LEARNING STYLES AND KNOWLEDGE REPRESENTATION SYSTEM IN ECAES (quality examinations for higher education) FOR MEDICAL STUDENTS.[1]

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Abstract

Research carried out with senior medical students in a higher education institution. Quantitative research was implemented a 2 x 4 factorial design of two variables; learning styles and knowledge representation systems. The participants were classified by applying The Kolb learning style inventory; according to learning styles they were classified in Assimilators, accommodators, Divergers and Convergers. The knowledge representation systems used during the research were concept maps, conceptual graphs, conceptual mentefactos and frames. The objective of the research was to determine if there are significant differences in the conceptual transfer between students according to their learning styles and their knowledge representation systems used in the study of basic medical skills using ECAES examinations as strengthening resources. The study revealed that 53% of the students were divergers (Reflective observation). The knowledge representation systems that allow students got the best findings were frames and conceptual mentefactos, although the results were not significant.

Key words: Learning stykes, Know representation system.

ESTILOS DE APRENDIZAJE Y SISTEMAS DE REPRESENTACIÓN DEL CONTENIDO EN ECAES (EXAMEN DE CALIDAD PARA LA EDUCACIÓN SUPERIOR PARA ESTUDIANTES DE MEDICINA .

Resumen

Investigación llevada a cabo con estudiantes de medicina internistas en una institución de educación superior. Investigación de tipo cualitativo, con un diseño factorial 2 x 4 de dos variables; los estilos de aprendizaje y los sistemas de representación del conocimiento. Los participantes fueron clasificados mediante la aplicación de El inventario de estilos de aprendizaje de Kolb; de acuerdo con los estilos de aprendizaje se clasificaron en Asimiladores, Acomodadores, Divergentes y Convergentes. Los sistemas de representación del conocimiento utilizados durante la investigación fueron los mapas conceptuales, gráficos conceptuales, mentefactos conceptuales y marcos. El objetivo de la investigación fue determinar si existían diferencias significativas en la transferencia conceptual entre los estudiantes de acuerdo a sus estilos de aprendizaje y sus sistemas de representación de conocimiento utilizados en el aprendizaje de las habilidades médicas básicas utilizando exámenes ECAES como fuente de creación. El estudio reveló que el 53% de los estudiantes eran Divergentes (observación reflexiva). Los sistemas de representación del conocimiento que permiten a los estudiantes los mejores resultados fueron marcos y mentefactos conceptuales, aunque los resultados no fueron significativos si existe una correlación.

Palabras clave: Estilos de aprendizaje, Sistemas de representación del conocimiento.

INTRODUCTION

This article shows the results of a research carried out with senior medical students in a higher education institution focuse on the teaching of health sciences. The main outcome was to determine the impact of the knowledge representation systems in a virtual learning environment using ECAES examinations as strengthening resources and reviewing of the knowledge. The learning styles were taking into account to process the information related to the results from the questionnaire based on ECAES examinations which were designed and assessed by the ICFES (Instituto Colombiano para el Fomento de la Educación Superior).

During this research was implemented a 2 x 4 factorial design of two variables; learning styles and knowledge representation systems. The participants were classified by applying The Kolb learning style inventory; according to learning styles they were classified in Assimilators, accommodators, Divergers and Convergers. The knowledge representation systems used during the research were concept maps, conceptual graphs, conceptual mentefactos and frames. The objective of the research was to determine if there are significant differences in the conceptual transfer between students according to their learning styles and their knowledge representation systems used in the study of basic medical skills.

The study revealed that 53% of the students were divergers (Reflective observation). The knowledge representation systems that allow students got the best findings were frames and conceptual mentefactos , although the results were not significant. The converger students got the best findings in this type of test, which is in line with KOLB's approaches.

Monereo, Castelló, Clarian, Palma and Perez (2007) raised that teachers in the teaching and learning processes should make sound decisions to set the conditions of the process, an activity that could be significant with prior instruction to any educational activity, taking into account the learning strategies to the students (Amsel, 1989). At present a new discipline "medical informatics" according to Campillo

(2004) computer science must be approached as a learning strategy of medicine, this approach agrees with Contessa , Ciardello and Perlman (2005) and De Simone (2008) researches. Furthermore, in medical education are difficulties which have been evidenced in the results of the quality examinations ECAES which are now called Saber Pro testing. From the previous statements, the following questions arise: How to improve teaching and learning strategies in medicine ?, How to teach medical concepts with computer applications ?, How to design an effective educational material for autonomous learning ?, these are some required questions in medical education, which are related to the transfer of scientific and technological developments into the academic environments.

To study the influence of different knowledge representation systems for teaching materials in a graphical interface show results in memorization, understanding and transfer of knowledge in autonomous learning processes of medical students. This work is an approach to how human beings acquire knowledge according to their learning style; this theory has been extensively studied by Alonso, Gallego and Honey (2000) and Alonso (1992) from graphical information. There are researches in medical teaching in which the instrument created by Kolb has been performed as the one carried out by Hauer, Straub, & Wolf (Fall 2005).

RATIONALE

Keywords: Learning styles, Virtual Learning Environment (VLE) and knowledge representation systems.
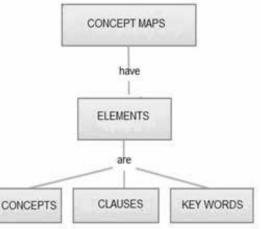
Virtual Learning Environment (VLE) is defined by Lopez, Stairs and Ledesma (2002) as "the set of interaction environments, synchronous and asynchronous, based on a curriculum, performed the teaching-learning process through a learning management system". In this research project, the VLE was developed on the Virtual Platform of the University made in Moodle, which is a Learning Managment System (LMS), Kats (2013) defines the LMS as software hosted on the server or in the cloud which has an interface with a database containing user information, courses and content,

providing a place for teaching and learning activities that occur in the network without limits of time and space. The virtual course and the questionnaires were designed with the synthesized information of the knowledge representation systems by using the software tools: Cmap tools and DIA.

These are some theories proposed about learning styles: Keefe (1988) defines style as "characteristics cognitive, affective and psychological behaviours that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment"for Ocaña (2010) students have to use their own method or set of strategies for learning, while for Messick (1984)defined cognitive styles as stable attitudes, preferences, or habitual strategies to obtain and process information within an environment, Riechman and Grasha (1974) suggested that behaviors and attitudes related to the context of learning, Kolb (1985) "are the preferred method to receive and process information", to Schmeck (1988) "are the willingness of learners to adopt a particular learning strategy regardless of the specific demands of the learning task". To define Learning styles In this study, it was used a learning style inventory, which was systematized with an application in Excel did with macros. The learning style inventory was developed by David Kolb, based on learning proposal, supported by experiences (Kolb, 1984) , it allows to identify students preferences to process the information and classified them into diverging, converging, accommodating and assimilating (Kolb, 1985).

San Segundo (2003) defines knowledge representation systems as "... the symbolization of data, images, figures and ideas studied , processed and structured, which replacing or refer to the information and mentions the technical process and recovery "pg. 399 in addition San Segundo (2003) knowledge representation is the symbolization of conceptual structures achieved with the establishment of structural, systematic relationships, association and distinction. The knowledge representation systems used for the research were concept maps, directed networks s, the conceptual mentefactos and frame networks.

According to Novack and Gowin (1984) concept maps (Figure 1) are tools that help students to learn about the structure of knowledge and the production process of that knowledge. The concept map represents a hierarchy of different levels of conceptual generality and inclusiveness and it is made up of concepts, clauses and linking words. The concepts refer to objects, events or situations.
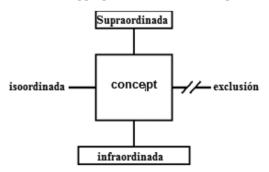
Figure 1 Concept maps

There are three types of concepts: Those with higher levels of inclusiveness (supraordinados) concepts at the same level of inclusiveness (isoordinados) and

those at a lower level of inclusiveness (subordinados). Relations between concepts are represented by lines labeled with linking words which are used to show connections between concepts making up clauses.

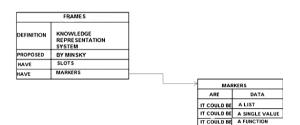**Figure 2** Conceptual mentefacto

Conceptual mentefactos (figure 2) are instruments which allow the construction of concepts, and the exercise and appropriation of intellectual operations

(supraordinación, infraordinación, isoordinación and exclusion). De Zubiria (2000). These intellectual operations lead to cognitive activity to define and/or set limits. There are notional, propositional, conceptual, formal, categorical and precategoricals. Through the relationship with the concept students will be able to propose meaningful clauses to be assessed in the construction of this instrument for knowledge.

Figure 3 Conceptual frames network

In 1975 Marvin Minsky, defined frame (Figure 3) as a data structure to organize events or situations. This system of knowledge representation has the advantage of being able to mix declarative knowledge with procedural. An important feature of the frame is its hierarchical ordering, frames lower nodes inherit properties of their superiors and the values and methods associated with these properties.

Frames features according to Winograd (1975):

• explicitness: objects are required, the relationships between objects and their properties; in the absence of contrary evidence default values are used

• Triggering: procedures can be attached to a frame or its components and to be called and executed automatically after verifying change some property or value (e.g: if-needed, if-added..)

• Heritage default non-monotonic: the frames are conceptually related, allowing object attributes are inherited from other previous objects in the hierarchy.

• Modularity: knowledge is organized into clearly distinguished components.

RESEARCH DESIGN AND METHODOLOGY

During the research process it was implemented a quantitative research. Correlational research scope, the correlation is established between variables learning styles and knowledge representation systems. A factorial design was applied.

These were the phases conducted and presented in the virtual learning environment:

Phase I: taking into account Kolb's Learning Styles, senior medical students were classified into four groups: diverging, assimilating, converging, accommodating.

Phase II: students from the four groups revised the contents of Child Health and Women's Health.

Phase III: The four groups revised the contents of adult's health, elderly health, and family health.

Phase IV: The four groups revised the content of public health and the environment, ethics and bioethics.

Phase V: The four groups revised the contents of medical-legal actions and administrative Actions.

NOTE: the groups concerted according to the learning styles, revised the contents implementing a different knowledge representation system in each phase (Table 1).

At the end of the second, third, fourth and fifth phases students had to take an examination similar to the ECAES through evaluation questionnaires, in the Virtual Classroom. These examinations are regulated by MEN (National Education Ministry) Decree 1781 of 2008, Resolution 00092 of 2008 issued by the ICFES (Colombian Institute for the Promotion of Higher Education) and the orientation guide for the medicine examination was prepared by ASCOFAME(Colombian association of Medical faculties) and was published by ICFES in 2008. From 2009 the decree 3963 redefined the design of this examination and changed its name

to SABER PRO. The examinations are regulated by law 1324 of 2009 (Congress of Colombia, 2009) establishing parameters and criteria to organize the results based evaluation for measuring the quality of education.

Students logged in their courses according to the learning style in the virtual classroom. In the course there was an image of the knowledge representation system (concept maps, conceptual graphs, frames and mentefactos) in GIFT format(it allows someone to use a text editor to write multiple-choice, true-false, short answer, matching missing word and numerical questions in a simple format that can be imported) of approximately 35 cm by 50 cm. Knowledge representation systems were developed based on ten (10) ECAES questions related to the topics defined, this definition was made because the knowledge domain was broad and students just had an hour to study.

In each session students had 50 minutes to study the topics proposed through the knowledge representation systems, then they answered a questionnaire on the platform which had five 5 questions taken at random from the 10 questions proposed in the knowledge representation systems, each student had 10 minutes available to answer those questions.

After classifying research participants, they attended virtual learning environment training. There were four stages designed to provide an overview of the basic topics of the ECAES medicine examination. The process developed in phases 2, 3, 4 and 5 is a quasi-experimental factorial design 2x 4 (Arnau, 1984) as follows in the Table 1.

There are two independent variables, learning styles and knowledge representation systems, each one with four indicators.

In each training phase students answered a questionnaire based on ECAES examination in order to answer the following research question:

To what extent the learning of basic skills in medical knowledge will affect the way of knowledge representation in a virtual learning environment and the learning styles of the last semester medical students evaluated through tests based on ECAES?

Two hypotheses were posed:

First Hypothesis: There are meaningful differences in the conceptual transfer between students according to their learning styles due to knowledge representation systems carried out in the study of basic medical skills.

Table 1. Experimental design of investigation

	Knowledge representation systems			
	FASE II	FASE III	FASE IV	FASE V
Learning Styles Acommodador	Concept maps	Conceptual graphs	Mentefactos	Frames
Assimilator	Conceptual graphs	Concept maps	Frames	Mentefactos
Diverger	Mentefactos	Frames	Concept maps	Conceptual graphs
Converger	Frames	Mentefactos	Conceptual graphs	Concept maps

Second Hypothesis: There are meaningful differences in the conceptual transfer between students due to learning styles used in the study of basic medical skills.
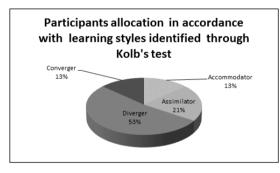
POPULATION AND SAMPLE

The population was composed of senior medical students at university located in Bogota, Colombia. To participate in the research the only requirement was to be senior medical student at the University, there were not exclusion criteria.

SAMPLING

There were 104 senior medical students divided into four groups according to learning styles proposed by Kolb.

Figure 4 Participants allocation in accordance with the learning styles

More than half of the participants have divergent learning style (53%) it can be inferred that more than half of senior medical students in 2009 perform well in concrete experience (CE) and reflective observation (OR). Their greatest strength is their imaginative ability. They are best at viewing concrete situations from different viewpoints. They are people who work well in situations requiring production of ideas (Kolb, 1985). Furthermore the assimilator participants (21%) who prefer abstract conceptualization (AC) and reflective observation (OR). Their strengths lie in the ability to use inductive reasoning, to create theoretical models, and to assimilate disparate observations into an integrated explanation. They are focused on ideas and abstract concepts rather than on people, and prefer theoretical and practical application (Seek Figure 4).

In line with Kolb's model (1984) it follows that these senior medical students learn through reflective and impartial observation, they are based on accurate observations judgments, they choose expository class sessions, and are introverted students.
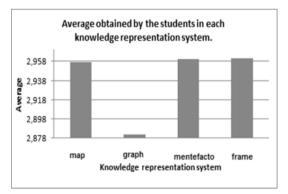
RESULTS

This is a summary of the data grouped by each of the components posed by ECAES examination, which was obtained from the questionnaires in the virtual learning environment.

Table 2 Statistical summary; data grouped according to the components posed by ECAES examination and the knowledge representation systems.

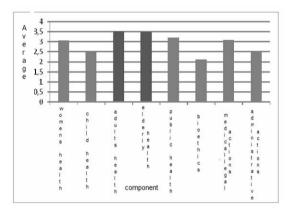|	Knowledge representation system			
Components	Map	conceptual graphs	Conceptual Mentefacto	frame
women's health	3,083333333	3,111111111	3,108695652	2,857142857
Child health	2,230769231	2,6	2,653846154	2,727272727
Adult´s health	3,210526316	3,75	3,833333333	3,255319149
Elderly health	3,818181818	2,8	3,833333333	3,481481481
Public health	3,4375	3,333333333	2,8	3,230769231
Bioethics	1,875	2	2,2	2,384615385
medical-legal actions	3	2,769230769	3,5	3
administrative actions	3	2,692307692	1,75	2,75
AVERAGE	2,956913837	2,881997863	2,959901059	2,960825104

Based on the data from the table 2 and the information provided by the figure 5 about knowledge representation systems: the implementation of mentefactos(2,959) and frames (2,96) allow higher levels of understanding, followed by the results of the students who implemented concept maps (2,957), conceptual graphs showed the lowest results (2,882). The use of concept maps as learning tools has positive results in researches conducted by Fonseca (2000) and Anez, Ferrer and Velazco (2007). There are works that evidence conceptual graphs implementation and their advantages in accordance with Caldero (2004), Montes and Gómez, Gelbuk, Lopez & Baeza (2001) who used graphs data mining. it is worth mentioning that those conceptual graphs did not have linking words which are present in the slots of concept maps and frames. On the contrary to the results of this research, in the thesis by Ibañez (2006) conceptual mentefactos are implemented as a pedagogical teaching strategy in health research, showing the advantages of this knowledge representation system. Rojas (2005) uses conceptual mentefactos to study the levels of geometric reasoning, according to Van Hiele, undergraduate students in preschool who studied with conceptual mentefactos showed the effectiveness in concept learning.

Figure 5 Average obtained by the students after study using knowledge representation systems.

It is important to highlight that the knowledge representation system in which students had the highest score were frames. The conceptual mente-

factos and frames have a higher requirement for grouping and structuring information, focusing on the consolidation of the concepts, the same requirement allows higher levels of conceptual evocation. Concept maps and conceptual graphs show lower levels of complexity and structure information, as Brachman and Leves (2004) state that frames are knowledge representation systems that are complex and are suitable to represent object-oriented programming.

Figure 6 Students' average according to the components of ECAES examination.

Taking into account the information given in the second part of **table 2,** where the averages of the components established by the ICFES (2008) are presented, and inferring Figure 6. It was found that in health issues of adult and elderly health scores were above the approving value (3.5), and the health of women, public health and medical-legal action value is exceeded 3.T ere is a concerning situation about child Health and Administrative actions, the results were above 2.5 and Bioethics which showed the lowest average. Bearing in mind these results, it concluded that these components of knowledge require more expertise and study. In the curriculum at the university there is just one course to study ethics, which was pertinent to the staff and academic bodies of the University within the medical career, in order to reconsider the curriculum and give more intensiveness of hours to the study of this subject..

Table 3 Summary of the results ANOVA test according to components in the ECAES examination.

Component	Average	F	Probability	Critical to F
Women' health	3,040070738	0,180231323	0,909545407	2,710646805
Child health	2,552972028	0,56390217	0,640265531	2,70940218
Adult's health	3,5122947	1,639960025	0,186104224	2,710646805
Elderly health	3,483249158	2,245757795	0,09591558	2,811543517
Public healh	3,200400641	0,467932798	0,705917345	2,782600438
Bioethics	2,114903846	0,877850538	0,458512234	2,779114361
Medical- legal actions	3,067307692	0,490085282	0,693302812	3,127350015
Administrative actions	2,548076923	0,67606679	0,577912453	3,159907598

In the ANOVA test (**Table 3**) all **F** value are less than the **critical F** value which justifies the significant differences between knowledge representation systems to study different components of the ECAES examination.

The following is a summary of the research data gathered by knowledge representation systems within each of the four experimental groups (assimilator, accommodator, diverger and converger)

With the data obtained in **Table 4,** it is found that the students who obtained the highest scores were converging. According to the features suggested by Kolb (1985) people who use this style performs better in tests involving a single concrete answer or solution to a question or problem, organize their knowledge so they solve problems using hypothetical deductive reasoning.

Table 4 Statistical summary: learning styles and knowledge representation systems.

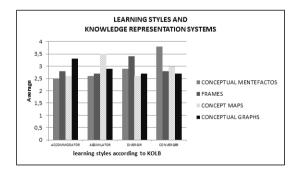| KNOWLEDGE REPRESSENTATION SYSTEM	LEARNING STYLE			
	ACCOMMODATOR	ASSIMILATOR	DIVERGER	CONVERGER
MENTEFACTOS	2,5	2,625	2,881270903	3,833333333
FRAMES	2,875	2,807692308	3,368400315	2,792207792
CONCEPT MAPS	2,657051282	3,514354067	2,65625	3
CONCEPTUAL GRAPHS	3,275	2,855555556	2,730769231	2,666666667
AVERAGE PER GROUP	2,826762821	2,950650483	2,909172612	3,073051948
	ACCOMMODATOR	ASSIMILATOR	DIVERGER	CONVERGER
F. obtained	1,846927847	2,914748686	8,224156235	2,383264039
Probability	0,097848437	0,008595028	4,89254E-09	0,034561946
F.critical	2,191626027	2,114255398	2,04573836	2,19533685

Converger and diverger students obtained higher average when they studied through mentefactos, assimilator students when used concept maps and accommodator students when they used conceptual graphs. (Table 4)

There is a significant effect in accommodator students. In addition, the group which had the lowest average belongs to the students who perform better on concrete experience (CE) and active experimentation (AE). Their strength lies in doing things and engages in new experiences. They tend to take more risks than people from the other three learning styles. It is called "accommodating" because they excel in situations where they have to adapt to specific immediate circumstances. They are pragmatic, and discard theories which are not coherent with the "facts".

From the data obtained in Table 4 and the information inferred from Figure 7 It can be asserted that assimilator students obtained higher scores when they used concept maps (= 3.5143) than they used conceptual mentefactos(= 2,625)

Accommodator students obtained higher scores using conceptual graphs, this result is significant because the value of F obtained (1,847) is less than F critical (2,191).

Figure 7 Learning styles and knowledge representation systems

CONCLUSIONS

To answer the research question posed, taking into account the knowledge representation systems and students' learning styles in the learning effect of the basic skills of medicine, through the experimental evidence observed during this research, it was found that:

Assimilator students achieved higher scores by using concept maps and the lower results with the use of conceptual mentefactos.

Diverger students achieved higher scores by using frames and the lower results with the use of concept maps.

Converger students achieved higher scores by using conceptual mentefactos and the lower results with the use of conceptual graphs

Accommodator students achieved higher scores by using conceptual graphs, although these scores were not meaningful

The knowledge representation system that achieved the best results in the tests type ECAES were frames, followed by mentefactos, concept maps and lastly conceptual graphs. The difference was meaningful as F obt. was higher than F crit.

these results are in keeping with the research of Burgos (2006) in which it is stated that the node structure of frames is much richer than in traditional frames, enabling procedures and methods to retrieve, complete and link information.

According to Sowa (1984) it can be inferred that the poor results achieved by the students using conceptual graphs were due to the high levels of conceptual knowledge to its understanding as these are systems of logic oriented to the representation of the semantics of natural language. Besides the do not have linking words as in the concept maps and grids or slots of the frames and the conceptual operations supraordinación, isoordinación, subordinacion and exclusion using in conceptual mentefactos.

Converger students achieved the highest scores, which is in line with the approach of Kolb (1985), who perform best in tests involving a single concrete answer or solution to a question or problem. Accommodator Students had the lowest scores who take a practical, experiential approach and are better suited to specific, immediate and practical circumstances.

Based on the eight components of ECAES examination; the results of the following components "Child Health", "Administrative Actions" and "Bioethics" had the lowest scores, still below the value to pass the test. This implies the need to take corrective action in the university to improve the scores of students to submit ECAES examinations.

This type of research will provide useful feedback for teachers to generate confident connections between domains of knowledge and students, taking into account their particular features to strengthen their skills and coping with the constraints in each learning style.

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