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Virtual course based on conceptual maps and autonomous work

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Article Info

Abstract

The computerization of university processes prioritizes the implementation of virtual courses in which the use of learning resources that do not repeat the face-to-face procedure is stimulated. The objective of the study is to describe the virtual course developed for the Infotechnology subject, based on the use of concept maps and autonomous work activities. The study shows a quantitative approach, with a descriptive non-experimental design. Through a survey, with a Likert-type scale, the opinion of the students on the usefulness and didactic value of the virtual course, the usefulness of concept maps to organize and present information, self-assess learning and stimulate autonomous learning were measured. The data were processed using Jamovi version 1.6. The results show the adaptation of the face-to-face Infotechnology course to a virtual teaching and learning environment, which was organized into 20 topics, made up of activities based on a conceptual map that organizes and presents the information to the student, a guide for work. Autonomous and self-assessment learning activities; For the communication of what has been learned, the student relies on PowerPoint presentations, algorithms, texts, videos and concept maps. The evaluations of those involved conclude that courses with this design achieve a teaching and learning dynamic adjusted to virtuality and favor the development of skills for autonomous learning.

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Introduction

Virtual education, seen as a consequence of the evolution of distance education and the irruption of information and communication technologies, broadens the possibilities of training for working people, pregnant women, migrants and displaced persons (Salcedo et al., 2021). Universities in Spain, Chile, the United Kingdom, the United States, Canada and Mexico regularly advertise virtual or semi-face-to-face programs (Salgado, 2015).

It is then necessary to reflect on the changes that must be introduced in university educational models, for example: the adaptation of curricular plans and specific didactics for virtual education, as well as criteria for the selection and design of virtual resources and a evaluation proposal for remote education (Salcedo et al., 2021).

An element to take into account in virtual teaching and learning is the use of media to represent and organize information; in this sense, several authors Matzumura et al. (2018); Galván and Gutiérrez (2018); Olivo (2021) refer to the use of conceptual maps for such purposes.

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On the other hand, the subject of autonomy, considered as the personal attitude and procedure to learn and achieve the objectives; constituted "in one of the neuralgic points of modernity" (Swatevacharkul & Boonma, 2020) as well as, the subject of autonomous work, a teaching and learning activity in which teachers and students are involved to meet curricular objectives (Ríos et al., 2021) are applicable in the development of virtual courses, if it is taken into account that learning can only be effective when it becomes conscious by the individual.

In this context, the University of Sancti Spíritus "José Martí Pérez" works on the virtualization of all its processes, paying special attention to the teaching and learning process. This has given rise to the need to adapt face-to-face courses to virtuality.

Particularly, when implementing the virtual course of the Infotechnology subject, concept maps were used to organize and present the information that is to be brought to students, as well as a means for them to show their results. In the same way, activities aimed at promoting self-employment were included. This brought with it the need to study several aspects, including how students perceived and adapted to the dynamics of autonomous learning and how the use of concept maps was influencing their ability to organize and synthesize content.

At the same time, it was interesting to know how autonomous work activities promote the development of independent study skills, self-regulation and self-discipline in students, especially in a virtual environment, as well as the teacher's ability to encourage active participation of students in a non-face-to-face environment.

In the same way, it was important to identify the difficulties that students could present in the elaboration and understanding of concept maps and how the technological infrastructure and the accessibility to virtual resources affected the learning experience of the students.

This article describes a virtual course adapted for the Infotechnology subject based on the use of concept maps and autonomous work activities and its didactic value based on the criteria of the participating students, as a step prior to the socialization of other results.

Literature Review

Principles of Virtual Education

Distance Education (DE) was defined as a planned option in which the pedagogical-didactic processes are mediated by distance communication supports, formats and languages. Among the essential components of any DE proposal, the planning of distance educational action, the tutorial model, the design of specific educational materials, the evaluation processes and the administrative management system stand out. Within DE, the modality referring to the use of ICT for a learning purpose is called e-learning (Russo et al., 2022).

An important element to proceed successfully in virtual education is to know the principles that support it, an issue that has been addressed by several authors. García (2016) refers to individualization, socialization and interaction, autonomy and independence, and creativity. For his part, Cortés (2011) adds the constant relationship between student and teacher, interaction between students, active learning, quick feedback, appropriate use of time, respect for the diverse learning styles and the setting of clear, achievable and measurable objectives.

On the other hand, Eyzaguirre et al. (2004) points out other principles such as self-education, self-training, deterritorialization, decentralization, virtualization, technologization, and virtual sociability. In the same way Gallo et al. (2022) states that virtual education must be flexible, open and ubiquitous

Generalities about Conceptual Maps and Autonomous Learning

Conceptual maps, according to (Novak , 1998) are a tool for the non-linear graphical representation of a specific domain of knowledge, through the set of concepts that make it up and relate it. They help to visually recognize the most important concepts of the subject, the relationships established between them, their form of hierarchical organization, and allow us to build a mental image of the information we are processing (Galván & Gutiérrez, 2018).

Conceptual maps use graph theory, nodes and links as an epistemological basis. The exercise of its preparation encourages reflection, analysis, synthesis, creativity, among other cognitive and procedural skills, as it is a tool for association, interrelation, discrimination, description and exemplification of content, with a high visualization power (Maraza & Zevallos, 2022). At the same time, they are considered tools for ordering concepts by categories or typology (Gutiérrez et al., 2009).

According to Abizu and Fondón (2017), the application of conceptual maps can be justified from two perspectives, that of the students and that of the teacher. The first is oriented towards learning, since it allows them to develop skills to discover the relationships between concepts; and favors analysis and group work, strengthening cooperative learning. The second is oriented towards teaching, since it helps to organize and represent the materials of the subjects

to be taught in the academic year; and it is useful in the evaluation process of students, both individually and in groups (Novejarque & Pisá, 2017).

Conceptual maps are also instruments to assess learning and cognitive development (Correia et al., 2010), allowing to determine the degree to which the objectives of educational importance are being achieved (Galván & Gutiérrez, 2018).

It coincides with Artini et al. (2022) when they highlight that teachers' awareness of the concept of student autonomy is important to help students become more autonomous, although the formers still need preparation and awareness also about their needs. Autonomy is a natural condition of being human; however, we do not realize that personal growth depends largely on how autonomous we are and the skills we can develop.

The term autonomy in learning is defined by several researchers, one of its pioneers was Holec (1981), who associates it with an individual capacity; Nunan (1997) relates it to the students' ability to take charge of their own learning, in its relationship with the individual decision to make decisions about the management and organization of learning. On the other hand, Rivers (2018) associates it with skill and with the active and independent management of learning, in which the learner establishes and controls the form, procedure and content to be learned.

For Tran and Duong (2020) students' autonomy can be understood as "self-management that involves the decision-making skills that a students must possess." To which Scharle and Szabó (2000) add that to promote it, it is necessary to develop a sense of responsibility and encourage students to make decisions about their learning.

It is then assumed, according to Román et al. (2018); Fernández et al. (2021) that autonomy is closely linked to the development of skills, both cognitive and procedural. The first is associated to the development of the intellect, that is, thinking, analyzing, storing, organizing ideas, expressing oneself, formulating answers, modeling, among others (Frías et al., 2017; Laya, 2009; Macías, 2017; Ortíz, 2010; Ramírez, 2014; Reed, 2007)

and the second, by proceeding to achieve the first, that is, the management, processing, implementation and communication of knowledge (Román et al., 2018).

Taking into consideration the aspects analyzed above and the premise that autonomous students are responsible, not only for decision making in their learning, but also for the implementation of their decisions (Dickinson, 1987; Nunan, 1997), we proceeded to the implementation of the virtual course on Infotechnology.

Methodology

The study was developed under a quantitative methodological approach, with a descriptive non-experimental design, following the following steps: (1) Structuring of the course content by topic in relation to the objectives to be achieved; (2) Preparation of concept maps and guides for autonomous learning; (3) Design of evaluation activities; (4) Selection and elaboration of complementary materials; (5) Creation of the course on the MOODLE platform; (6) Development of the course; (7) Application of the instrument to know the opinion of the students; and (8) Processing, analysis and conclusion on the data obtained.

The evaluations of the students on the development of the virtual course were collected through a survey consisting of 10 questions. Students had to indicate their degree of agreement or disagreement with the proposed statements using a 5-point Likert scale. The charactetristics of the subjects who participate in the study, are shown in Table 1.

The course will be evaluated taking into account the criteria and criterion actions that appear in Table 2.

Table 1 Characteristics of the student beginners in the study

Students beginners in the study	Average age	Sex Female	Sex Male	Total
3rd year	21	5	5	10
5th year	23	6	9	15

Table 2 Criterion actions

Criteria	Criterion actions
Overall conception	Content distribution; objectives to be achieved for each content; use of guides for autonomous work that relate concept maps to practical activities; evaluation through the development of computer resources.
Methodological utility of conceptual maps	Form of representation of the information; form of organization of information and way to evaluate the knowledge acquired
Ability of autonomous work	Identification of new sources of knowledge to reinforce learning; systematic reading of learning material; modeling of learning content; summary of ideas; synthesis of content and passive listening of what is oriented
Personal and professional growing	Autonomous information management; teacher teaching and content reinforcement through study activities; autonomous preparation by motivation and personal effort; and study of bibliographic material through autonomous work guides

The administration of the questionnaire was carried out through the MOODLE platform and the Whatsapp group. In both cases, the teacher used audio recordings to communicate and answer the students' questions; emphasis was placed on the need for a sincere and conscious response by the students. The data obtained were processed using the statistical package Jamovi version 1.6. The ordinal qualitative variables were characterized by means of the arithmetic meaning, median, standard deviation, percentage calculations and frequency tables.

Results

Description of the Virtual Course

For the implementation of the course, the interactive MOODLE platform was used and it was organized as shown in Figure 1. The dynamic followed (Figure 1) begins with the revision of the conceptual map by the students for their familiarization with the content to be learned; then they interact with the guides of autonomous work that orient them towards the objective to be achieved, for which it proposes learning activities that complement the information that, in a schematic way, they have appreciated in the conceptual map; finally, they access to the corresponding self-assessment task.

The dynamics of work and exchange with the virtual course is based on guides and learning tasks based on the elaboration and understanding of the content guided by the teacher through conceptual maps (Figure 2).

The learning activities of the guides and the tasks to be carried out are classified into some of the following types:

Type 1 activities. Focused on conceptual maps: readings across the concept map, in-depth readings of the conceptual map (Figure 3), analysis of the hierarchical organization of the conceptual map, determination of generalization and relationships between concepts, determination of specification and relationships between concepts, analysis of the relationship of the parts with the whole and vice versa, writing sentences, paragraphs and summaries derived from the previous actions.

Type 2 activities. Focused on the achievement of autonomous learning oriented to search for information: internet search to delve into each of the concepts of the maps, search in complementary materials provided by the teacher, construction of summaries with the essential ideas learned, graphic modeling of the learned content and preparation of initial conceptual maps.

Type 3 activities. Focused on the achievement of autonomous learning oriented to the organization and

presentation of the knowledge acquired: preparation of conceptual maps construction of Power Point presentations, preparation of explanatory videos, writing explanatory texts and construction of algorithms.
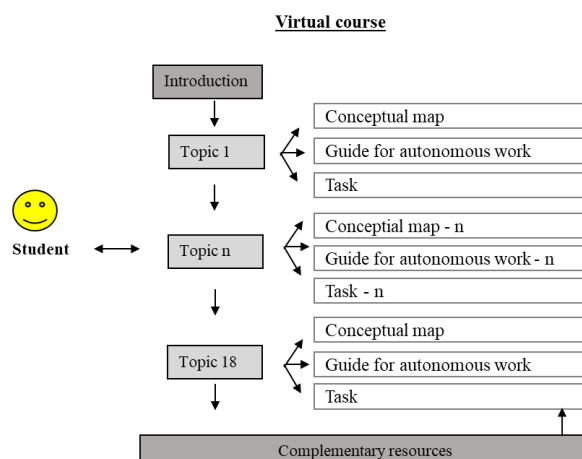

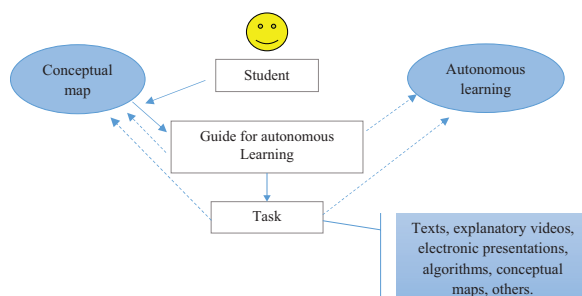**Figure 1** General structure of the course

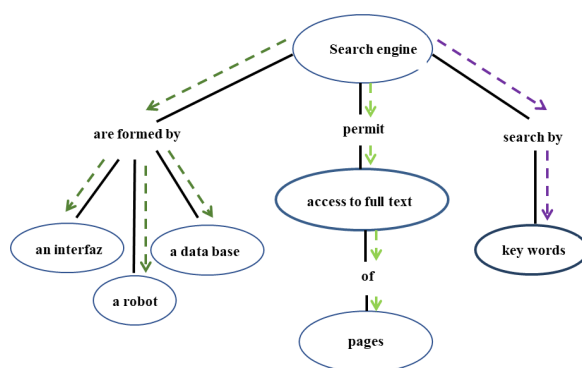**Figure 2** General dynamics of student-course interaction.

Figure 3 In-depth tour of the conceptual map.

Course Evaluation

For the analysis of the results, the 3rd and 5th year students were studied separately, then the results were analyzed in a general way (Tables 3 and Table 4).

Table 3 Opinion of 3rd year students about the virtual course.

Variables	Median	Mode	DT	5	4	3	2	1
Third year				MA%	A%	IND%	I%	MI%
Content distribution	4.7	5	0,5	70	30	0	0	0
Guides for independent work	4.9	5	0,3	90	10	0	0	0
Knowledge of the objectives to achieve	4.4	4	0,5	40	60	0	0	0
Necessity to elaborate videos, conceptual maps, electronic presentations, texts, algorithms as resources for the evaluation	4.6	5	0,5	60	40	0	0	0
Conceptual maps to present the information	4.5	4	0,5	50	50	0	0	0
Conceptual maps to organize the information	4.4	4	0,5	40	60	0	0	0
Need to search information	4.6	5	0,5	60	40	0	0	0
Final assessment of the experience	4.4	5	0,7	50	40	10	0	0

Note: MA = very suitable; A = adequate; IND = indifferent; I = inadequate; MI = very inappropriate.

Table 4 Opinion of the 5th grade students about the virtual course

Variables	Median	Mode	DT	5	4	3	2	1
5th grade				MA%	A%	IND%	I%	MI%
Content distribution	4.5	5	0,5	53	47	0	0	0
Guides for independent work	4.7	5	0,5	73,3	26,7	0	0	0
Knowledge of the objectives to achieve	4.4	4	0,5	40	60	0	0	0
Necessity to elaborate videos, conceptual maps, electronic presentations, texts, algorithms as resources for the evaluation	4.8	5	0,4	80	20	0	0	0
Conceptual maps to present the information	4.9	5	0,3	86,7	13,3	0	0	0
Conceptual maps to organize the information	4.9	5	0,3	86,7	13,3	0	0	0
Need to search information	4.8	5	0,4	80	20	0	0	0
Final assessment of the experience	4.0	4	0,2	6,7	93,3	0	0	0

Note: MA = very suitable; A = adequate; IND = indifferent; I = inadequate; MI = very inappropriate.

On the distribution of the contents of the virtual course, 100 percent of the students of both years gave values between 5 and 4, with 5 being the most repeated one, which indicates that the general opinion is favorable, that same value was given to the usefulness of the guides for independent work. The average of the values given by the 3rd year students to the role played by them in the development of the course is 4.9, while the 5th year is 4.7, which indicates that they were very adequate.

The possibility of knowing the objectives to be achieved in each topic and, therefore, of being able to control compliance, was not assessed by any student as inadequate (there are no ratings of 3, 2 or 1). To the extent that students understand and share learning goals, they can self-assess their progress and the performance of their peers to support and provide feedback.

The need to develop videos, conceptual maps, PowerPoint presentations, texts and algorithms to evaluate what has been learned was also not evaluated as inadequate by any respondent. It received scores of very adequate and adequate by 60 and 40 percent of the 3rd year students and 80 and 20 percent of the 5th year students, respectively.

Conceptual maps are a method of graphic representation of information, which positively affects the rate of success in the students' academic results, since they reduce the problems of information overload and improve conceptual

disorientation in learning (Chen et al., 2008). Assuming this criterion, the questions about their use in courses where attendance is null are analyzed. When compiling the evaluation given to this technique as a way to present information by 3rd year students, an average equal to 4.5 was obtained, since 50 percent marked the box corresponding to very adequate and the other 50 percent marked the box corresponding to adequate, while the answers of the 5th year averaged 4.9 from which 86.7 percent gave a rating of Very adequate and 13.3 percent of adequate.

In the question related to conceptual maps as a resource to organize information, 40 percent of 3rd year students considered it very appropriate while the remaining 60 percent considered it adequate. In the case of the 5th year, the same results were obtained as in the previous question.

The need to search for information in scientific journals, indexed databases, official sites or in the folder of supplementary learning materials, received scores averaging 4.6 and 4.8, respectively, indicating that it was appropriate or very appropriate for most students.

Likewise, in a general evaluation of the attitude of each person surveyed towards the course, it turned out that there were no scores for inadequate or very inadequate, 10 percent of the 3rd year is neither adequate nor inadequate, 40 percent adequate nor 50 percent very suitable, while 6.7 percent of the 5th year in very adequate and 93.3 percent in adequate.

The remaining two questions are related to autonomous learning (Figure 4); the percentage of students, from both academic years, whose acknowledge having developed some of the skills for this type of learning during the development of the virtual course. These data were obtained from the responses to question 8 of the questionnaire.

Question 9 of the questionnaire focuses on delving into the skills that led to autonomous learning (Figure 5) in the achievements of the students.
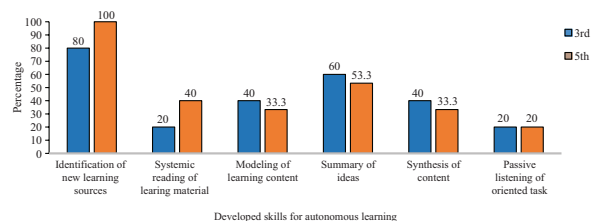
Figure 4 Percentage of students whose knowledge having developed skills for autonomous learning.
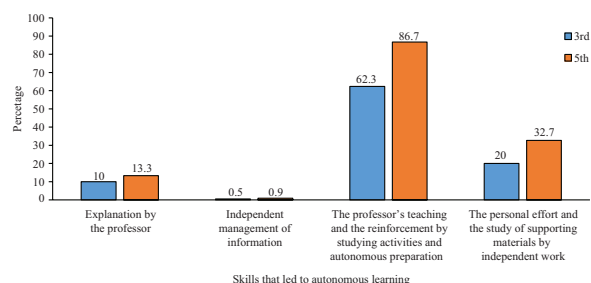
Figure 5 Skills that contributed to autonomous learning.

In order to know the respondents' preference for the various forms used to communicate the acquired knowledge, a subsection was placed to question 4. Tables 5, 6, 7 and 8 show the order that was given to each resource. The score received by the conceptual maps stands out in this analysis, since it agrees with Parrales and Solórzano (2014) when they state that this type of strategy favors the integration of the different contents, and with Pottier et al., (2010) when they assure that it is of a valuable tool that enables a type of structural evaluation focused on the appearance of the map and its links.

Finally, the median comparison test for independent samples (Mann-Whitney U test) was applied, which showed that there are no significant differences between the median of the 3rd and 5th grade groups in the different variables evaluated.

Table 5 Videos

Order	Third year		Fifth year	
	Frequency	%	Frequency	%
1	1	10,0	3	20,0
2	2	20,0	2	13,3
3	1	10,0	2	13,3
4	1	10,0	4	26,7
5	2	20,0	3	20,0
6	3	30,0	1	6,7
Total	10	100,0	15	100,0

Table 6 Conceptual maps

Order	Third year		Fifth year	
	Frequency	%	Frequency	%
1	5	50,0	11	73,3
2	2	20,0	2	13,3
3	3	30,0	1	6,7
4	0	0,0	1	6,7
5	0	0,0	0	0,0
6	0	0,0	0	0,0
Total	10	100,0	15	100,0

Table 7 Power point presentations

Order	Third year		Fifth year	
	Frequency	%	Frequency	%
1	3	30,0	1	6,7
2	2	20,0	3	20,0
3	3	30,0	6	40,0
4	1	10,0	5	33,3
5	1	10,0	0	0,0
6	0	0,0	0	0,0
Total	10	100,0	15	100,0

Table 8 Algorithms

Order	Third year		Fifth year	
	Frequency	%	Frequency	%
1	0	0,0	0	0,0
2	2	20,0	7	46,7
3	3	30,0	3	20,0
4	2	20,0	2	13,3
5	2	20,0	3	20,0
6	1	10,0	0	0,0
Total	10	100,0	15	100,0

Discussion

The study carried out provides a novel architecture for virtual courses, which fosters a dynamic in which the student is the protagonist of their learning and develops skills that will allow them to perform autonomously in the new educational and professional scenarios. At the same time, they interact with a schematic summary of the content to be learned, which facilitates the inclusion of new concepts and the relationship with previous ideas. Coinciding with Villalustre and del Moral-Pérez (2010), it is considered that training activities that use graphic organizers, conceptual maps, timelines, etc. They constitute some interesting tools that not only facilitate the understanding and assimilation of the contents for students, but also the creation of meanings.

The growing importance of alternative instructional designs, higher order cognitive achievement, and the use of new technologies in university education entails the need to develop alternative assessment methods (Henao, 2002). In this sense, the study reveals the order of preference of the students on the various resources used in this important stage of the virtual teaching-learning process, which elaboration requires different levels of assimilation; however, it is recognized that it is necessary to achieve a transformation of the students' thinking towards a more autonomous work that depends on their own skills to manage learning (Artini et al., 2022).

Under the philosophy that the distance university is more than learning from distance (Indova et al., 2015), in new versions of the course, the conceptual maps prepared by the teacher could be migrated to hypermedia conceptual maps. Authors such as Crocco et al. (2011); Campbell (2022), suggest this type of maps to present and organize information, supported by the fact that they maintain all the educational richness of Novak's conceptual maps, enhanced with the benefits provided by hypermedia technology Señas and Moroni (2005). In addition, its use is valid in the teaching of any discipline Campbell (2022).

It would also be interesting to evaluate the quality of the concept maps prepared by both the teacher and the students. In this sense Marcano (2020) proposes a rubric as an instrument for this purpose.

On the other hand, following Taberneiro (2009), in an academic environment of collaboration and reflection, the evaluation of the performance and progress of the students is not only the responsibility of the teacher, an issue that must be internalized by the students and in that it is necessary to continue working because the observation of their behavior revealed deficiencies in this sense.

Conclusion and Recommendation

1. The implementation of an innovative architecture in virtual courses, focused on autonomous learning and self-assessment, gives students the opportunity to become active protagonists in their training process. This approach promotes the development of skills that will allow them to function independently in constantly evolving educational and professional contexts.

2. The training activities that use concept maps are valuable for the understanding and assimilation of the content, which highlights the importance of developing alternative evaluation methods in university education, especially in virtual environments. It is essential to promote the transformation of the student's thinking towards a more autonomous training based on skills to manage learning.

3. It is suggested to migrate the elaborated concept maps to hypermedia formats, taking advantage of the benefits that technology can offer to enrich the educational experience. In this sense, it would be relevant to evaluate the quality of the concept maps of both the teacher and the students. The implementation of a rubric could be a useful instrument in this sense, promoting collaboration and reflection between teachers and students. With a view to improving the course, it is recommended to delve into the relationship between the use of concept maps and the development of autonomous work skills.

Conflict of Interest

The authors declare that there is no conflict of interest.

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