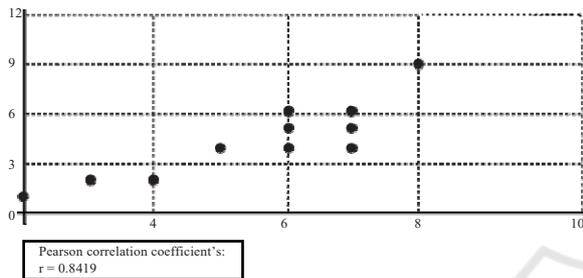


Figure 3: Pearson correlation coefficient for input degree x grade 1<sup>st</sup> High School.

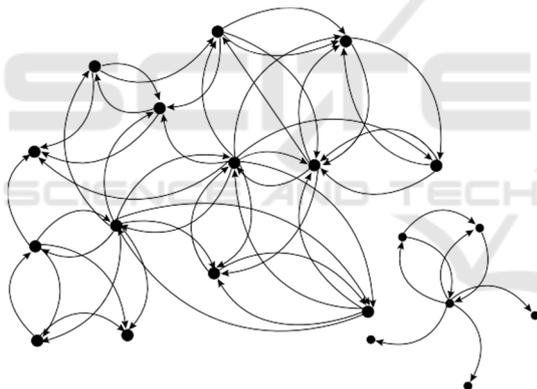


Figure 4: Social network graph of High School Third Grade students.



Figure 5: Social network graph of Secondary School students.

After structuring the social networks of each room, and analysing the data according to the graph

theory, the comparative tables were constructed with the information surveyed in order to prepare the Pearson's Correlation Coefficient chart.

In Table 2 we have the number that represents the student, which is a standardized numbering and does not correspond to the actual call number made to make it impossible to recognize the student by an external agent. In Figure 3 we find the Pearson Correlation Coefficient graph, which was calculated by this data.

Table 3: Analysis input degree x grade 1<sup>st</sup> series High School.

Student	Input degree	Grade	Student	Input degree	Grade
18	4	80,0	26	4	82,8
19	2	77,2	27	2	77,5
20	4	82,7	28	2	73,0
21	1	69,8			
22	3	81,0			
23	3	76,4			
24	2	76,4			
25	1	68,6			

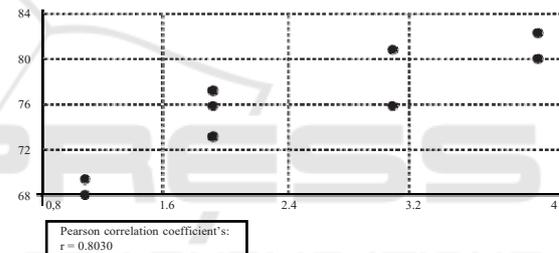


Figure 6: Pearson correlation coefficient for input degree x grade 2<sup>st</sup> High School.

As can be seen (Table 3 and Figure 6), there is a positive linear correlation between Input Grades and Grades. In detail, this means that the higher the input grade number, the higher the student's grade, i.e., the more friends the student has the better chance of achieving a grade. Considering that Pearson's correlation coefficient in the 2nd year High School analysis is 0.8030 we can conclude that this correlation is strong.

Table 4: Analysis input degree x grade 3<sup>rd</sup> series High School.

Student	Input degree	Grade	Student	Input degree	Grade
29	2	42,5	37	3	59,9
30	6	70,0	38	6	80,0
31	5	66,3	39	3	54,3
32	5	70,0	40	6	70,9
33	6	75,8			
34	4	61,6			
35	4	62,2			
36	6	75,3			

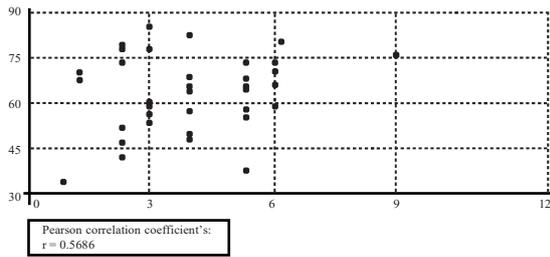


Figure 7: Pearson correlation coefficient for input degree x grade 3<sup>rd</sup> High School.

As can be seen (Table 4 and Figure 7), there is a positive linear correlation between the Input Grades and Grades. In detail, this means that the higher the number of input grades, the higher the student's score. Considering that Pearson's correlation coefficient in the analysis of the 3<sup>rd</sup> year of MS is 0.5686 we can conclude that this correlation is strong.

Table 5: Analysis Input degree x 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> grade.

Student	Input degree	Grade	Student	Input degree	Grade
1	6	58,9	37	3	59,9
2	6	70,5	38	6	80,0
3	2	49,0	39	3	54,3
4	4	57,5	40	6	70,9
5	2	56,9			
6	1	35,0			
7	4	50,0			
8	4	64,8			
9	4	62,6			
10	5	65,9			
11	5	58,4			
12	6	73,9			
13	9	76,1			
14	4	49,2			
15	4	57,3			
16	5	37,7			
17	3	56,6			
18	4	80,0			
19	2	77,2			
20	4	82,7			
21	1	69,8			
22	3	81,0			
23	3	76,4			
24	2	76,4			
25	1	68,6			
26	4	82,8			
27	2	77,5			
28	2	73,0			
29	2	42,5			
30	6	70,0			
31	5	66,3			
32	5	70,0			
33	6	75,8			
34	4	61,6			
35	4	62,2			
36	6	75,3			

As can be seen (Table 5 and Figure 7), there is a positive linear correlation between the Input Grade and the Grades of the 3 high school series when they are compared with each other. This may mean that the higher the input grade number the higher the student's grade. That is, in this experiment we can notice that the more friends the student has, the higher is their chance to achieve a grade. Considering that Pearson's correlation coefficient in this case is 0.5000 we can conclude that this correlation is strong.

However, the entry note and the note have a strong relationship repeatedly, as we can observe in the analysis, which indicates that the research can be reproduced by other researchers through the questionnaire applied to the students found in table 1. As the results of this analysis show, that students with more friends have a higher chance of obtaining a grade. Also noted was that there is a strong correlation between the networks of friendships and grades, which allowed to verify that repeating students do not fit in with students of the grade in which they are and that students with good grades have many friendship bonds, however these bonds are weak since they are only bonds with interest in the notes.

## 6 COMPLETION AND FURTHER WORK

The difficulties of interrelationship between students, and the problems of implementing and using technologies as pedagogical and inter-relational tools is what motivated us to develop this research. Technology can be a facilitator in this process of implementing educational technology in schools, but, according to Sancho (8), for this to happen, it needs to be inserted together with a reflection and action project that uses it in a meaningful way.

What is expected, is that the school is favoured with tools, for the development of a method that enables the creation of group works in class, it means offering collaborative and inter-relational work among students by developing processes that allow the control of technologies and their effects, so that, in this way, students can fully develop through the interrelation with the aid of technologies.

We believe that a quality human structure should be tangented between psychic (groups the competencies for the so-called "superior" activities) and somesthesia (groups the bodily functions correlated to the so-called "human" activities), and this tangentially may be fostered through the interrelationship between individuals instantiated in

the opposing capacities through an intervention in the process of diagnosed enturmatation.

This research's goal is to understand the results of student's social network analyses to help teachers better understand groups and develop better cooperative works., using a method to measure the weight of social networks built among students and diagnosing the processes of enturmatization in evidence: hedonistic and utilitarian.

However, this action may favor new inter-relational processes, and it is for this reason that we propose the development of this method which allows the measurement and diagnosis of the types of enturmatations which occur within the classroom. From this method we may identify hedonistic and utilitarian enturmatations and, consequently, an operationalization of the tangent through collective knowledge applications.

We applied this method associated with storytelling technique and we realized that the techniques of regrouping encouraged the teachers as we could see in the comments made by them: "I thought it was very special. These activities cause a good movement in the College, they win and so do we ... "and they also commented" It was a rewarding experience, this type of activity is always something enriching for both sides, but especially for students..." (Siqueira et al., 2020).

As future work we indicate the reproduction of the method in other schools mainly in public schools, the increase of the method with the insertion of more metrics and a next research with the comparative of the evolution of the class after the implementation of the method.

## REFERENCES

- Bastos, Cecilio Ricardo de C; Queiroz, Márcio Pedro C. P. de. 2015. Use of educational social network in research project at the university. *Brazilian Symposium on Informatics in Education (SBIE)*: 1270-1273.
- Bezerra, Y.M.S., Correia-Neto, J.S., Santos, R.E.S., Vilar, G., Magalhães, C.V.C., Queiros, L.M. 2014. Virtual learning environments and virtual social networks: preliminary results of a systematic mapping in the context of information technology in education. In *Nuevas Ideas en Informática Educativa, TISE*.
- Degenne, Alain, and Michel Forse. 1999. *Introducing Social Networks*.
- Delbem, Edgar, sjr. (2014) *Modelo computacional colaborativo para mensurar o desenvolvimento inter-relacional em alunos do Ensino Médio*. Dissertação (Mestrado em Informática) – Universidade Federal do Rio de Janeiro, Instituto de Matemática, Instituto Tércio Pacitti Gessinger, R.M. (2008) "Atividade em grupo, In: A gestão da aula universitária PUCRS", editado por Grillo, M.C., Freitas, A.L.S., Gessinger, R.M., Lima, V.M.R., EdiPUCRS, Porto Alegre.
- Delbem, Edgar. 2014. Collaborative computational model to measure interrelated development in high school students. *Dissertation (MSc in Informatics) - Universidade Federal do Rio de Janeiro, Instituto de Matemática, Instituto Tércio Pacitti*.
- Deroy-Pineau, Françoise. 1994 *Reseaux sociaux: bibliographie commentée*. Montréal: Université de Montréal.
- Domingues, Diana Maria Gallicchio. (2004). Ciberespaço e rituais: tecnologia, antropologia e criatividade. *Horizontes Antropológicos*, 10(21), 181-197. DOI: 10.1590/S0104-71832004000100008.
- Fuks, Hugo; Pimentel, Mariano. *Sistemas Colaborativos*. Rio de Janeiro, Elsevier, 2011.
- Liu, Z.; Kang, L.; Domanska, M.; Liu, S.; Sun, J. and Fang, C. (2018). Social Network Characteristics of Learners in a Course Forum and Their Relationship to Learning Outcomes. In *Proceedings of the 10th International Conference on Computer Supported Education: CSEDU*, ISBN 978-989-758-291-2, pages 15-21. DOI:10.5220/0006647600150021.
- Marinho, É. C.; Ferreira da Silva, M.; de Souza Dias, D.; Schmitz, E. and Alencar, A. (2015). Motivational Factors and the Intention of Use of a Virtual Learning Environment - A Preliminary Study about an e-Learning Application Developed by the Brazilian Ministry of Education in *Proceedings of the 7th International Conference on Computer Supported Education - Volume 2: CSEDU*, ISBN 978-989-758-108-3, pages 477-482. DOI: 10.5220/0005429104770482.
- Marteleteo, Regina Maria. 2001. Analysis of social networks - application in studies of information transfer. In *Ci. Inf., Brasília*, v. 30, n. 1, p. 71-81, jan./abr.
- Sancho, J. M.; HERNANDEZ, F. et al. (Org). (2006). *Tecnologias para transformar a educação*. Revista Educ. Nº 28, p. 279-282. UFPR, Porto Alegre: Artmed.
- Souza Vieira, M. E.; López-Ardao, J. C.; Fernández-Veiga, M.; Ferreira-Pires and Rodrigues-Péres (2018). Prediction of Learning Success Via Rate of Events in Social Networks for Education. In *Proceedings of the 10th International Conference on Computer Supported Education: CSEDU*, ISBN 978-989-758-291-2, pages 374-382. DOI:10.5220/0006780703740382.
- W. S. Moura, J. de O. Sampaio, J. B. S. França, A. Dias, and M. R. S. Borges, "Colabsaber: a Pedagogical Support Framework in the Collaborative Construction of Knowledge / Colabsaber: Uma Estrutura Pedagógica De Apoio Na Construção Colaborativa Do Conhecimento," *Brazilian Journal of Development*, vol. 6, no. 12, pp. 103018–103031, 2020, doi: 10.34117/bjdv6n12-705.
- Xavier, Jr., Joaquim Ferreira. *A psicogenética – demarcando os processos da vida*. Tremembé: VespeR Editora, 2004, p. 40-43.