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Structured Cabling Development in 3D Virtual Learning Environment en OpenSim

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Abstract

Virtual Learning Environments in 3 Dimensions can be considered a valuable tool in Education, especially in this context of Virtual Education due to the COVID-19 Pandemic, which is why after determining some problems related to this type of platform. That is why the present investigation has been guided under the Design Science Research Methodology, where the investigation has to go through the 6 phases iteratively: Identification of the problem, Design, Development, Demonstration, Evaluation, and Communication of the results. , that is why the present platform developed in OpenSim has been used for the construction of the present virtual world. The results have been evaluated using the Technologies Acceptance Model methodology. Finally, it can be determined that the results indicate that this type of platform can be considered by students as a useful tool and also that there is no greater resistance to its use due to its ease of use.

Keywords: Virtual Learning Environments, Educational Platform, Virtual Worlds, OpenSim Platform, Learning Analytics.

1. Introduction

Virtual Learning Environments have achieved a relevance in education, since they are considered as a natural and common form of virtual environments [1], which is why they are currently considered as an alternative tool to what is considered as traditional education [2], and also, valid mainly for 2 reasons: the first because it promotes and improves communication among the participants of the process and the second because it provides tools to somehow supervise, monitor and determine conditions within the activities that frame the learning process [3].

Although they can be considered as an innovative tool due to the characteristics with which it is presented, problems can be determined in practice such as: problems related to what happens insideor the virtual environment at the time of identifying conflictive behavior of the participants [4]–[6], lack of a real follow-up in the interactions of users with the virtual world [3], [7] , absence of indicators to determine the degree of evolution of students in each virtual course [8], absence of well-defined evaluation parameters [8], difficulty in evaluating contributions while students develop tasks [9], difficulty in keeping students motivated and engaged[10], by teachers excessive time spent searching for signs of doubt, stress or fatigue in students [11], pedagogical problems that are inherent to the traditional educational process [12], [13], absence of tutors with expertise to induce students in the learning process [14], [15], these are some of those for which it should be attacked in a personalized way.

To solve these problems, you must have indicators through which you can measure the degree of failure in each feature and make technical decisions at each operational level. These decisions should be informed and based on the correctness of the different options determined [16]. That is why we will rely on Learning Analytics that will contribute to the resolution of some of the problems mentioned in the previous paragraph. Punctually Learning Analytics refers to the measurement, collection, analysis and reporting of the

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data of the participants of the learning process in the virtual world [17], [18], applied to our virtual learning environment, learning analytics establishes the analysis of data on tutors and students who use the environment to identify patterns of behavior that allows evaluating the learning process, It will improve the aspects related to the learning experience and will give us an option to use this feedback information to improve the experience of both students and tutors in the development of courses in virtual mode in three dimensions. In addition, these indicators should allow pedagogical administrators to see from a new perspective, reduce blind spots and assimilate complex data structures on the problems of future courses that can be offered from a virtual learning environment.

These indicators will help us understand what happens within a virtual learning environment in 3 dimensions and how they can help us with the design of courses where the problems that have been described cannot be repeated but also in the impact to achieve the learning objectives, these indicators will give us an idea of how healthy an experience in a virtual learning platform [3], [6], [10]

In addition, the methodology for research known as Design Science (DSR) [19] will be used for the present work, where basically 3 objectives must be achieved: (1) to provide a nominal process that conducts RSD research, (2) to build on the foundations of previous literature in RSD and Information Systems (IS), and (3) to provide researchers with a mental model to structure and present the results of the research, with the purpose that both tutors and students can adapt a simulation so similar to the real world (Saracevic, 2014).

In relation to the OpenSimulator platform or also known as OpenSim is oriented to the design and development of virtual worlds such as Second Life, the cual has been widely disseminated[20] and distributed by Linden Inc. laboratories. It can be used from several perspectives, in this specific case that of the tutor and that of the students [21] , who will be more useful because it will help them enhance their skills and abilities, in addition to the development of different types of strategies and apply them in each scenario that presents it in the resolution of problems [22].

2. Related Works

Different jobs can be determined that help us determine through parameters to establish a baseline to attack problems and find solutions for virtual learning environments.

In the work [4], a framework is proposed for the collection and analysis of data related to virtual learning environments, applied to a virtual pharmaceutical laboratory called Usalpharma Lab, whoseis implemented in Second Life. The objective of this case study is to acquire the skills to develop what is known as 'Good Laboratory Practices', where students and tutors have their respective avatars. The tutor is in charge of guiding the practice to the students, then the students will have to replicate according to the indications of the tutor through the proposed tasks and activities, where the interactions are stored in the databases. This stored data is deployed through the following layers: (1) the 'evidence description layer' collects evidence of interactions between the student and objects in the virtual world, (2) the 'collection layer' which focuses on processing the data in the evidence description layer, (3) the 'storage layer' which is the layer responsible for storing the processed data in the collection layer, (4) the 'analysis layer' where the information stored in the database is analyzed, through statistical procedures and data mining methods, and finally (5) the 'presentation layer' that is responsible for presenting the information to users and other applications that are integrated with the presentation. You architecture. The most important feature of the vision of this work is to place the learner at the center of the architecture from the initial interactions where the data that is generated is processed through the 5 layers described.

On the other hand, in the work [23], a recognition and identification of the patterns of behavior in the virtual world by the students is carried out, with the purpose of avoiding or reducing dropout in these virtual learning environments. In addition, after finishing a class in the virtual world, participants evaluate the acceptance and relevance of the virtual world through surveys previously determined for each type of user, which will lead to determine actions to prevent students from dropping out, but also, will contribute to continuous improvement for the adoption and expansion of the use of virtual worlds. The aspects that are raised to determine acceptance by student users are (1) the versatility of interaction with other users available through the virtual world using available tools such as avatar gestures, text chat and audio chat, and (2) the freedom to move around the virtual world.

On the other hand, in the work [24], the authors present a model of prediction of movements by the avatars of students in the virtual world, using this model, it is possible to predict the behavior of students. The authors focus the processing of data through the log files of the errors made by the students within the proposed activities, once the practice concludes. Each defined clúster is called an avatar, which will be used to classify students through different typologies. The authors call it a Predictor of student behavior, the cual focuses its attention on predicting future movements based on previous movements.

Another aspect to take into account is the evolution of tools to abstract virtualization from traditional learning to virtual learning, this is described by the authors in the work [25], where they determine the opportunities that software developers who specialize in design and development can have to virtualize learning environments aimed at higher education. .

In research [26], they promote useful tools to reduce student dropout on these types of platforms. In addition, they focus their attention on the development of skills and abilities by students through virtual training, which allows on the other hand to obtain predictions about the behavior and attitudes that the student-type user can adopt when faced with specific activities, content or even evaluations.

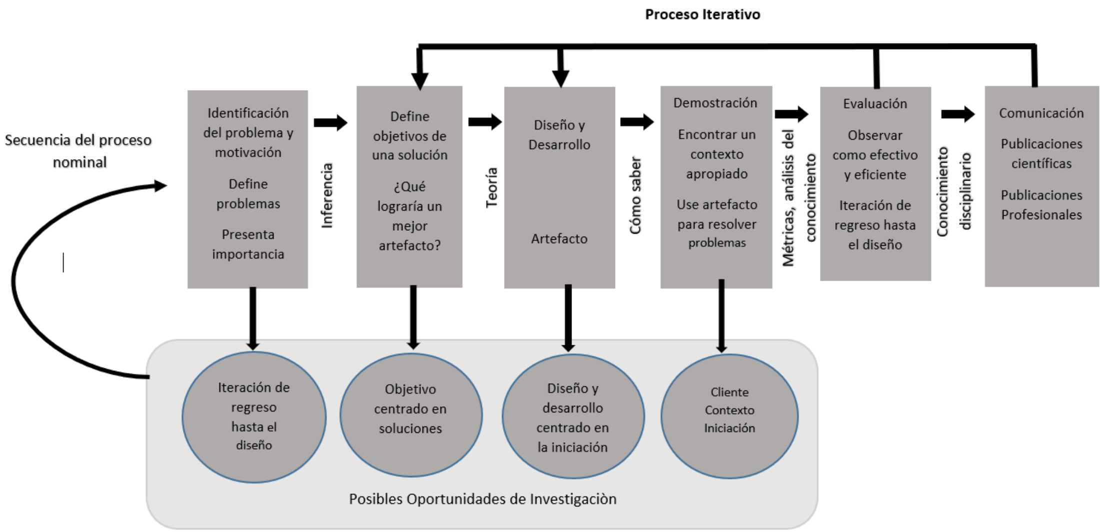

Figure 1. Design Science Research Methodology

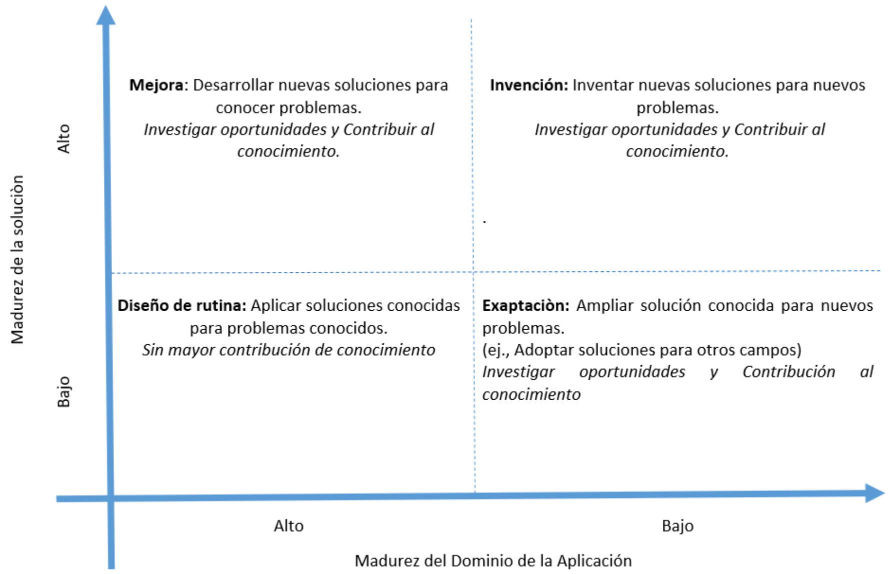

Figure 2. DSR Knowledge Contribution Quadrants

3. Methodology

The present research, is developed under the methodology called Design Science Research or Design Science developed by [19], where it presents a six-phase structure (Figure 1.) determined as follows: (1) the first phase called Motivation and Identification of the Problem, it is required to describe in detail the identification of the problem in addition to justifying the value of the solution, (2) the second phase where must answer the question How should the problem be solved?, (3) The third phase corresponds to the creation of an artifact to solve the problem, (4) In the fourth phase the artifact must be used developed in the previous phase to collect the necessary data to determine if the solution is valid to solve the problem, (5) in the fifth phase we proceed to evaluate the artifact generally answering the question How well does the artifact work?, by andl which collects and processes the information necessary to determine whether the solution to the problems is found, and finally (6) the sixth phase called Communication where aspects related to the problem, solution, usefulness, innovation and effectiveness of the solution must be communicated to other researchers and audience that has relevancshe in the actors involved.

It also serves especially to identify and locate in one of the quadrants in Figure 2., having as in the vertical axis the maturity of the solution as limit values, from the Low value to the High value and on the horizontal axis the maturity of the Application domain with the same limit values [27],

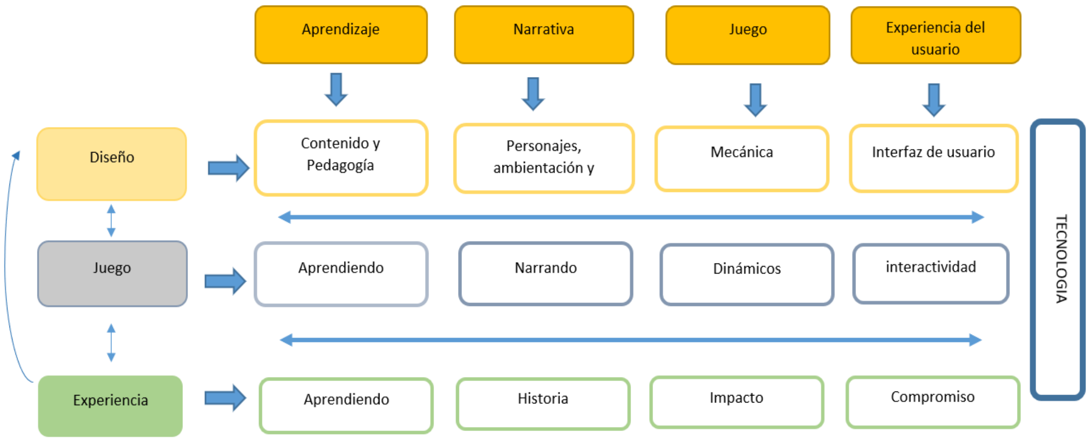

Figure 3. *Design Science Research Methodology*

where we must identify if our research is considered as (1) Improvement: which consists of the development of new solutions for known problems, (2) Invention: where invents new solutions for new problems, (3) Exaptation: the extent of known solutions for solving new problems is determined, and finally (4) Routine Design: for the application of known solutions for known problems.

This case study is designed under the Design Play Experience framework [28], which contains as a fundamental characteristic its wide diffusion in the design and development of serious games such as our case study of Virtual Learning Environment, this framework found in Figure 3., presents a structure of the process in a formal way as a methodology oriented to the design and development in 4 phases called Learning, Narrative, Game and User Experience, through 3 layers: Design, Game and Experience.

3.1. Learning

In this phase the contents and the pedagogy that will contain the Virtual Learning Environment is decided, it is here where the content designers must determine what content they want to transmit through the platform to the students

3.2. Narrative

In this phase, two perspectives are clearly defined: the perspective of the story designer and that of the player. In the first perspective, it focuses its attention on the narrative of the game, that is, what phases, activities and tasks the player will have to fulfill to acquire knowledge through the development of skills and abilities through the avatar.

The other perspective refers to the interaction of the player with the other objects designed and present in the virtual platform, where depending on the degree of development of skills and abilities, the degree of certainty in the fulfillment of the activities and tasks proposed will be determined.

3.3. Gameplay

This phase determines what the player does within the game, or in our case of the platform, here 3 subphases called mechanics, dynamics and effects are defined, of which it is presented below:

3.3.1. Mechanics

The activities to be executed by the avatars of the students are defined, the different challenges or objectives to be achieved will be imposed in this subphase

3.3.2. Dynamics

They are basically the results of the activities carried out and proposed through the previous subphase, through the interaction of the students with the objects within the virtual platform.

3.3.3. Effects

It consists of the perception by users while they are on the platform observing, navigating and even interacting with the other users and objects of the platform.

3.4. User Experience

It is the layer where the user will navigate, in other words, it is what the user can perceive, it is where the game will be tested, where the main challenge for the designer is that the game is trained with an interface that allows tutors and content designers to transmit the desired content through an adequate interface that is attractive to users. For this, the limits must be taken into consideration so that it does not become an activity too easy for the user to feel bored or on the other limit where it becomes an excessivelyeasy activity, which on the contrary produces in the user the feeling of frustration.

In addition to the methodology used for the design and narrative within the virtual learning platform, in the phase corresponding to evaluation within the main methodology used not only in this work, but throughout the research, it will be done using the metordology Technologies Acceptance Model TAM [29], This theory is disseminated in the research area of Information Systems where it helps us understand how users use and accept technology, in our case the virtual world of learning. TAM suggests that users when using a new technology where several factors can influence their decisions based on How? and When? they will use it due to 2 factors [30], (1) Perceived Utility (PU) where the author defines it as 'the degree to which the person believes that using a specific system would improve their performance and productivity within work', projected in another way, whether or not someone perceives that technology is useful to do what they want to do, and (2) Perceived Ease of Use which is defined as 'the degree to which a person believes that using a specific system would be effort-free', this concept tries to explain if the technology is easy to use, then the initial barrier to using a new technology has been overcome. , on the contrary, if this system does not present an interface where it is difficult for a user to use, then he would unconsciously have a negative attitude to use it.

Figure 4. OpenSim Platform Starter Page

4. Case Study: Development and Implementation of an Artifact

According to DSR methodology [31] that guides this research, the creation or development of an artifact is required, the artifact consists of the development of a platform based on OpenSimulator, which, represents the physical infrastructure to scale of the Faculty of Systems of the National Polytechnic School located in the city of Quito(Ecuador). This device consists of being designed in such a way that at the first level the tutor can determine the minimum standards that must be used in the subject Structured Cabling taught both in the Faculty of Systems and in the Faculty of Electrical and Electronics, this artifact, is designed and developed GISuGoing the phases and layers of the DPE framework[28].

In Figure 4. , you can see the home page, where users can register prior to entering the OpenSim platform, the user must enter the site available at the following url: http://144.126.149.213:8002/wifi/, when entering you can create a user account and then the user need to have a browser for virtual worlds, among the most recommended are Singularity Viewer since version 1925.

4.1. Learning

For the development within this phase, it begins with the knowledge that you want to transmit in the virtual world, the theme of Structured Cabling has been selected because it can be determined through the proposed activities, if the student can correctly apply the knowledge taught by the tutor, that is why there are certain basic aspects of structured cabling such as:

- The player cannot extend a connection for a distance greater than 100 meters.
- The student's avatar must establish a minimum distance of 353 cm between any structured data wiring and electrical wiring throughout the faculty building.
- Curvatures of closed degrees less than 90 ° should be avoided to obviously take care of data cable material

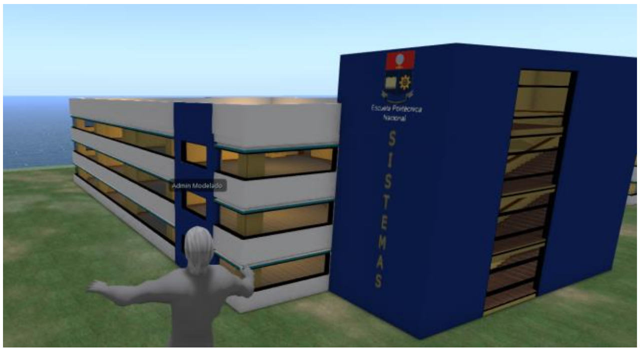

Figure 5. Virtual Learning Environment based on the OpenSim Platform

In addition, the player has objects to which he can access an inventory system, where the necessary components are found so that the student can perform the activities proposed through the platform, it should be emphasized that an analysis of the structured cabling model obtained at the end of the practice can be carried out taking into account the standards determined by the Wiring. Structured.

4.2. Narrative

In this phase you can determine two levels through which the student-type player can interact the view can be seen in Figure 5., (1) the first level is designed for the student to understand the notions of structured wiring, for this the tutor must make a virtual tour emphasizing The most relevant aspects of the topic, in the virtual tour, the tutor can perform actions such as moving through the faculty building, the opening of doors of each of the laboratories and offices of the teachers shown in Figure 6. , turn lights on and off as needed, move objects, hide or show certain aspects such as the places where the vertical wiring of the building is located, determine the exact location of objects such as computers, routers, access points, and RJ-45 boxes that are installed on this level.

Figure 6. *Virtual Office of a Teacher on the OpenSim Platform*

Additionally, the student can be shown the data center, which as dictated by the standard must be located at the most central point of the building, both horizontally and vertically. (2) The second level determines the activity that the teacher can propose, i.e. at this level the teacher can ask the student or group of students to perform a certain activity, after the tutor Presented The first level to students, you can request the design and implementation of the objects involved in a computer laboratory of a university career Figure 7., for this students can Use object inventorywhich which can be viewed in The Figure 8., where you can find elements such as: computers, RJ-45 boxes, routers, racks, etc., then the tutor can determine the correct aspects as the wrong ones based on the structured cabling standard such as:

- The student must design and develop the data center, which can be visualized in Figure 9. based on the rules and indications given by the instructor.
- Another task that must be performed is to build a gutter system (Figure 10.) that allows you to reach all data points distributed throughout the building, depending on the needs that arise.
- In addition, you should keep in mind that it may be necessary to add communication cabinets if deemed necessary following the basic rules of structured cabling.

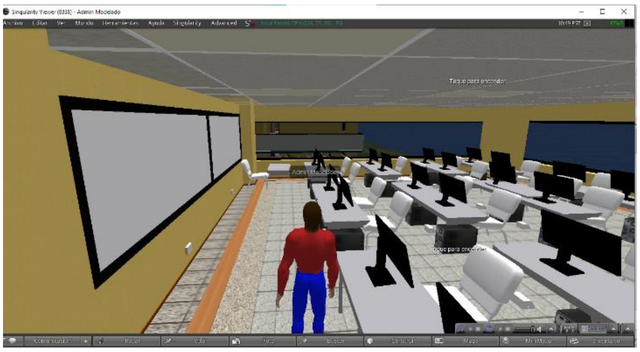

Figure 7. Virtual Lab on the OpenSim Platform

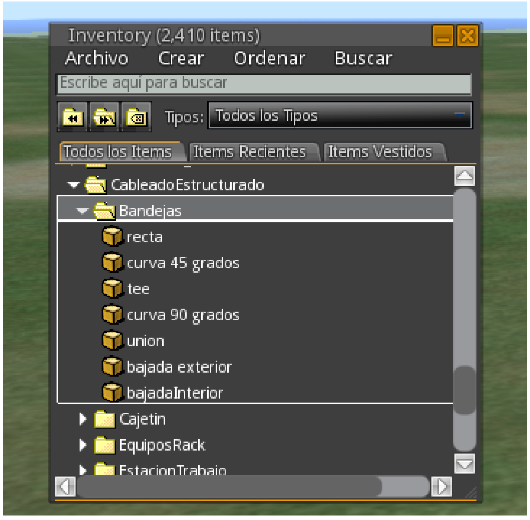

Figure 8. Inventory with available objects from the OpenSim Platform

4.3. Gameplay

Basically, In this phase the player must follow through the two levels of interaction following the instructions of the instructor, in the first level, the student must pay attention to the virtual tour and indications by the tutor, the student's participation is limited to observation. In the Second level of interaction, the player will be able to replicate an environment that is raised by the instructor, for this you can access Objects such as: tables, computers, RJ-45 boxes, communication cabinets, racks, etc., previously loaded through the inventory available to students.

Figure 9. Virtual Datacenter of the Building within the OpenSim platform

4.4. User Experience

Our learning platform in 3 dimensions, is designed and developed for an interaction by the avatars of the user, both among them, and with the different objects available throughout the 2 levels of interaction proposed, where it can be determined that the first level the tutor will be the one who clearly has the greatest interaction while touring the different points of the building so that the students Can observe compliance with the basic standards of structured cabling such as in laboratories, teachers' offices and other points that contain structured cabling elements. While in the second level the interaction focuses on the students when developing the task that is posed by the tutor, it is here where the platform takes a challenge by developing skills and abilities in a learning environment in three dimensions, in addition, a cost of savings can be determined by not using implements and supplies from the real world, constituyisa link between theory and the real world for students.

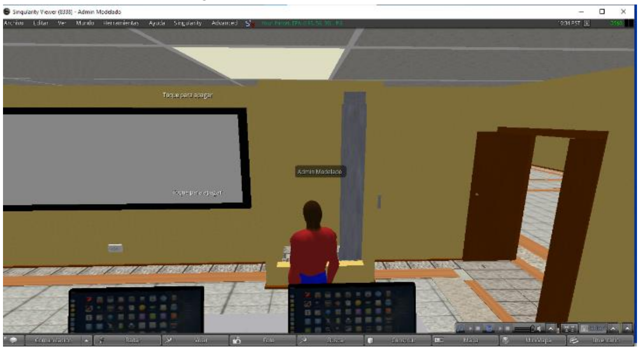

Figure 10. Gutters corresponding to the Vertical Wiring of the Virtual Building

5. Analysis and results

In relation to the results, it can be determined that they come from 2 clearly defined phases through of the tests carried out on the students. In the first phase, tests were carried out on a total of 25 student-type users, for this, surveys were taken as a technique for collecting information and following the TAM methodology [29], whose main objective is to determine the degree of acceptance of a new technology within the area of information systems research by users, based on 2 factors such as Perceived Utility and Ease of Use, which is why were developed surveys that were applied to students after completing the respective practice, with a duration of approximately 2 hours, in where the hourly was oriented to be completed each of the respective 2 proposed levels through the virtual learning platform in 3 dimensions.

Table 1. Comparison table Model TAM-phase 1

Ease of Use		Usefulness	
Positive	Negative	Positive	Negative
18	7	15	1

The survey contained questions for data collection and information necessary to determine the qualitative values to continue with the TAM methodology, the questions were:

- How easy is it for you to use the environment?
- Do you find this tool useful for learning structured cabling?
- What recommendations could you give regarding the Virtual Learning Environment?

Based on this survey designed under the TAM Information Systems methodology, the results shown in Table 1 can be determined, these results correspond to phase 1, of the application of the Virtual Learning Environment, which was implemented through the Intranet of the Institution, where they were applied mostly by students of the Faculty of Systems.

After that, the respective tests corresponding to a phase 2 were carried out, where for a better stabilization of the research results, they were tested with students from the Faculty of Systems and the Faculty of Electrical and Electronics of theNational Polytechnic School, it was also possible to test with students from the University of the Armed Forces, Santo Domingo Campus, in the career of Engineering in Information Technologies and which was implemented in a public url, the results of this second phase are presented in Table 2.

After reviewing the results in the first phase, it can be deduced that there is a perception of ease of use by users in a relationship of 18 positives and 7 negatives out of a total of 25 surveys applied.

On the other hand, in relation to utility, it can be deduced that there were 15 positive results versus 1 negative comment, which is considered a 15:1 ratio, the rest of the comments wereneutrales, that is why they are not considered in the proportion.

In relation to the second phase of testing of the learning platform, of a total of 88 students of which the survey was applied, after interacting with the platform for the 2 levels of interaction described, a trend can be deduced similar, to the one presented in phase 1, that is why referring to the first factor on Ease of Use, there is a ratio of 55:25, where the first value corresponds to users who have the positive perception of the platform in relation to its ease of use, the difference to complete the 88 users of the universe of respondents who have used the platform, which are a total of 8, have issued neutral comments.

Table 2. Comparison table Model TAM-phase 2

Ease of Use		Usefulness	
Positive	Negative	Positive	Negative
55	25	83	5

In the same trend as the first phase of tests is in relation to the utility factor, where the ratio of 83: 5 is determined, where of the universe, 83 emit comments where they think that the plataforma has utility in the teaching of structured wiring through a 3D learning platform.

6. Discussion

From the results, it can be deduced that both in the first phase and in the second phase of tests, the trend in relation to the 2 qualitative factors that determine the acceptance or resistance to use a technology according to the TAM methodology, is clear, because in the case of the first factor related to Ease of use where with a of 73 users think that the platform has a ease of use, which corresponds to 64.60%, that is, twice as many users think that the tool is easy to use in relation to those who do not. This can be determined through the TAM methodology, that if this platform is implemented for the teaching of Structured Cabling, users will accept it more easily than those who think otherwise, in other words, users will adopt it.

In the same way, in relation to the second qualitative factor related to Utility, it can be deduced that a total of 98 users consider as positive based on their responses to the surveys applied, which implies 86.73%, consider that the use of this virtual learning platform is useful for the development of skills and abilities related to Structured Cabling.

These results in accordance with the TAM methodology, suggest that they are positive from the point of view of the acceptance of the use of this new platform in the teaching of the basic aspects related to Structured Cabling, but also seems to them a useful tool that could be considered for practical aspects, due to the characteristics of the platform.

7. Conclusions

- Through the application of the DSR methodology, it has been possible to develop the present study, where the different phases determined by the methodology are fulfilled such as: Introduction, Related Works, Methodology, Development of the Artifact, Analysis and Results, Conclusions, obtaining as a result the present research.
- The problems described for the virtual learning platform are key points, which focuses us on looking for certain and different solutions, some of these problems are addressed and try to be a solution by proposing this virtual learning platform such as: problems related to what happens within the virtual learning world, lack of follow-up on user interactions in the virtual world, Difficulty in evaluating the tasks performed by students and keeping students motivated and engaged, although it is true that more problems that may be the subject of future research work are still missing.
- We have managed to determine that through the tests determined with the guidelines of the TAM methodology focused on its 2 qualitative factors such as the acceptance of this new technology in the teaching of subjects as structured wiring through this type of virtual learning platform can be well received by students, in addition, the same users consider that it is a useful tool to achieve competencies on knowledge, skills and attitudes of structured cabling.
- In the first instance we had the tests and results proposed in the first phase, but it was considered to expand the sample of users of type students to achieve a better conception and verify if the trend obtained with the results determined in this phase were maintained by expanding the range, that is why it is extended not only to students who receive the same subject in another faculty of the National Polytechnic School, but also include another institution of Higher Education in Ecuador.

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