Wikis supporting research workshops in higher education

Prospective use in Cuban universities

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Abstract—**This paper reports the results of a pilot study conducted on a Cuban Higher Education setting. A classroom of twenty students of the Sciences of Information career at Central University "Marta Abreu" of Las Villas (UCLV[1]) was inquired during the use of a wiki tool supporting a research workshop in the course of Databases Theory (DBT). The purpose of this study is to test the following hypotheses: (1) the collaboration supported by social software reinforces the peer relationships among the students of the class and (2) improves the time efficiency of the students and instructors (stakeholders) participating in these collaborative activities. A survey and several interviews were conducted to gather data about the social network the students formed for studying DBT, and about the time they spent on that. The results of these instruments were contrasted with the results of an observation conducted during the collaborative activities. The data of the students' achievements and social network state using the wiki tool were compared to similar data from other two precedent, non-wiki-supported research workshops. The use of the wiki tool was found effective to reinforce the peer learning relationships, and consequently, to improve their achievements on the subject. Finally, the time spent for accomplishing the collaborative learning activities did not decrease significantly during the use of the social software.**

Keywords-collaboration; collaborative learning; Cuban higher education; Databases; graphs theory; networked learning; peer learning relationships; research workshop; social networks analysis; Sciences of Information career; social software; teaching and learning process; Web 2.0; wiki.

I. INTRODUCTION

The role played by the human beings within the social spaces is characterized by a typical phenomenon of our days: the globalization. Education is one of the most influenced sectors by this phenomenon. The growth of the Information Society (IS) [1] has required the support of ICT in the recent years, for avoiding the communication gaps occasioned by its evolution. It caused the development of the Knowledge Society (KS). The virtual nearness –provided by our "global village"- has a great importance because of the paradigmatic change promoting the collaborative practices as pillars of the knowledge building. The strategic transformations in this field of the teaching and learning process are aligned with the necessary synergy among the people who collaborate online.

II. COLLABORATION

Collaboration is a catalyst element in the KS. It contributes to the acceleration of the knowledge building processes; being defined as "an interactive process that engages two or more participants who work together to achieve outcomes they could not accomplish independently" [2].

The achievements of the learning communities depend on its members' activity, whose membership objectives are similar [or identical], accomplished by the collaborative learning support. The collaborative learning is "(…) an instruction method where small groups of students work together for the accomplishment of shared objectives". This term is situated within e-learning by the association with social software, allowing distance collaboration for research, teaching and learning activities [3]. The field of action of Computer-Supported Collaborative Work (CSCW) typifies the ways of acting under collaborative settings in the teaching and learning process.

The collaborative learning in higher education trains the students of the classroom in the ways for effective collaboration. It supposes the joint work for achieving their goals within their Zone of Proximal Development (ZPD) [4]. Learning under these conditions contributes to the dynamics of the students' future work relationships, since the point of view of the acquisition of new competences in the field of collaboration. The development of the students in their specific collaboration group depends on the roles they are capable of playing within different academic levels. The academic levels for Cuban higher education context are the classroom, the academic year, the career, the faculty and the Higher Education Academy (CES[2]).

III. SOCIAL WEB

The expansion of ICT since the 90's submits the KS to constant changes, so that from a sociological point of view

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[1] UCLV: Spanish acronym for *Universidad Central "Marta Abreu" de Las Villas.*

[2] CES: Spanish acronym for *Centro de Educación Superior.*

confers KS a sense of *social network*[3] where the members participate in the construction of knowledge. The social Web has emerged as a consequence of using ICT –especially Internet- as a communication medium of social spaces. Actually, it is a reference term used to point out the change from a passive Web –whose users are mostly information consumers- to a collaborative Web –whose users contribute to the creation of knowledge networks. The social software plays a fundamental role supporting the online communities, and so, it contributes to the success of online learning experiences [5].

A. Web 2.0. Tools for the social Web

The Web 2.0 emerges as a result of the evolution of social networks, which are sustained by the communication facilities of the Web supporting the users' interactions. The last decade has been typified by the successive improvement of collaborative practices supported by social software.

Actually, the research on ICT for education is a prioritized field in educational research. The research on Computer-Supported Collaborative Learning (CSCL) has been a revolutionary branch of this field in the last years because of – among others- the efforts of social researchers on studying the behaviors and ways of acting of the people, who use the ICT for collaborating during teaching and learning [6-9].

Many European researchers investigate the Networked Learning (NL) using this term –for practical reasons- as a synonym of CSCL [10]. The NL is understood as the use of internet-based information and communication technologies to promote collaborative and cooperative connections: between learners; between learners and tutors; between a learning community and its learning resources [10-13].

The analysis of social networks in schools and classrooms has been object of research since 70's [14]. Although, the emerging Web 2.0 tools have increased the studies on this topic due to the need on analyzing a great amount of data coming from social interactions in the Web.

IV. INQUIRING THE WEB. NETWORKS ANALYSIS

The origin of the networks analysis comes from the evolution of the graphs theory for representing the relationships (edges) among a group of elements (nodes). In online learning these elements represents the stakeholders and the resources they use. Their attributes are considered or not, depending on the nature of the study.

The field of Network Analysis (NA) accumulates the knowledge on examining the networks for the subsequent decision-making. This term appears contextualized in teaching and learning related to Social Networks Analysis (SNA) [15], [16]. Many instruments, metrics and methods have been designed for inquiring social networks [14-18]. The growth of social Web has opened a field of research on SNA for studying the structures and dynamics of online communities.

A. Basic metrics for networks analysis

Almost all metrics for networks analysis derive from primitive metrics whose computation is relatively simple. These metrics are easy to understand when the basic elements of the graphs theory are known.

Better interpretations of social networks are provided by the use of weighted digraphs, where the edges are denoted with weights depending on the strength of the relation they represent [19]. A digraph is a network N integrated by a set of nodes V, and a set of directed edges, E. A directed edge e ($e \in E$) is an edge whose endpoint is designated as the tail, denoted as $tail(e)$, and whose other endpoint is designated as the head, denoted as $head(e)$, where $tail(e)$, $head(e) \in V$.

1) Degree and isolated nodes

The degree (or valence) of a node v in a network N, denoted $deg(v)$, is the number of proper edges incident on v plus twice the number of self-loops[4]. The higher the degree of a node, the more its possibilities to access the information flowing in the social network. Other degree-metrics are the indegree and the outdegree[5].

A node v is an isolated node when $deg(v)=0$. Isolated nodes in social networks are understood as nodes with minimal possibilities of accessing the information hosted in the other nodes of the network.

2) Graph Density

The density measures how close the network is to complete every possible edge among all pairs of nodes. A full-connected graph/network has a density value equal to 1. The higher the density of a network, the better the connectivity among its nodes. Hence, an added-value of teaching and learning process could be inferred taking into account the principle of "connecting entities" considered in the theory of connectivism[6] [20-23].

B. Graph distance metrics

SNA is supported by many statistical methods which vary on the use of different measures. A lot of these are established on the bases of centrality measures [24-27]. At date, the social researchers have employed these measures for inquiring performance and collaboration in the academy [28-32].

1) Average Shortest Paths

The graph distance, γ, between two nodes u and v is defined as the minimum number of edge-hops required to traverse the network starting from node u and ending at node v (in an undirected network these two values are identical, but not so in a directed network). The average shortest path between all nodes in a network is seen as a measure of the small world effect.

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[3] Social network: A set of bonds between social actors providing interpretations about the social behaviors of the actors implied in the network [55].

[4] Self-loop: An edge that joins a single endpoint to itself. For a self-loop e, $tail(e) = head(e)$.

[5] Indegree and outdegree: The indegree of a node v in a directed graph is the number of edges directed to v; the outdegree is the number of edges directed from v.

[6] Connectivism: Social learning theory focusing on the emergent forms of learning networks [56].

2) Node Betweeness Centrality

This metric indicates how often a node is found on a shortest path between two nodes in the network.

3) Node Closeness Centrality

This metric indicates how long it will take for information from a node *u* to reach other nodes in the network.

C. Modularity

Real world networks have been shown to separate into logical clusters in which nodes are tightly connected to each other but only loosely connected to nodes outside of their module. Newman's modularity is currently the most widely used metric to measure how modular a network is [33], [34]. The meaningful value of Newman's algorithm is set over 0.4 units.

D. Clustering Coefficient

This metric measures how close the neighborhood of a specific node *u* is to a complete subgraph, where the neighborhood of a node is defined as the set of nodes that are immediately adjacent to *u* [35]. It is possible to determine the number of communities integrating a given graph based on the clustering coefficient.

Another cluster-related metric is the number of full connected triads of the network (triangles). It offers a measure of completeness of the network through the three-by-three association of the nodes.

E. Networks visualization

The need of visualizing networks comes from the finding of better ways to understand its structure and main characteristics. The use of nodes and edges as core elements in networks visualization seated the bases for current advances on analyzing large and dense networks [36], [37], content authorship [38], as well as networks' clusters and structures [39]. Moreover, the use of eigenvector and eigenvalues has reached a remarkable importance in networks visualization due to the advantages it offers to obtain fast graphic representations [26], [28], [39], [40]. For instance, it is frequently used to explore the structure of huge social networks on Internet.

V. WIKIS

Although the tools provided in the Web for the social interchange are heterogeneous and multi-functional, some of these can be classified as core tools, according with its spread. These are the blogs, the threaded discussions, the chats and the wikis. The extensive presence of technological solutions provided in the Web for installing and using these tools in few steps has generalized its use before others.

A "wiki is a software application that permits to create collectively documents on the web using a simple scheme of labels and marks" [41]. It is a valuable tool for promoting the students interactions for sharing and distributing the knowledge during collaboration [42], even in extra-large classrooms [43]. Wikis have the potential of building up communities where the students collaborate for achieving common objectives [42]. Its use in the classroom comprises an extent variety of activities.

Some of these are the independent study to apprehend the knowledge, and the research workshops conducted as problem-solving, both for theoretical and practical solutions finding.

The most diffused wiki software solutions in the Web are MediaWiki, PmWiki, WackoWiki, TWiki, JSPWiki, EditMe, Wikispaces, Socialtext, and WikiWikiWeb. The choice of these solutions for supporting the collaborative learning in higher education depends on the purpose of the course, the topic studied, the functionalities required by the users, the integration with other services and tools, the way of acquiring the software, etc. The planning for its use should be integrated in the instructional design of the study subject, as well as the training of the stakeholders on collaboration and ICT use [44-47].

VI. CLASSROOM WORKSHOPS IN CUBAN HIGHER EDUCATION

The workshop –contextualized in the teaching and learning process- is referred to as the way of intellectual work where small groups of students follow the objectives of developing the scientific research, the teamwork, the group dynamics, and their participation [48]. This type of class is one of the most dynamic instructor-guided activities in the classroom.

Various authors have exposed the classroom workshop as an organizational, educational way of teaching complementing other ways such as the lecture, the training class and the laboratory [49], [50]. Other classifications are based on the methodologies followed for its execution. Many kinds of workshops are referred in literature; these are the asking & responding workshops, the dialogue workshops, the presentation workshops, the panels, the round tables, the video debates and their combinations [50].

The asking & responding and the presentation workshops are the most spread types of workshop in Cuban higher education. The panels are developed too, but with a minor frequency. Moreover, their combination allows the students to interchange their ideas about the performed presentations. This kind of interaction is very much used at UCLV, which is one of the most heterogeneous Cuban universities due to the diversity of the careers coexisting on the same campus. The teaching and learning process of this university is characterized by frequent workshops following instructional objectives aligned with the Norms for Educational, Methodological Work in Higher Education [49].

The use of another type of workshop is extended in this setting: the "research workshop". Despite it is not referred in scientific literature, it could be classified as a presentation workshop; according to the methods the instructor follows for the class. It consists of orienting research topics to the students for the later presentation of their findings in the classroom. One or more discussion sessions are organized for the presentations, depending on the complexity of the proposed topics.

VII. TECHNOLOGICAL SETTING IN THE CENTRAL UNIVERSITY "MARTA ABREU" OF LAS VILLAS

The last two decades have imposed new challenges to Cuban higher education. Many instructional processes are

evolving from the traditional model. The mission of higher education today is: to preserve, develop and promote the culture of humanity through the substantive processes, in close relation to the society [51]. Nowadays, ICT is one of the key components for improving the higher education. It is caused by the close relation between the quality of the teaching and learning and the technological settings at the universities.

The UCLV is located in Santa Clara, at the middle of Cuba. It is around five thousand students' university, distributed in five academic years, 13 faculties and 33 careers. This CES[2] regulates the higher education activities of the province of Villa Clara. The UCLV is one of the three principal CES in Cuba, and the most important campus at the central region of the country.

There are almost three thousand personal computers connected at the local Intranet at UCLV, with a similar speed to the other CESs in the country (100 Mbps). It means an improvement of the services, sustained on the fast data interchange between the faculties. Moreover, many faculties are using virtual spaces on the Intranet (shared folders, web sites and e-learning platforms) to publish learning resources. The last changes in Cuban higher education demand a transformation in the curricula. The authorities of the Cuban universities dedicate huge efforts in designing a new generation of curricula –the curricula D- which promotes the b-learning[7] and finds new ways for organizing the teaching and learning process to stimulate the students' specialization. So, it is necessary to offer innovative ways for improving the process efficiency. Are the ICT the correct support to face this challenge?

VIII. Wikis supporting workshops. A pilot study

According to the previous introduction, the conditions to face the issue of adopting instructional practices supported by social software are given. Taking into account the diffusion of the social Web in the educational environments, the vast knowledge in the field of ICT in Education and the technological conditions of the UCLV, it is possible to improve the teaching and learning process using this kind of technologies.

The purpose of this pilot study is the subsequent promotion in the Faculty of Sciences of Information and Education (FCIE[8]) [and so in the UCLV] of the use of social software for supporting the collaborative activities in the teaching and learning process. Its specific objectives are the gathering of relevant preliminary data, the designing of the research protocol for a later experiment, and developing and testing of the instruments for this experiment. It is based on the use of a wiki for supporting the collaboration among the students of a classroom during a research workshop. The course of Databases Theory (DBT) hosted this study.

The instructional design of DBT includes three research workshops during the course. Two of them try to promote the

discovery learning among the students through the research on transforming methods related to the conceptual, logical, and physical models of databases. The third one tries to deepen the acquired knowledge through the problem solving: the instructor proposes the students the solution of problems related to the acting modes of the professionals of the field of Sciences of Information, and they should apply their knowledge to solve it. All these workshops are supported by the collaboration that the students are capable of managing in their research, while they are assisted by the information resources the instructor of the subject delivers. The students' performance on workshops are evaluated by the instructor, who delivers the independent scores (one score per student per workshop), according to their skills on the following criteria: (1) the knowledge about the topic, (2) the demonstrated collaboration skills, (3) the time management during the final presentation, (4) the coherence in discourse during these presentations, (5) the ICT use and (6) the quality of the research report. All of these criteria are systematized for delivering each student's score –which is among 2 and 5 points[9].

A. Research methodology

A mixed research methodology was used to conduct this study [52], [53]. Observational and quasi-experimental research methods were combined to analyze the data gathered through its triangulation, comparing the views on the topic.

The quantitative data collection was performed throughout the study. Two questionnaires were administered for obtaining relevant data on the social network composition and the time employed by the students in their DBT's weekly self-study. Moreover, the data on students' achievements were collected from the instructor's learning outcomes history about the students. These quantitative data was analyzed through descriptive statistics and SNA's methods.

The collected, qualitative data registered the students' collaboration strategies and their perceptions of the course development, as well as their thoughts about the wiki tool. The semi-structured interviews, the interchanged e-mails and the students' contributions in the wiki served as data collection instruments for this purpose, as well as an observation controlled by the instructor of the course.

Content analysis provided a better interpretation of the students' contributions to the wiki and their thoughts about using these kinds of tools for supporting the learning process. Both quantitative and qualitative data were contrasted to obtain the final results on testing the hypothesis of the study.

B. Sample

The sample for this study was 20 students of the career of Sciences of Information (SI) of the FCIE, at UCLV. The study was conducted while the students attended the course of DBT

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[7] Blended-Learning: Instructional method mixing various learning environments.

[8] FCIE: Spanish acronym for Facultad de Ciencias de la Información y de la Educación.

[9] In this system a score of 2 points qualifies the student who did not accomplish the course objectives. The students who inefficiently accomplished the objectives are qualified with 3 points. A score of 4 points is delivered for the students who accomplished the objectives with minor difficulties; and 5 points for the students who did not have difficulties for accomplishing the objectives of the learning activity.

during the second semester of their first academic year. This group of students was 18 to 20 years old; including one (1) male and nineteen (19) females.

The students of this course never used social software tools before. They just had the basic competences for using office software (e-mail included). Moreover, they were attending other seven courses during the semester.

C. Study design and instrumentation

This study is designed with the purpose of conducting a broader research intending the inclusion of the social software for supporting the collaborative learning in the UCLV in the digital space. It examines the performance of the students during three different moments: (1) before, (2) during and (3) after the social software use for developing the research workshops. A wiki tool was used to support the students' collaborative learning. The data gathered on collaboration after the use of the wiki are contrasted with the data gathered before. An instructor's intervention was executed during the use of the wiki for guiding the students on the acquisition of collaborative skills, because they did not experience the use of this kind of tools before.

1) Before the wiki use

This period was characterized by the execution of the first and the second research workshops. Both were performed without using any kind of social software. Moreover, the students just had the information resources on the research topics that the instructor delivered. Three teams were constituted for working on these workshops. Two of them were consisting of seven students; the other was consisting of six. The teams' members worked together during the course since this moment. However, the instructor guided two intermediate sessions to offer the students little tips about the collaboration and research protocols.

Two instruments for data gathering were applied after the second research workshop. The first instrument measured the composition of the social network for learning DBT. The second examined each student's habits learning the subjects whose courses they were attending for in the semester, this one included items for measuring the students' spent time during the semester. Both instruments were applied, as questionnaires, before the execution of the third research workshop.

The figure 1 shows a graph representing the students' network for studying DBT. The image was generated from the data gathered with the first questionnaire. The researcher mapped each student's preferred peers for studying with the weights of the edges among them. The scale used was eight points for the preferred peer and five, three and two for the subsequent ones; the rest of the preferences received one point. A tool for graphs and networks analysis – Gephi[10]- was used in this phase for obtaining and exploring the classroom network. The size of the circle representing each student (node) signifies the connotation of the knowledge socialized by him/her; the

greater nodes are the most accessible nodes within this network. So, these are the students whose biggest amount of information flows through.
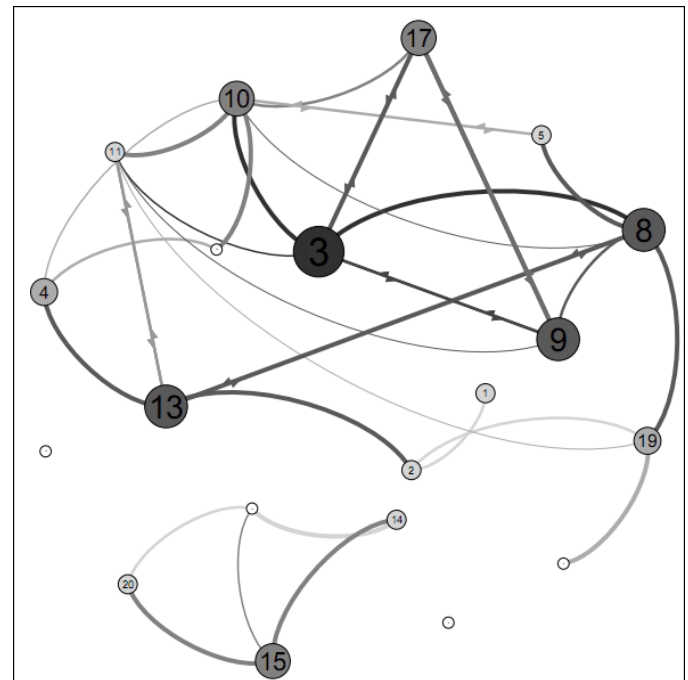

Figure 1. Students' network for studying DBT before using the wiki tool (the numbers identify the students).

2) During the wiki use

This phase of the pilot study took place during the execution of the third research workshop of the course, which was supported by a social software tool dubbed "Wiki Docente"[11] –a wiki tool built over the core of MediaWiki[12], designed for this setting. The research teams kept the same membership during this workshop as in the previous workshops. This time the students could ask for instructive sessions on the wiki use, and for being supported in the ways to face the research around the proposed topics. The instructor supported them with the required tips.

Although the "Wiki Docente" allows the communication through discussion forums, this function was not used; the students used the e-mail to ask for help. This issue reduced the complexity of the process taking account that in the course were not planned specific sessions for the students' training in the use of this kind of social software, first time used by them. Then, the intermediate sessions were eliminated under the communication improvement supposed by this new framework, thus the b-learning replaced the classroom attendance sessions. Even though the use of the e-mail in place of the wiki forums just allows the peer-to-peer communication, it was necessary to avoid an additional complexity for the students who never use this kind of tools before.

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[10] Gephi: Free software tool developed over the Java platform. It offers many functions for graphs and networks analysis. Although it is in the testing phase (beta version 0.7) includes facilities for connecting to MySQL and Postgre databases for the users who need to gather data from this kind of sources.

[11] "Wiki for Instruction" could be an approach of the translation of "Wiki Docente" (in Spanish).

[12] The sources of MediaWiki could be found at the website of WikiMedia Foundation (http://www.wikimedia.org/).

This workshop –like the others- finished with a final presentation where the research teams presented their findings in terms of the solution to the proposed problems. This session was planned in the course schedule and all the students attended at the same time, at the same place, for discussing their research with the other teams and with the instructor as moderator of the session. The students were supported by the Wiki Docente for presenting their findings. It was the digital space where they elaborated the final report of the research, whose main issues were previously highlighted by the instructor.

A controlled observation was conducted in this phase for analyzing the students' performance in the virtual collaborative environment (the Wiki Docente). The observation script included items for collecting information about the students' dynamics and the collaborative learning strategies, among others. It was executed during the non-presencial sessions. Although the instructor was in the classroom for executing the observation, he was inactive, according with the research protocol. He just interacted with the students through the digital media.

3) After the wiki use

The student's contributions on the digital environment were analyzed after the pilot study. The artifact used for this purpose was the Wiki Docente, where all the students' inputs were collected and structured by the collaboration of the research teams. Likewise, the composition of the network for studying DBT was explored, as well as the time the students spent for accomplishing the workshops objectives. The data gathered both in this phase and in the "before" phase, were compared for testing the hypotheses of this study.

A semi-structured interview was conducted for inquiring the students about the use of the Wiki Docente and the collaborative research process during the workshop period. It had as main items the students' thoughts about the software and the time spent by them for accomplishing the workshop objectives. Moreover, the Wiki Docente was explored for analyzing the reflections and the knowledge of the students, in addition to the composition of the network. Hereby, the students had the opportunity to compare the collaborative process both with and without the use of the Wiki Docente.

D. Tools for data analysis

The instruments used to analyze the composition of the network and the time spent by the students for studying DBT were applied during each phases of this pilot study. The data collected both before and after the third workshop about the usage of the Wiki Docente were compared.

The analysis of the composition of the network is mainly based on the students' relations for studying, emerged during the execution of the third workshop. Similarly, the quality of the final research reports was compared. It is remarkable that the final reports of the third workshop were shaped from the contributions in the Wiki Docente, so that at the end of the collaborative research period the teams obtained their reports immediately.

The results of the semi-structured interviews and the observation were used for validating the data obtained through the application of the rest of the instruments.

E. Limitations of the study

There is a noteworthy limitation of this study. It concerns to the order of the workshops activities planned in instructional design of the course of DBT. Although the questionnaire for exploring the social network was administered once finished the second workshop, the students who interacted within this course achieved experience in teamwork during the first and second workshops, which could facilitates the collaboration process faced during the third workshop –with the Wiki Docente supporting. Moreover, this issue exposes the study to the Hawthorne effect, which supports the theory of the predisposition of the sample being studied during the experimental activities [54].

IX. RESULTS

The results of this study are organized in four principal issues, which mainly influence the acquisition of new learning strategies by the students and contribute to enlarge the knowledge in the field of CSCL. Likewise, the findings exposed here have a considerably importance due to the stimulation of the stakeholders' reflection about their collaborative learning interactions, independently of the nature of the developed activities.

A. Composition of the network for studying DBT

The data gathered from the content analysis on students' contributions to the Wiki Docente revealed the interactions of the students during the third workshop. The final network structure was obtained from the transformation of these data into relationships. It was taken into account the dynamics of each couple of peers' interchange for assigning the weights of the edges.

An increase on the students' study relationships was perceived. Betweeness and closeness centrality measures indicated a meaningful change according to the network's composition when compared the moments before and after the use of the Wiki Docente (Table 1). It means an improvement of the students' access to the information flowing through the network nodes, and so a potential improvement of the students' learning possibility, perceived from the increase of the knowledge access probability.

TABLE I. VALUES OF THE NETWORK METRICS, BEFORE AND AFTER THE WIKI USE.

Metric	Before	After
Isolated nodes	5	1
Directed edges	36	102
Graph Density	0.095	0.268
Shortest Paths	123	326
Average Shortest Paths	2.528	1.995
Average Betweeness Centrality	0.055	0.126
Average Closeness Centrality	0.987	0.450
Modularity	0.389	0.435*
Clustering Coefficient	0.225	0.617
Number of Communities	7	3

Triangles	12	149

There is a perceived augment in the directed edges between the students interacting in this network (from 36 to 102); it contributes to increase the graph density and clustering coefficients of the nodes (a comparing of the Figure 2 with the Figure 1 offers a better interpretation of this issue). Likewise, the quantity of triangles augmented from 12 to 149. These issues contribute to the improvement of the learning possibilities through the increase of the information flowing among the network nodes.
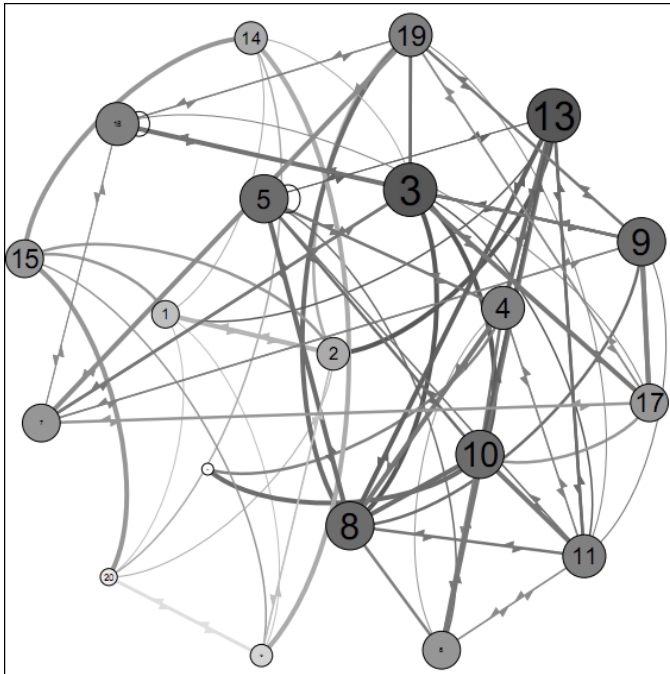

Figure 2. Composition of the network for studying DBT after using the wiki tool (the numbers identify the students; this enumeration matches with the Figure 1 enumeration).

It was found that after the use of the Wiki Docente the number of communities in the network decreased from seven to three, according to a comparing based on the modularity test. The significant value (0.435) indicated by the modularity test surpasses the value before using the wiki (0.389). Moreover, there was a meaningful augment in the quantity of shortest paths of the network (from 123 to 326), which could be considered as an improvement taking account the efficiency of the time spent by the students for finding information through the interaction with their classmates. The perceived improvement of the density of the network (from 0.095 to 0.268 units) influences the reduction –from five to one- of isolated students (nodes) within the network after the third workshop, which means an improvement in terms of the students' success in the third workshop.

The integration of new research teams for subsequent studies –alternating the number of members and the teams' membership- is recommendable, taking care of each student's characteristics. It supposes an improvement of the network for studying the subject due to the growth of new study relations among the students, which could increase the completeness degree of the network. Also, it is suggested the use of new collaboration strategies during the workshop development, taking into account that the observation in this study registered the use of a unique, collaborative strategy. It consisted on the distribution of the proposed topics among the students of each team for the subsequent posting of their findings in the Wiki Docente –as chunks of the final report. It could be a lack in terms of the necessary consensus in favor of the effective achievement in collaborative learning activities.

B. Spent time

The time spent by the students for researching the third workshop topics were not considerably minor than in the other workshops. The questionnaire they filled was analyzed statistically, correlating the spent time during the first two workshops with its results in terms of the students' scores. This correlation did not have a meaningful value, it was of 0.407 (SD=0.887). Likewise, there was no correlation between the spent time during the third workshop and its scores, resulting in a non-significant correlation of 0.212 (SD=0.513). Moreover, the spent time for the third workshop realization does not differ of the spent time for the previous workshops; it was tested by the spent time means: 1.95 hours per student before and 1.66 hours after the third workshop. However, the standard deviation decreased from 1.37 to 0.73, as well as the differences between the minimum and maximum values of the spent time (6.00 hours before and 2.50 hours after), indicating a higher homogeneity for this variable. This homogeneity was corroborated through the semi-structured interviews, where the students stated that during the third workshop their teamwork was intensified, compared with the previous workshops. It contributed to eliminate the collaborative learning lacks like passive or null participation of the students during these activities.

The analysis of the time refutes the second hypothesis proposed in this study, which states that the use of the Wiki Docente for supporting the collaborative activities improves the time efficiency of the students in this context. However, there is a perceived improvement in the collaboration process for achieving the objectives proposed for the activity, where the students' participation is more active than in activities without ICT supporting. This issue was referred by the students in the semi-structured interviews, whose 75% –six (6) of eight (8) interviewed students- expressed that the additional complexity of using the wiki tool required a higher amount of time for the workshop realization. Contrariwise, it was found a reduction of the time the instructor spent on guiding this kind of activities. It is a consequence of the introduction of b-learning practices supported by ICT tools for coordinating and controlling the teaching and learning process.

C. Students' contributions to the Wiki Docente

The analysis of the students' contributions to the digital space provided by the Wiki Docente is based on the results obtained by them in the final report of the workshop, one of the evaluated issues during the research process. The mean of the scores of the final reports shows a significant improvement on this issue. It was increased from 3.03 points (SD=1.08) to 5.00 points (SD=0.00) for the third workshop, achieving a constant behavior.

A better knowledge of the students is appreciated on the topics of the third workshop, according with the means analysis made about this issue for the first two workshops (M=3.53 points) and for the third workshop (M=3.90 points). Although there is no a significant difference between these means, is remarkable that the topics proposed for researching during the third workshop had a higher complexity than in the other two workshops due to the requirements for organizing the theoretical and practice contents of the subject of DBT.

Resuming, there is an appreciable improvement in the quality of the students' contributions, verified by the structure of the Wiki Docente and by the scores achieved during the third research workshop. This improvement comes from the instructor possibilities for a better guiding and controlling through the wiki scaffolding.

D. Peer to peer interchanges

Although the Wiki Docente provides effective tools for supporting the discussions and coordination within the digital space, the e-mail was used in place of these tools. This decision was in correspondence with the specific setting, where the students have incorporated the e-mail as the preferred communication tool they use during the teaching and learning process. The e-mail was used by the students for clearing their doubts about the wiki use, and occasionally, about the topics for researching in the workshops. The instructor responded them with the required tips about the wiki use, taking into account that this was the first time they used this kind of tool and they did not have a previous training on collaboration supported by ICT. A mailing-list was used for this porpose.

It is recommendable the use of the online forums provided by the Wiki Docente for its subsequent use in the teaching and learning process. This way the instructor could monitor the student-student interactions in addition to the student-instructor interactions, increasing the feedback among every peer in the process. Moreover, these communication choices could be used in other setting where the access to the e-mail is not effective [or preferred]. Likewise, it is suggested the use of RSS [13] channels integrated with the proposed topics of the workshop for controlling the activity through the monitoring of the contributions in the digital space of the Wiki Docente.

X. DISCUSSION AND CONCLUSSIONS

This pilot study inquired into the collaborative activities during the teaching and learning process using social software tools. In this case, a wiki tool –dubbed Wiki Docente- was used for supporting a research workshop of the DBT subject of the SI career at UCLV. Four issues characterizing this setting were investigated: (1) the composition of the network for studying DBT, (2) the time spent by the students for studying this subject, (3) the students' contributions within the digital space provided by this collaborative tool and (4) the peer to peer interchanges during the workshop development.

The analysis of the results of this study related to the current conditions of the Cuban higher education supposes extensible the experience of using this kind of social tools –the wikis- within other undergraduate subjects. It is demonstrated that a better engagement of the students is obtained by this way, based on the homogenization of their participation in the research process, as well as in the quality of the elaborated research reports. Although the time spent by the students during the use of the wiki tool does not differ significantly from the common setting, it is possible to shape strategies allowing its efficient use in this direction.

The findings of this pilot study include the data gathered from the referred setting, which will be used for a subsequent needs analysis about the use of ICT for collaborating in the teaching and learning process. It will be used for validating the instruments and the social software tools, designed for a subsequent experiment whose research protocol is validated too. The following recommendations have emerged from the analysis of the faced situations during the use of the Wiki Docente; these could be useful for improving the wiki effectiveness in subsequent undergraduate activities:

- Forming new research teams, alternating its number of members and membership.

- Providing the students with various collaboration strategies for executing the research process.

- Using the online forums of the Wiki Docente instead of the e-mail for supporting the students' communication.

- Using the RSS channels for controlling the contributions and discussions on the digital space.

- Promoting the use of references to the resources for a better supporting of the students' contributions. The Wiki Docente should include this function.

- Warranting the training of the students for acquiring the necessary skills to use this kind of tools.

- Providing the instructors with less complex tools for analysing the composition of the classroom network.

- Improving and increasing the ways of feedback between students and instructors through the digital space –e.g. through online questionnaires.

Another remarkable issue in this kind of activities is the attitude of the peers towards collaboration. The higher the capability and interest of the students and instructors towards the collaborative practices development, the better achievements will be obtained in the teaching and learning process. It warrants new acting modes for the future professionals whose potentialities are in the hands of the higher education.

REFERENCES

[1] D. Bell, The coming of post-industrial society: A venture in social forecasting, New York, NY: Basic Books, 1976.

[2] J. Salmons and L. Wilson, Handbook of research on electronic collaboration and organizational synergy, New York, NY: Information Science Reference, 2009.

[3] K.L. Murphy, L. Cifuentes, and Y.-C.D. Shih, "Online collaborative documents for research and coursework," TechTrends, Atlanta, GA: 2004, pp. 40-46.

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[13] RSS: Acronym for Really Simple Syndication.

[4] L.S. Vygotsky, Mind in society: The development of higher psychological processes, Cambridge, MA: Harvard University Press, 1978.

[5] O. Muniz-Solari and C. Coats, "Online experiences," International Review of Research in Open and Distance Learning, vol. 10, 2009.

[6] M. Valcke and R. Martens, "The problem arena of researching computer supported collaborative learning: Introduction to the special section," Computers & Education, vol. 46, 2006, pp. 1-5.

[7] C.L.Z. Gress, M. Fior, Aa.F. Hadwin, and P. Winne, "Measurement and assessment in computer-supported collaborative learning," Computers in Human Behavior, 2007.

[8] B.G. Silverman, "Computer supported collaborative learning (CSCL)," Computers and Education, vol. 25, 1995, pp. 123-129.

[9] G. Kanselaar, G. Erkens, J. Jaspers, and H. Schijf, "Computer supported collaborative learning," Teaching and Teacher Education, vol. 17, 2001, pp. 123-129.

[10] M.D. Laat, V. Lally, L. Lipponen, and R.-J. Simons, "Investigating patterns of interaction in networked learning and computer-supported collaborative learning: A role for social network analysis," Computer-Supported Collaborative Learning, 2007.

[11] S. Liping, Song; Yinchi, "Structure study on e-invisible college by SNA," Journal of the China Society for Scientific and Technical Information, vol. 26, 2007, pp. 902-908.

[12] S. Chen, Zuo Lian; Watanabe, "A case study of applying SNA to analyze CSCL social network," International Conference on Advanced Learning Technologies, ICALT, eds., Niigata, JP: 2007, pp. 18-20.

[13] H. Xia, R. Wang, and S. Hu, "Social networks analysis of the knowledge diffusion among university students," 2009 Second International Symposium on Knowledge Acquisition and Modeling, Nov. 2009, pp. 343-346.

[14] M.T. Hallinan, "A structural model of sentiment relations," American Journal of Sociology, 1974, pp. 364-378.

[15] K. Numela, E. Lehtinen, and T. Palonen, "Evaluating CSCL log files by social network analysis," Computer Supported Collaborative Learning, 1999.

[16] S. Wasserman and K. Faust, "Social network analysis: methods and applications," 1995.

[17] G. Bartal, Alon; Sasson, Elan; Ravid, "Predicting links in social networks using text mining and SNA," 2009 International Conference on Advances in Social Networks Analysis and Mining, ASONAM, eds., Athens, GR: 2009, pp. 131-136.

[18] C. Thovex and F. Trichet, A multidisciplinary model of dynamic and semantic social networks analysis for institutions, IEEE, 2010.

[19] J.L. Gross and J.A.Y. Yellen, eds., Handbook of graph theory, New York, NY: CRC Press, 2003.

[20] G. Siemens, "Knowing knowledge," Lulu.com, 2006.

[21] G. Atwell and P. Pumilia, "The new pedagogy of Open Content: bringing together production, knowledge, development, and learning," Data Science Journal, vol. 6, 2007.

[22] J. Cross, Informal learning, Pfeiffer, 2007.

[23] S. Downes, "E-learning 2.0," ACM eLearn Magazine, 2005.

[24] L. Freeman, "Centrality in social networks: ii. experimental results," Social Networks, vol. 2, 1980, pp. 119-141.

[25] L. Freeman, "Centrality in social networks conceptual clarification," Social Networks, vol. 1, 1979, pp. 215-239.

[26] C.T. Butts, "Social network analysis: A methodological introduction," Asian Journal Of Social Psychology, vol. 11, Mar. 2008, pp. 13-41.

[27] L.C. Freeman, "A set of measures of centrality based on betweenness," Sociometry, vol. 40, Mar. 1977, pp. 35-41.

[28] E. Yan and Y. Ding, "Applying centrality measures to impact analysis: A coauthorship network analysis," Journal of the American Society for Information Science and Technology, vol. 60, Oct. 2009, pp. 2107-2118.

[29] A. Coromina, L; Guia, JCoenders, G; Ferligoj, "Duocentered networks," Social Networks, vol. 30, Jan. 2008, pp. 49-59.

[30] L. Lella and I. Licata, A new model for the organizational knowledge life cycle, Singapore: World Scientific Publishing Co. Pte. Ltd., 2009.

[31] H. Wi, J. Mun, S. Oh, and M. Jung, "Modeling and analysis of project team formation factors in a project-oriented virtual organization (ProVO)," Expert Systems with Applications, vol. 36, Apr. 2009, pp. 5775-5783.

[32] A. Abbasi and J. Altmann, On the correlation between research performance and social network analysis measures applied to research collaboration networks, IEEE, 2011.

[33] P.J. Mcsweeney, Gephi network statistics, 2010.

[34] P. Van Mieghem, X. Ge, P. Schumm, S. Trajanovski, and H. Wang, "Spectral graph analysis of modularity and assortativity," Physical Review E, vol. 82, Nov. 2010, pp. 1-11.

[35] D.J. Watts and S.H. Strogatz, "Collective dynamics of 'small-world' networks.," Nature, vol. 393, Jun. 1998, pp. 440-2.

[36] J.-D. Fekete, Visualizing networks using adjacency matrices: Progresses and challenges, IEEE, 2009.

[37] H. Fuji, S. Nakai, H. Matoba, and H. Takano, Real-Time Bifocal Network-Visualization, IEEE, .

[38] R.R.T. Santamaría, "Overlapping clustered graphs: Co-authorship networks visualization," SG '08 Proceedings of the 9th international symposium on Smart Graphics, Berlin, DE: Springer-Verlag Berlin, Heidelberg, 2008, pp. 190 - 199.

[39] A.J. Seary and W.D. Richards, "Spectral methods for analyzing and visualizing networks: an introduction," Workshop on Dynamic Social Network Modeling and Analysis, B.R.C.K.P. P, ed., Burnaby, BC: 2002, pp. 1-20.

[40] R.A. Hanneman, Introduction to social network methods, 1998.

[41] L. Moreno, C. Gonzalez, I. Castilla, E. Gonzalez, and J. Sigut, "Applying a constructivist and collaborative methodological approach in engineering education," Computers & Education, vol. 49, 2007, pp. 891-915.

[42] L. Logan-Rich, W. Cowan, S.D. Herring, and W. Wilkes, "Collaborate, engage, and interact in online learning: Successes with wikis and synchronous virtual classrooms at Athens State University," 14th Annual Instructional Technology Conference, 2009, pp. 1-14.

[43] P. Aborisade, "Investigating a Nigerian XXL-cohort wiki-learning experience: Observation, feedback and reflection," Electronic Journal of e-Learning, vol. 7, 2009, pp. 191-202.

[44] F. Prinsen, M. Volman, J. Terwel, and P. Vandeneeden, "Effects on participation of an experimental CSCL-programme to support elaboration: Do all students benefit?," Computers & Education, vol. 52, 2009, pp. 113-125.

[45] B. Teclehaimanot and G. Mentzer, "Teacher education faculty perceptions of the integration of technology into their courses: An exploratory study," 31st annual Proceedings: Selected research and development papers presented at the Annual Convention of the Association for Educational Communications and Technology, M. Simonson, ed., Orlando, FL: Nova Southeastern University, 2008, pp. 188-192.

[46] A.Z. Özgür and B. Batmaz, "How effective is the use of videoconferencing in distance education? Capabilities and limitations: an overview of Anadolu University Experience," 31st annual Proceedings: Selected research and development papers presented at the Annual Convention of the Association for Educational Communications and Technology, M. Simonson, ed., Orlando, FL: Nova Southeastern University, 2008, pp. 167-177.

[47] K. Cekerol, "Face-to-Face Support for distance learners in a mega University," 31st annual Proceedings: Selected research and development papers presented at the Annual Convention of the Association for Educational Communications and Technology, M. Simonson, ed., Orlando, FL: Nova Southeastern University, 2008, pp. 64-70.

[48] S. Sánchez-Cerezo, J.L. Castillejo-Brull, and J. Mesanza-López, Dictionary of the Educational Sciences, Mexico, D.F.: Santillana, S.A. de C.V., 2003.

S. Sánchez-Cerezo, J.L. Castillejo-Brull, and J. Mesanza-López, Diccionario de Ciencias de la Educación, México, D.F. Editorial Santillana, S.A. de C.V., 2003.

[49] MES, "Norms for educational, methodological work in Cuban higher education," 2007, pp. 1-37.

MES, "Reglamento para el Trabajo Docente y Metodológico en la educación superior," 2007, pp. 1-37.

[50] M. García-Hernández, M. Lugones-Botell, and L. Lozada-García, "Theorethical and methodological considerations about the workshop," Cuban Journal of General, Integral Medicine, vol. 22, 2006, pp. 1-7.

M. García-Hernández, M. Lugones-Botell, and L. Lozada-García, "Algunas consideraciones teóricas y metodológicas sobre el seminario," Revista Cubana de Medicina General Integral, vol. 22, 2006, pp. 1-7.

[51] P. Horruitiner-Silva, "The university in the current age," The Cuban university: the professionals formation model, La Habana, CU: 2007, pp. 1-12.

P. Horruitiner-Silva, "La universidad en la época actual," La Universidad Cubana: el Modelo de Formación, La Habana, CU: 2007, pp. 1-12.

[52] Z. Todd, B. Nerlich, S. McKeown, and D. Clarke, Mixing methods in psychology, Hove: Psychology Press, 2004.

[53] I. Silverman, "Why social psychology fails," Canadian Psychological Review, vol. 18, 1977, pp. 353-8.

[54] M. Hansson and R. Wigblad, "Recontextualizing the Hawthorne effect," Scandinavian Journal of Management, vol. 22, Jun. 2006, pp. 120-137.

[55] F. Requena-Santos, "The concept of social network," Reis, 1989, pp. 137-152.

F. Requena-Santos, "El concepto de red social," Reis, 1989, pp. 137-152.

[56] R. Klamma, "Emerging research topics in social learning," Proceedings of the 7th International Conference on Networked Learning 2010, 2010, pp. 224-231.