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A way to measure students´ perceptions of ict terms in education using pathfinder associative networks: a multicultural focus

This paper shows the results of the comparison between the Pathfinder Associative Networks extracted from data tests given to students of the University of Extremadura in Spain (UEx) and students of the Herzen State Pedagogical University of Russia (HSPU) about essential ICT concepts in education. Using a neutral method of obtaining data, students were asked to set the level of relationship between six different aspects concerning ICT and teaching-learning process, with the aim of developing students cognitive maps related to such concepts. Then, researchers compared the resulting graphical networks, both individually and aggregated. Finally, they tried to show analogies and differences in students understanding of concepts relationships and the importance of socio-educational context in it.

Способ изучения понятийного аппарата студентов в области терминологии икт в образовании с применением ассоциативных сетей: мультикультурный фокус

В статье показаны результаты сравнения ассоциативных сетей, демонстрирующих существенные понятия из области ИКТ в образовании, извлеченных из ответов студентов Университета Эстремадуры в Испании (UEx) и студентов РГПУ им. А.И. Герцена, Россия (HSPU). Используя нейтральный метод получения данных, студентам было предложено установить уровень отношений между шестью различными понятиями, *касающимися ИКТ и учебно-методического процесса, с целью создания когнитивных карт, связанных с этими понятиями. Затем исследователи сравнили полученные графические сети как по отдельности, так и в совокупности. В заключении реализована попытка показать аналогии и различия в понимании студентами понятийных отношений и важности социально-образовательного контекста в данном исследовании.*

INTRODUCTION

Currently, Information and Communication Technologies (ICT) are an active part of the daily life of Higher Education students. It is possible that one of the first people who coined the term "Net Generation" was Tapscott as early as 1999, that is, already in the last century (Tapscott, 1998). Thus, in his subsequent publication (Tapscott, 2008) distinguished these young people, who are our students of higher education, from the rest of adult population, based on a set of competencies that manage to improve the use of ICT, such as speed to execute tasks, freedom of choice, the tools customization and, of course, multitasking.

On the other hand, it is ((Prensky, 2001) who defined the term "digital natives", on the hypothesis that the brain of these young people is probably different, even physically, as a consequence of the digital environment in which they have grown up. He reached to this conclusion based on some neurobiology studies, specifically those concerning the phenomenon of neuroplasticity. This author argued that the brain "can be, and is" constantly reorganized throughout childhood and during adult life.

It is also crucial in terms of the use of ICT tools to try to measure their homogenizing potential; the reason for that is the idea of ICT as a valuable tool to bring different cultures closer together (Leiva Olivencia & Priegue Caamaño, 2012). Although this potential seems obvious when using ICT within the classroom or in the same educational system, it can be wrong to broaden this conclusion when the perception that higher education students have of the use of ICT in the classroom varies from very different socio-educational contexts, such as the Spanish and Russian educational systems can be.

The perception of ICT use in higher education has been established in limited systems, where the use of surveys can approach their measurement. As results, some aspects as motivation and the active role of students in the learning process were considered as relevant, provided that the tools are managed with the required expertise (Morales Capilla, Ortiz Colón, Trujillo Torres, & Raso Sánchez, 2015). However, we must not forget that these studies are influenced by the context that makes up the educational system and the degree of penetration of ICT in it. Thus, in (Tapasco & Giraldo, 2017) there are certain similarities between the perceptions of ICT by the teachers of Colombia and Mexico, indicating the poor use of Facebook or videoconference with respect to the mostly known email or Internet.

However, we can use other means to know the perceptions and associations that users have concerning ICT and education. Specifically, one way of representing the cognitive structure, widely used, is through the Pathfinder associative networks (PAN). Such networks, by obtaining user data regarding the association of certain ideas or concepts, and after applying various statistical algorithms, can determine the nuclear concepts. After discriminating them from the rest and selecting the minimum distance or more significant links, then we can draw a representation in a graph approximated to the student cognitive structure (Contreras, Arias Masa, Luengo Gonzalez, & Casas Garcia, 2015).

Following (Casas, 2002), there are four major categories of techniques in order to obtain data about the knowledge structure, which can be applied in combination: the association of words, verbal tests, user settings and similarity score. Precisely regarding to this last technique, there are also several tools that allow set a concepts similarity score, such as Tree Building, Conceptual Maps, Cognitive Maps and PAN, as previously mentioned. It is through these techniques of scoring similarity between concepts through which we can observe the proximity between them easily, thanks to its spatial graphical representation.

Particularly, PAN (Casas, 2002) are graphic representations in which concepts are depicted as nodes and their relationships, as segments that link them. Such segments can be of greater or lesser length according to the weight or strength of their semantic proximity.

The great advantage of this technique is that it allows creating graphic representations of the cognitive structure of a person in a fully automatic and immediate way, without mediation of any other context than the user's own decision. These representations are obtained from a matrix of proximity data between concepts indicated by the users. When these data are transformed by means of an algorithm in a network structure, then we can display them graphically as a graph of interrelated nodes.

In order to obtain networks, the experience must begin with the selection of a concepts set in a certain field of knowledge. In our case, six usual concepts have been chosen concerning learning processes and the use of ICT in classrooms. The entire research team have agreed them, with the aim of making comparisons of the students' cognitive structure. Such students have been selected from the Herzen State Pedagogical University of Russia (HSPU) and form the University of Extremadura of Spain (UEx).

RESEARCH OBJECTIVE

The main research objective is to compare the cognitive structures of students from two very different systems of higher education. First group of students come from an EU country and the second group from a non-EU country. Cognitive structures are simplified through a small group of concepts concerning the use of ICT in the classroom and their relationship to learning processes. Each participating students can associate them freely and autonomously, allowing the research team to make comparisons of their different perceptions.

RESEARCH METODOLOGY

Firstly, data form students and teachers who are going to participate in this experience must be obtained. The only thing that they should be requested is to set a score that show the relationship between two concepts. In order to determine the concepts similarity score, we use the data collection system configured in MeBa server (Arias Masa, 2005), which allows us to obtain data matrices for the later extraction of Pathfinder associative networks. In MeBa, students who are going to perform the similarity test must be previously registered. As previously mentioned, in this case they will be Spanish and Russian students and teachers (see Figure 1). Once registered, they can later access the server for data entering, so that, in this way, it will be possible to store information that they provide individually for the purpose of granular analysis.

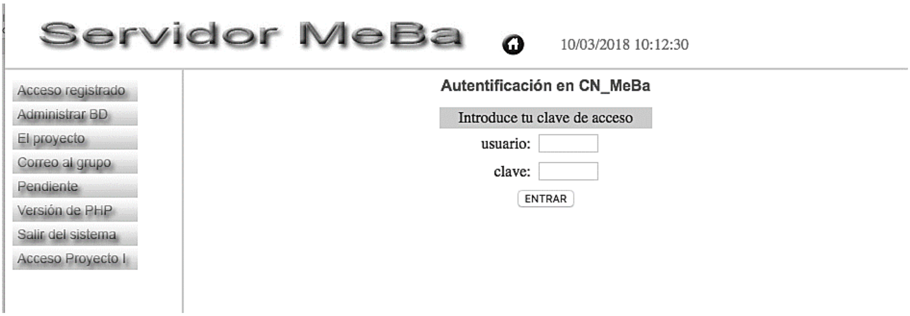

Figure 1. MeBa Registered Access

Similarity assessment is carried out by showing on the screen previously selected concepts in pairs and asking users to click with the mouse on a place in the scale where they think it represents the proximity between a couple of concepts (see Figure 2). Scale is designed as a triangular bar placed at the bottom of the window. The reason for that is to get an analog precision, not digital. The described system tries that the user does not remember any discrete value that has set before when marking the relationship score of two previous concepts, as it would happen with a digital scale system. Thus, an inappropriate bias can be avoided.

As already mentioned, concepts will be showed in pairs, in order to form a triangular matrix with concepts similarity scores, marked by users in the continuous triangular scale (relationship between any two concepts is considered bidirectional, which means that relationships AB and BA are exactly the same; so, resulting matrix is triangular).

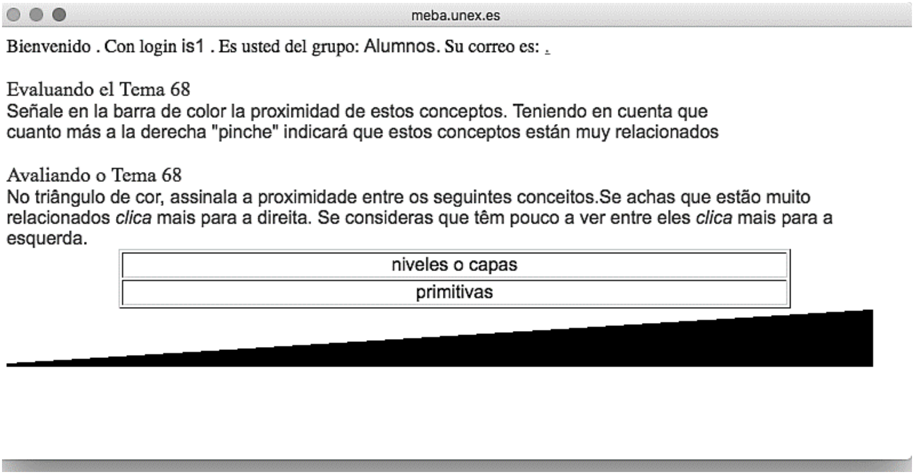

Figure 2. System for entering concepts similarity scores in MeBa

Therefore, depending on the number of concepts we are evaluating, the number of comparison pairs to be processed is:

$$Number\ of\ Comparison\ Pairs = \sum_{i=1}^{n}(n-i) = \frac{n^2 - n}{2}$$

where "n" is the number of different terms on which we are going to perform the Pathfinder associative network. Thus, if we select 6 concepts to analyze, as in the example we are considering in this paper, the user will be asked for 15 comparison tasks. The results will be stored in a matrix like the one shown in Figure 3, where "x" represent the concepts similarity values that are extracted from the user's selection.

	concepto1	concepto2	concepto3	concepto4	concepto5	concepto6
concepto1						
concepto2	x					
concepto3	x	x				
concepto4	x	x	x			
concepto5	x	x	x	x		
concepto6	x	x	x	x	x	

Figure 3. Example of concepts similarity matrix

Only when the users have performed the concepts similarity test, the system build a matrix with the similarity scores or distances between each pair of concepts. Once finished, it is possible to calculate those parameters and make necessary transformations to draw the appropriate Pathfinder associative network. In this case, as previously discussed, comparisons are made between the average networks of the two students groups from HSPU and UEx.

Next, let us go further into the phases that the experience followed.

CONCEPTS SELECTION

As students who were going to take the concepts similarity test belong to higher education, concretely to the 3rd and 4th years of the Degree in Telecommunications Engineering of the University of Extremadura and to the 2nd year of the Degree of Pedagogical Education of the Herzen State Pedagogical University of Russia, the research team from both universities discussed broadly about concepts to be selected. Finally, they decided to include the following terms, in three languages (English, Russian and Spanish), to facilitate the general understanding of terms:

1. Sistemas de Gestión de Aprendizaje (Moodle) - Learning Management Systems (Moodle) - система управления
2. Pizarra Digital - Digital Blackboard - цифровая доска
3. Herramientas de videoconferencia - Videoconference tools - инструменты видеоконференции
4. Interacción de los estudiantes - Students interaction - взаимодействие студентов
5. La motivación - Motivation - мотивация
6. El aprendizaje significativo - Meaning learning - осознанное обучение

DATA COLLECTION

Based on the previous concepts selection, next step is to register users who are going to perform the concept similarity test on the web server. For doing this, student-user accounts are activated and assigned to one of the two objective research groups, with the aim of being able to work with all data provided in a compact way. Particularly, it will allow us to treat all users as a whole or as segregated groups, in order to perform the partial calculations of means, medians and other valuable statistics.

```
data student1
similar
6 Nodes
0 decimal places
0 minimum weight
768 maximum weight
lower triangular:
575
726   762
670   682   655
597   526   710   730
483   676   729   744   738
```

Figure 4. Example of a user data file

As previously described in this document, data has been collected through Meba platform (Arias Masa, 2005). Data obtained after tests carried out on Spanish and Russian students are shown in Annex I of this document. UEx students are labeled with prefix "alu", while HSPU students are labeled with prefix "st". Then, triangular matrices are filled in with collected data, according to Figure 3 and, in addition to distance scores, additional information is obtained so that the algorithm can interpret them. This is the reason why information format is as shown in Figure 4.

The first line serves to identify the MeBa user who has performed the test. The second line expresses what kind of data are stored in the file, which refers to similarity data in the example. However, in the same way it could refer to other parameters: distance, probability, etc. The line, referred to as "6 Nodes", as you can guess, expresses the number of nodes or concepts on which information has been collected (in our case, it is shown 6 nodes). The fourth line should always be present and indicate what kind of values are used. They will be decimal values in our case. Following lines indicate the maximum and minimum value that values of similarity distances can take, set by MeBa administrator for each pair of nodes.

Next, the type of matrix is determined from a range of values, namely: matrix / upper / lower / list / coord. / featur / attrib. In our case, a triangular type has been chosen because, as explained above, we start from the premise that two concepts similarity is bidirectional or symmetric, that is, it is the same distance in one direction as in another. However, there may be researches in which to differentiate the sense of relationship between two concepts is appealing.

Finally, the rest of the lines correspond to the matrix that we have described in Figure 3 and those values are the similarity score between different concepts presented in pairs.

RESULTS ANALYSIS

Then, once data has been collected, the next stage is to analyze them. This results analysis has been performed in Jpathfinder software (Schvaneveldt, 2017), whose latest version makes it possible to carry out an exhaustive analysis of Pathfinder associative networks based on the data obtained and formatted as distances matrices built by MeBa.

In order to achieve that, the first step will consist of removing the non-coherent responses. Coherence is a parameter that indicates to what extent user data have been filled with attention and knowledge (Casas, 2002). Once filtered, coherent answers let us determine the average networks for each group and then compare them through the similarity measurement between them.

Finally, nuclear concepts for all networks will be determined, based on the definition established in the Nuclear Concepts Theory by ((Casas Garcia, Luis Manuel & Luengo González, Ricardo, 2004).

COHERENT ANSWERS

From our experience in data obtainment through Pathfinder Associative Networks, particularly using distance matrices and according to (Interlink, n.d.), where it is recommended to eliminate those distance matrices with a very low coherence, less than 0,15, matrices form the remaining students are depicted in Figure 4.

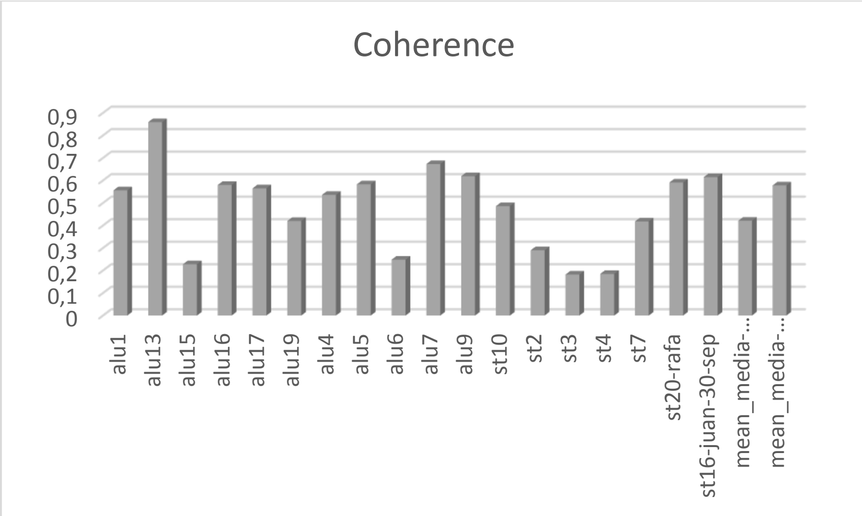

Figure 5. Graph of valid coherence for students distances matrices. Data from UEx and HSPU students and their means

AVERAGE NETWORKS

On the one hand, we calculate the average network of students with coherent answers from UEx and, on the other hand, we do the same with students from HSPU. Results of the average networks are shown in Figure 5 and Figure 6.

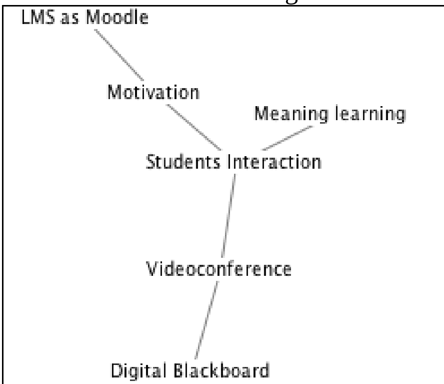

Figure 6. Mean Pathfinder associative network of UEx students

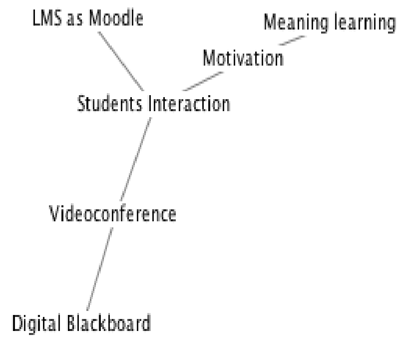

Figure 7. Mean Pathfinder associative network of HSPU students

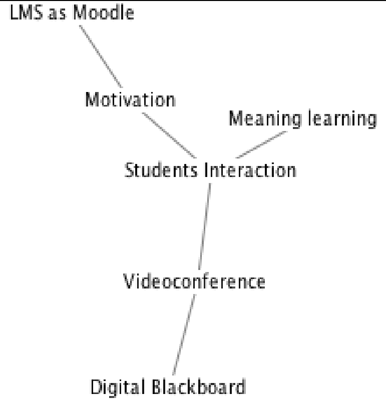

Figure 8. Mean Pathfinder associative network of all students together (from UEx and HSPU)

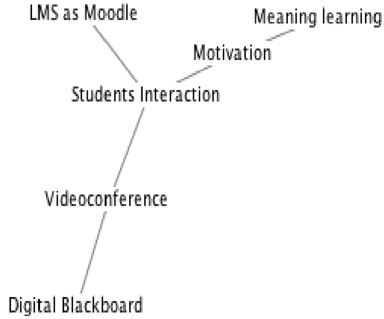

Figure 9. Mean Pathfinder associative network of teachers from the research team

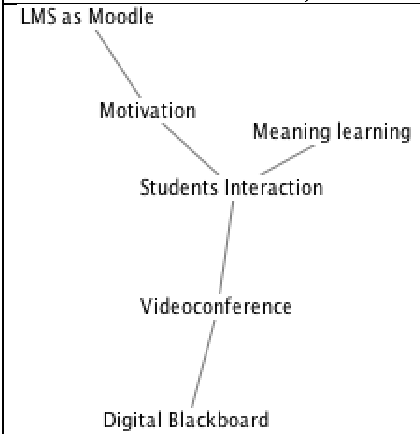

Figure 10. Mean Pathfinder associative network of students and teachers from both universities

SIMILARITY

Similarity can also be measured and calculated between any two networks, and sets a measure of how alike they are. Its value is comprised in a range of 0 to 1 and is determined by the correspondence or coincidence of the links that make up the networks. Indeed, similarity is defined as the number of common links divided by the total number of unique links contained in both networks being compared.

Therefore, two identical networks must offer a similarity value equal to 1 and two networks that do not share any link will yield a similarity value of 0. The measure we obtain is the proportion of all the links that appear in both networks. A hypergeometric probability distribution is used to generate information about the expected value of several means, in order to determine whether the links were selected by chance.

In Figure 10, we can see the similarity relationship between the different people who have participated in the experience and the average networks of the UEx and HSPU students groups. Comparisons of these average networks with the average of the teaching team also appear. All of them are shown in the figures: Figure 5, Figure 6, Figure 7, Figure 8 and Figure 9. Thus, we can see that the average of the HSPU students fully coincides with the average of the teaching team. However, when we compare the average network of UEx students with the average of the teaching team the result is further away. For better understanding of what may be influencing, we can see in Figure 11 how most of the HSPU students (those ones labeled as pf_st) have a higher similarity compared to the average network of the teaching team. Consequently, the average of such students' networks will also be higher, as shown in Figure 10.

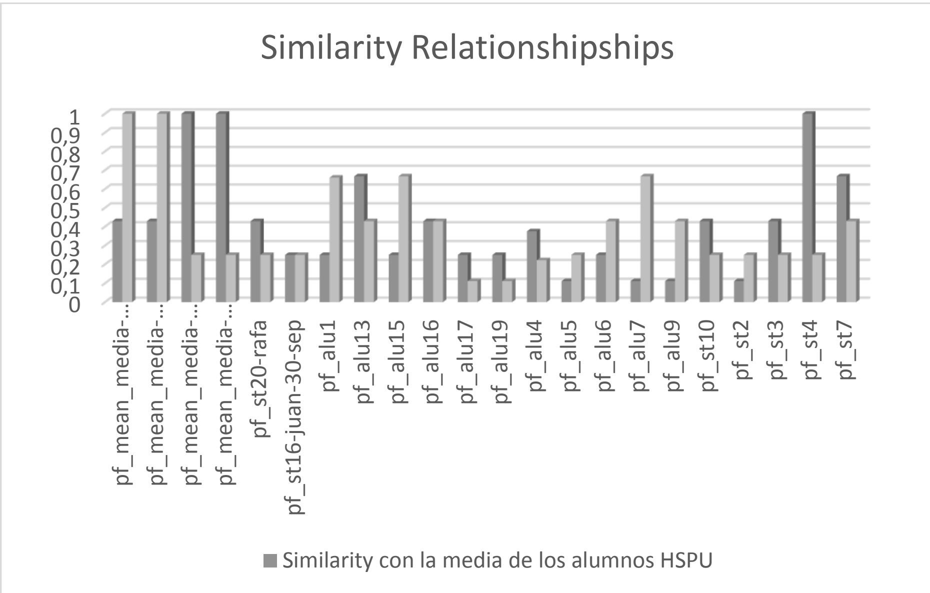

Figure 11. Similarity carried out from comparison between user networks and average networks

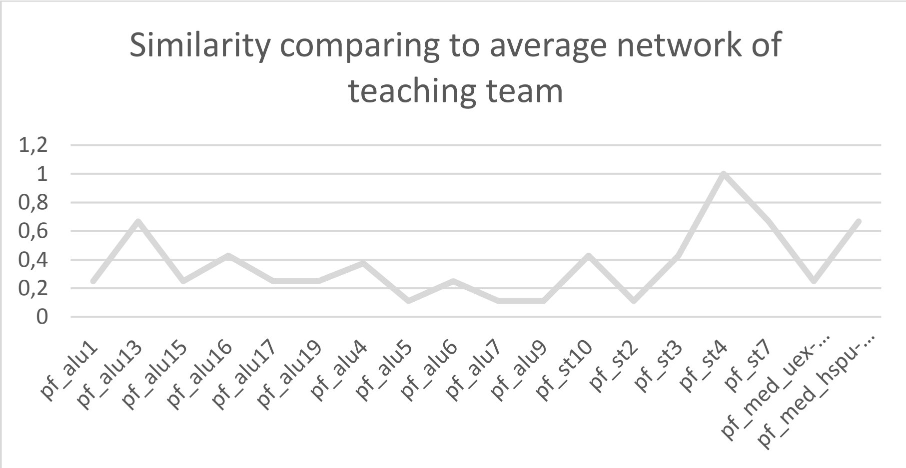

Figure 12. Similarity carried out from comparison between user networks and average network of the teaching team

NUCLEAR CONCEPTS AND AVERAGE NETWORK ANALYSIS

The Nuclear Concepts Theory by (Casas Garcia, Luis Manuel & Luengo González, Ricardo, 2004) indicates that a concept is considered nuclear when it has more than two links to other concepts. In this case, the nuclear concept is unique and is the term "Students interaction" for all medium networks, including those of UEx students, of HSPU students, of the teaching staff and, therefore, of all the users involved in this experience, as we can see in Figure 13. Even more, related to this concept is the branch "Videoconference", which is linked to the nuclear node "Students interaction" on the one hand and, on the other, to the concept of "Digital Blackboard". In addition, this happens for all medium networks. Such relationship may seem obvious, as the basic element or tool for videoconferencing is the digital blackboard, which is associated with a greater and better interaction of students as it is where the teaching-learning process converges, beyond simply viewing other students' images in the usual videoconference.

Another common concept to all the analyzed average networks linked to the nuclear node is "Motivation". It is quite probable that, according to what is expressed by the average networks of the Pathfinder associative networks from all the users, motivation is related to a greater interaction of students, which coincides with the importance of social interaction in learning theories (García & Doménech, 1997).

LMS Moodle, in the same way that it happens with Digital Blackboard, is one of the remote elements of the core. This likely indicates that it is a replaceable concept within the basic ones chosen by the teaching team for this experience. Probably, it is so because of a bad selection of the term, by reducing the concept to the LMS Moodle environment with the aim of clarifying the acronym LMS for students comprehension, when in fact there are many others. However, to complete its replacement, it would require further research to be confirmed, since there is no absolute confidence on all the average networks.

Finally, the concept Meaningful Learning is linked to the nuclear node in the average networks of UEx students but not in the case of the teaching team or HSPU students, who place the concept Motivation between them. This is another difference that should be corroborated in further research. That is, if it is really perceived that Motivation is a main element towards the final objective of meaningful learning and that is achieved with the interaction between students or otherwise both terms are complementary. Even it is possible that UEx students, not being specialists in education, have trivialized the term Meaningful Learning.

Figure 13. Nuclear Concept in the general Pathfinder associated network for all users

CONCLUSIONS

Using MeBa server and JPathfinder program, we have been able to make an exhaustive analysis of the opinions of UEx students and HSPU students about six basic concepts related to ICT and the teaching-learning process and their relationship. Among those six concepts, all the participants (students and teachers) have determined that Students Interaction is a nuclear concept, so we can conclude that it represents the main contribution of using ICT for the teaching-learning process. In the same way, the complete lower branch of the calculated average networks is common for all networks and they take the same form when linking concepts "Student Interaction", "Videoconference" and "Digital blackboard". The same occurs with the relationship between the concepts "Student Interaction" and "Motivation", which are directly linked in all networks.

Therefore, from the previous analysis, we can conclude that there is an absolute coincidence in the relationship with four of them. In addition, if the network of figure 14 is valid, where all these concepts are related as shown, the two concepts that have been eliminated from this final network (LMS as Moodle and Meaning learning) should be analyzed and reviewed in further research where their exclusion is ratified or rejected. By the moment, in this study we can only remain with the shown in such figure as common relationships in very diverse cultural contexts.

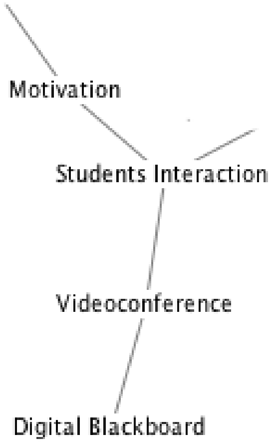

Figure 14. Common part of Pathfinder Associative Networks for this experience

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Teachers' digital skills for the 21st century

The paper presents the first results of an international research on teacher skills for the digital age. With the purpose of identifying a list of skills that teachers need in the digital age, a survey among university teachers, trainers and secondary level teachers was carried out and the importance of the results was classified according to the Cronbach's Alpha for Reliable Surveys. The video presentation of this research paper is available at: https://youtu.be/gd1dsxtmL5I.

Цифровые умения педагогов в 21 веке

В статье представлены первые результаты международного исследования, посвященного педагогическим умениям в эпоху цифровых технологий. С целью определения перечня умений, необходимых учителям в 21 веке, был проведен опрос среди преподавателей университетов, тьюторов и учителей средней школы. Для определения надежности полученных результатов был использован коэффициент альфа Кронбаха. С видео презентацией данного исследования можно ознакомиться по адресу: https://youtu.be/gd1dsxtmL5I.

When we reflect on the topic of didactic skills in the digital age, we face immediately the question: which are the required skills for a good teacher in the