UNIVERSIDAD TÉCNICA DE AMBATO

CENTRO DE POSGRADOS

MAESTRÍA ACADÉMICA (MA) CON TRAYECTORIA PROFESIONAL (TP) EN MAGÍSTER EN TECNOLOGÍAS DE LA INFORMACIÓN MENCIÓN SEGURIDAD DE REDES Y COMUNICACIONES
COHORTE 2021

Tema: CYBER-PHYSICAL SYSTEMS IN EDUCATION: A NEW APPROACH TO CONTINUOUS IMPROVEMENT AND AGILE LEARNING

Trabajo de Titulación, previo a la obtención del grado académico de Magíster en Tecnologías de la Información Mención Seguridad de Redes y Comunicaciones

Modalidad del Trabajo de Titulación: Artículos Profesionales De Alto Nivel.

Autor: Ingeniero Fausto Fabricio Robayo Zurita

Director: Ingeniero Milton Neptalí Román Cañizares, Magister.

Ambato – Ecuador

2022

A la Unidad Académica de Titulación del Centro de Posgrados

El Tribunal receptor del Trabajo de Titulación, presidido por el Ingeniero Héctor Fernando Gómez Alvarado. PhD, e integrado por los señores: Ingeniero Oscar Fernando Ibarra Torres Magister; Ingeniero Félix Oscar Fernández Peña. PhD, designados por la Unidad Académica de Titulación del Centro de Posgrados de la Universidad Técnica de Ambato, para receptar el Trabajo de Titulación con el tema: *"CYBER-PHYSICAL SYSTEMS IN EDUCATION: A NEW APPROACH TO CONTINUOUS IMPROVEMENT AND AGILE LEARNING* elaborado y presentado por el *señor Ingeniero Fausto Fabricio Robayo Zurita,* para optar por el Grado Académico de Magíster en Tecnologías de la Información Mención Seguridad de Redes y Comunicaciones; una vez escuchada la defensa oral del Trabajo de Titulación, el Tribunal aprueba y remite el trabajo para uso y custodia en las bibliotecas de la UTA.

Ing. Héctor Fernando Gómez Alvarado. PhD.
Presidente y Miembro del Tribunal

Ing. Oscar Fernando Ibarra Torres. Mg.
Miembro del Tribunal

Ing. Félix Oscar Fernández Peña. PhD.
Miembro del Tribunal

AUTORÍA DEL TRABAJO DE TITULACIÓN

La responsabilidad de las opiniones, comentarios y críticas emitidas en el Trabajo de Titulación presentado con el tema: CYBER-PHYSICAL SYSTEMS IN EDUCATION: A NEW APPROACH TO CONTINUOUS IMPROVEMENT AND AGILE LEARNING, le corresponde exclusivamente al: Ing. Fausto Fabricio Robayo Zurita, Autor bajo la Dirección de Ing. Milton Neptalí Román Cañizares, Mg., Director del Trabajo de Titulación, y el patrimonio intelectual a la Universidad Técnica de Ambato.

Ing. Fausto Fabricio Robayo Zurita
c.c.:1803282258
AUTOR

Ing. Milton Neptalí Román Cañizares, Mg
c.c.: 0502163447
DIRECTOR

DERECHOS DE AUTOR

Autorizo a la Universidad Técnica de Ambato, para que el Trabajo de Titulación, sirva como un documento disponible para su lectura, consulta y procesos de investigación, según las normas de la Institución.

Cedo los Derechos de mi trabajo, con fines de difusión pública, además apruebo la reproducción de este, dentro de las regulaciones de la Universidad.

Ingeniero Fausto Fabricio Robayo Zurita
c.c.:1803282258

ÍNDICE GENERAL DE CONTENIDOS

ÍNDICE DE TABLAS

ÍNDICE DE FIGURAS

AGRADECIMIENTO

Gracias a Dios por permitirme tener y disfrutar a mi familia, gracias a mi familia por apoyarme en cada decisión y proyecto, gracias a mis amigos que me apoyaron con palabras de empuje cuando mas lo necesitaba, gracias a todos los que creyeron en mi para poder culminar con esta meta profesional

No fue fácil el camino para llegar aquí, pero con el apoyo de Todos cuando mas lo necesitaba estuvieron ahí para demostrarme lo bonita que es la vida y que nunca debo rendirme ante cualquier prueba que se presente en mi vida, gracias a Dios por demostrarme cual es el camino para llegar a la meta

DEDICATORIA

Este logro lo dedico con mucho amor a mi Abuelito Papito Fausto, aunque no esté aquí presente físicamente, se que desde el cielo está ahí apoyándome, cuidándome y se que se siente muy orgullos, le extraño desde el fondo de mi corazón y estoy seguro que desde el cielo me envía un abrazo. Te extraño Papito Fausto.

UNIVERSIDAD TÉCNICA DE AMBATO
CENTRO DE POSGRADOS
MAESTRÍA ACADÉMICA (MA) CON TRAYECTORIA PROFESIONAL (TP) EN MAGÍSTER EN TECNOLOGÍAS DE LA INFORMACIÓN MENCIÓN SEGURIDAD DE REDES Y COMUNICACIONES
COHORTE 2021

TEMA:

CYBER-PHYSICAL SYSTEMS IN EDUCATION: A NEW APPROACH TO CONTINUOUS IMPROVEMENT AND AGILE LEARNING

MODALIDAD DE TITULACIÓN: *Artículos Profesionales De Alto Nivel*

AUTOR: *Ingeniero Fausto Fabricio Robayo Zurita*

DIRECTOR: *Ingeniero Milton Neptalí Román Cañizares Magister.*

FECHA: *Dieciséis de septiembre del dos mil veintidós*

RESUMEN EJECUTIVO

Los sistemas ciberfísicos (CPS) son la compleja evolución de los sistemas de software clásicos. Estos sistemas integran la capa física tradicional junto con los nuevos aspectos de CPS. Posibilitando una amplia gama de aplicaciones en diversos campos como el académico, gubernamental, industrial, etc., ampliando significativamente la funcionalidad y calidad de los servicios, donde la fusión tecnológico-virtual permite una mejor interacción entre el usuario y el sistema, creando nuevas realidades en la gestión tecnológica.

La combinación de componentes integrados y el ciberespacio, son relevantes en su construcción, permitiendo ampliar la funcionalidad y la calidad en muchos dominios comerciales e informativos. Generando entornos donde la aplicación de metodologías gráficas como el Design Thinking metodología de aprendizaje que garantiza de forma inmediata el desarrollo de competencias, en conjunto de Lean Startup estén enfocadas con el cliente.

En dicho contexto se plantea una solución que permita mejorar la calidad de la educación en el país, la aplicación de CPS es una alternativa a las clases virtuales actuales, donde la generación de sistemas permite un acercamiento y comunicación

entre docentes, estudiantes y representantes legales, fomentando la creatividad a través de la implementación de entornos virtuales con actividades clave relacionadas con cada tema de estudio, que despiertan el interés de los estudiantes.

El objetivo principal es demostrar la viabilidad de SCP en un entorno educativo a través del análisis de un sistema inmersivo enfocado a la mejora continua del usuario, a fin de promover el uso de mecanismos que permitan la participación colectiva entre alumno y docente, buscando implementar sistemas híbridos controlado, que permitan a los niños en un contexto de escasez económica tener acceso a una educación de calidad, permitiendo a su vez la participación conjunta de alumnos, profesores y tutores a cargo a través de sus dispositivos móviles u ordenadores, creando una educación participativa.

DESCRIPTORES: *CIBERFÍSICOS, CIBERESPACIO, DESIGN THINKING, EDUCACIÓN, ENTORNO, ESTUDIANTES, LEAN STARTUP, MODELOS 3D, PROFESORES, VIRTUAL.*

UNIVERSIDAD TÉCNICA DE AMBATO
CENTRO DE POSGRADOS
MAESTRÍA ACADÉMICA (MA) CON TRAYECTORIA PROFESIONAL (TP) EN MAGÍSTER EN TECNOLOGÍAS DE LA INFORMACIÓN
MENCIÓN SEGURIDAD DE REDES Y COMUNICACIONES
COHORTE 2021

THEME:

CYBER-PHYSICAL SYSTEMS IN EDUCATION: A NEW APPROACH TO CONTINUOUS IMPROVEMENT AND AGILE LEARNING

DEGREE MODALITY: *High Level Professional Articles*

AUTHOR: *Engineer Fausto Fabricio Robayo Zurita*

DIRECTED BY: *Engineer Milton Neptalí Román Cañizares, Master*

DATE: *September sixteen, two thousand twenty-two*

EXECUTIVE SUMMARY

Cyber-physical systems (CPS) are the complex evolution of classical software systems. These systems integrate the traditional physical layer together with the new aspects of CPS. Enabling a wide range of applications in various fields such as academic, governmental, industrial, etc., significantly extending the functionality and quality of services, where the technological-virtual fusion allows a better interaction between the user and the system, creating new realities in technological management. The combination of integrated components and cyberspace are relevant in its construction, allowing to extend the functionality and quality in many commercial and informative domains. Generating environments where the application of graphic methodologies such as Design Thinking, a learning methodology that immediately guarantees the development of competencies, together with Lean Startup, are focused on the client.

In this context, a solution is proposed to improve the quality of education in the country, the application of CPS is an alternative to the current virtual classes, where the generation of systems allows an approach and communication between teachers, students and legal representatives, encouraging creativity through the implementation

of virtual environments with key activities related to each subject of study, which awaken the interest of students.

The main objective is to demonstrate the viability of SCP in an educational environment through the analysis of an immersive system focused on the continuous improvement of the user, in order to promote the use of mechanisms that allow collective participation between student and teacher, seeking to implement controlled hybrid systems that allow children in a context of economic scarcity to have access to quality education, allowing in turn the joint participation of students, teachers and tutors in charge through their mobile devices or computers, creating a participatory education.

KEYWORDS*:* *CYBER-PHYSICAL, CYBERSPACE, DESIGN THINKING, EDUCATION, ENVIRONMENT, LEAN STARTUP, STUDENTS, TEACHERS, VIRTUAL, 3D MODELS.*

Cyber-Physical Systems in Education: A New Approach to Continuous Improvement and Agile Learning

Fausto Robayo[1], Milton Román[2], Freddy Morales[3], Daniel Jerez[4], Ricardo Plasencia[5]

[1] Technical University of Ambato, Ambato, Ecuador.
[2] University of the Armed Forces ESPE, Latacunga, Ecuador.
[3] Espíritu Santo University, Guayaquil, Ecuador.
[4] {frobayo2258, mn.roman}@uta.edu.ec, jcjuniorcheo@gmail.com, jrz.daniel@outlook.com, arguanoluisa1@espe.edu.ec

Abstract. The current changes have allowed technology and daily activities to intertwine in a better way, causing activities such as work or education to become virtual, in that aspect the implementation of specialized systems that allow a better management of the new modalities generated is a first level priority, in that aspect, the implementation of cyber-physical systems is an alternative, because they allow the integration of physical and virtual modules, in addition, to generate communication between all entities that manipulate or manipulate the system, in that context, The objective of this project is the implementation of mechanisms that allow the educational improvement, being one of the most worrying factors in Ecuador, for this reason the proposal presented is the implementation and testing of a cyber-physical system, applying Lean Startup and Design Thinking agile methodologies, destined to the interactivity between students, teachers and tutors, in order to improve the deficiencies produced by virtual education, generating environments and areas of study that allow to improve the intellectual capacities of the students, which will be evaluated by the users themselves through the use of tests and means of satisfaction that verify the quality of the system.

Keywords: Cyber-physical, Design Thinking, Education, Environment, Lean Startup, Students, Teachers, Virtual.

1 Introduction

Cyber-physical systems (CPS) are the complex evolution of classical software systems. These systems integrate the traditional physical layer together with the new aspects of CPS [1, 2]. Enabling a wide range of applications in various fields such as academic, governmental, industrial, etc., significantly expanding the functionality and quality of the services [3], the technological-virtual fusion allows a better interaction between the user and the system, creating new realities in the technological management.

The CPS being a new type of digital technology, where, the combination of integrated and cyberspace components, are relevant in its construction, allowing to extend the functionality and quality in many commercial and informative domains [4, 5]. For this, the use of agile methodologies allows a better communication between the users

and the CPS. Generating environments where the application of graphic methodologies such as Design Thinking (experimental and innovative learning methodology that immediately guarantees the development of competencies and growth for those who apply it) together with the activities proposed by the system produce a greater absorption of information [6].

In addition, the use of Lean Startup, a methodology much more focused on developing the customer, the market, the business model and obtaining validated learning [7]. in the development of the proposal, allowed speeding up development times, thanks to the creation of canvases and the generation of minimum viable products.

With the outbreak of COVID-19, in Ecuador, in the educational field, the virtual modality was implemented, being a country that does not have technology as a priority, it has been a serious blow, producing that 70% of students have difficulty in accessing online education. The lack of smart phones or Internet, the drop in income and the lack of training prevent the normal education of millions of children [8], and taking into account that the role of tutor is taken by the parents themselves, adding one more task to their morning activities, they do not allow the child to develop in a better way, since he/she does not have an appropriate guide [9], producing poor quality education and therefore underestimating online education, underestimating the importance of the application of systems and tools that help to improve academic activities.

In this context and with the vision of improving the quality of education in the country, the application of CPS is an alternative to the current virtual classes, where the generation of systems allows an approach and communication between teachers, students and legal representatives, allowing the application of agile methodologies such as Design Thinking [10], encouraging creativity through the implementation of virtual environments with key activities related to each subject of study, which awaken the interest of students.

The main objective is to demonstrate the feasibility of SCP in the educational environment through the analysis of an immersive system focused on the continuous improvement of the user, in order to promote the use of mechanisms that allow collective participation between student and teacher [11].

This research seeks the implementation of controlled hybrid systems in the educational environment, allowing children in a context of economic scarcity to have access to quality education, for this we took into account the current trends in the area of gamification, working with 3D models focused on capturing the attention of each adult and the use of routines in the handling of scripts, improving the interaction with the system, allowing in turn that while students participate in an activity, they are controlled by teachers and tutors in charge through their mobile devices or computers, creating a participatory education.

2 Background

2.1 Virtual Education

The current education gave a great change with the emergence of the pandemic, making it unintelligible without the use of new technologies. The school, as an educational agent, assumed the changes of society, in general, and of children, in particular, sharing this burden with the tutors of each student by becoming virtual, incorporating virtual classes as a means of teaching, where, Ecuador a growing country showed the lack of implementation of these media, not only in the implementation, but also in the management of each of the teachers in charge of teaching, leaving in sight the lack of training of the same [12].

Virtual education, also known as online education, develops the teaching-learning relationship virtually, whereby teachers and students must interact without the direct face-to-face relationship between teacher and student through a virtual classroom [13, 14]. The situation is similar in Ecuador, where 70% of students have difficulty in accessing online teaching in the Andean country. The lack of smartphones or Internet, the drop in income and the lack of training prevent the normal education of millions of children during the pandemic [15].

Even so, not everything is negative, the adaptation of students to new technologies has given way to a better distribution of their time, being the first step towards a better education, from that point, we seek to change the approach of the current teacher, focused on a task-based teaching to a teaching based on interactivity.

2.2 Smart Education

Currently, teaching methods are seeking a new approach, focused on improving the interaction between the teacher and the student, where intelligent learning allows to perceive through various audiovisual techniques, movement, expression and other factors applied in the education process, allowing to better impart knowledge [16, 17]. In such a way that it enables web accessibility for the students [18], an essential resource in human activity which, when carried out in the best way, broadens capabilities by being a means of expanding knowledge.

2.3 Design Thinking

In these times where technology has changed, is changing, and will continue to change, we must create a link between matching people's needs with what is technologically possible, aligned with a feasible strategy that can be converted into value for each client [19]. This is where Design Thinking puts developers in the customer's shoes, allowing development teams to create empathy with the user before development begins. Empathy is the core of Design Thinking and does not require expertise in the field that the customer resides in, rather it requires critical thinking [20].

As a methodology that can not only be applied in the development environment, but expands to other areas, it allows the developer, project leaders and stakeholders to expand their base idea into an infinite set of possibilities.

2.4 Lean Startup

The lean startup method is a methodology based on "validated learning", i.e., verifying hypotheses little by little before having the final product (the definitive startup) and starting to scale the business [21]. The idea is to define and shorten the development cycles, launching different proposals for a period of time and obtaining valuable feedback from our potential customers or users, with which to improve the next final version of the product.

The application of Lean Startup, allowed to improve development times and ensured a constant workflow, thanks to the creation of Canvas boards and the implementation of combined tools of agile methodologies, allowing the rapid implementation of the system.

3 Structure of the Environment

The design of the applied software schematizes the connection and interaction between the main users and the main application, allowing to observe the communication between each of the actors, where the principles of cyber-physical systems were taken into account as shown in Figure 1, where, (a) the process starts with the sending of tasks and activities from the school to a server where it can be reviewed by teachers, (b) with the assigned tasks the teachers will have the permissions to access these activities and manage the students that enter as well as the development of the same, while the tutor or parent will receive direct notifications to the linked device, on the part of the students, they will have the ability to perform tasks and be in communication with each of the teachers, allowing them to have a direct contact with the subject to be studied.

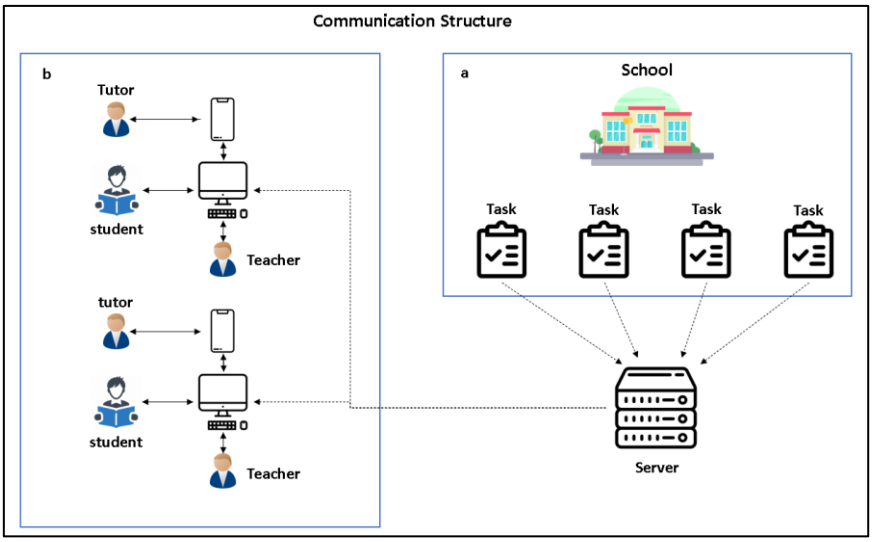

Figure 1 - Integration of Mixed Reality Software

The proposed design allows to generate a technological stack focused on the co-communication of each one of the actors, where making use of new technological means allows a better communication, therefore, better interaction between the user and the system, In such a way that the user can carry out a process which at the moment of execution will call a series of multitasks or routines that will work internally, allowing to improve the precision by generating parallel work between the action and the moment to be executed, emulating processes similar to those of real life without affecting the performance of the application, as shown in Figure 2.

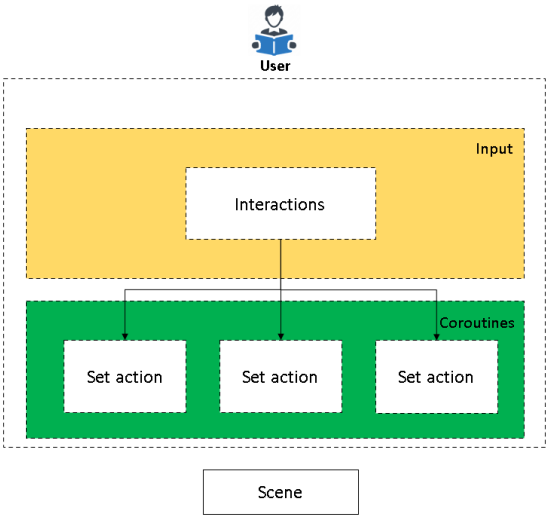

Figure 2 - Subprocess and task execution

4 System Development

The development of the system was focused on generating the greatest interaction between each of the users with the system. Through the use of agile methodologies Desig Thinking (used in the process of creating environments by applying user experience concepts) and Lean Starup (in charge of managing all task organization flows) a constant and iterative flow was managed, which allowed the creation and quick modification of both scenarios and scripts, also allowed to divide into groups the management of tasks, separating development and design tasks with those focused on issues of server connection, where infrastructure was used as code, facilitating the deployment of the application.

The development process begins with the creation of a modular style architecture, which allows specifying each of the modules with which the system interacts for its operation, as shown in Figure 3.

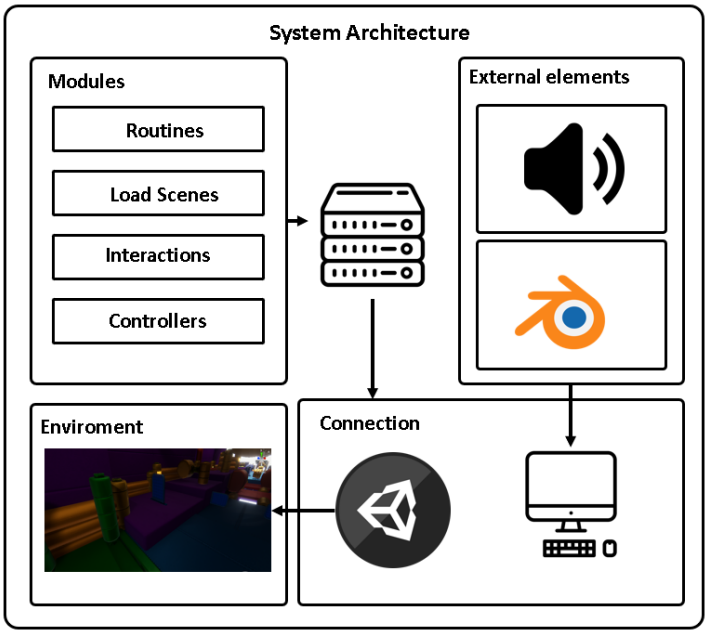

Figure 3 – System Architecture

The architecture of the application consists of four modules, (i) Modules: responsible for controlling the scripts, routines and actions of the actors in the process of interaction of the system, in addition, there is the necessary coding to perform the connection of the system, (ii) External elements: this module has each model designed, in addition to the sounds created for the realization of the environment within the application, (iii) Connection: this module is responsible for linking each of the elements for the proper functioning of the application, (iv) Scene: represents the execution of the application.

4.1 System construction

The development process of the system consists of five modules, from the creation of each one of the elements, the construction of the application and its testing stage.
Construction Modeling of elements: For this section we proceeded to the design of models and bases similar to known games of today, generating a recovery that allows to develop the skills of the users tested in the first instance, using the Blender modeling tool [22], which will allow to clean and improve the performance of each element.
Model integration: For this stage, the models were added to the Unity development environment [23], where we proceeded to the generation of the path and the sections corresponding to the activities to be performed.
Codification of actions and controllers: With the developed environment we proceeded to the generation of scripts in Visual Studio [24], destined to be each one of the actions to be developed within the virtual environment, in addition we made the

corresponding connections with the databases destined to send and receive information of each activity.

Configuration of communication services: For the communication between applications we configured the Unity connect services [25], which allow to quickly manage the connection between different users, allowing to have a control of each of the participants and reducing the development times of a traditional cloud.

Environment and Communication Functional Tests: The testing stage was carried out by preparing in a room of the educational unit a total of 30 users, including students and teachers, who were subjected to a short introduction (See Figure 4).

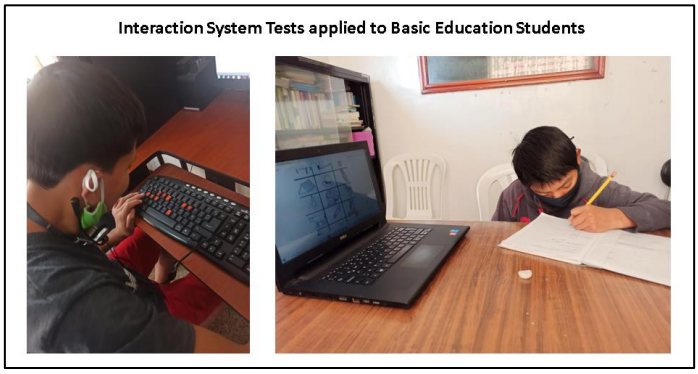

Figure 4 - Tests applied to students

5 Results and Discussion

This section presents the results obtained in the development and implementation of the Cyberphysical System. These results are divided into two stages, (i) Interaction with the system, which details the functionality of the developed application through the main attractions of the virtual environment and (ii) Validation of the application, which analyzes the results obtained from the manipulation of the system by a group of users.

5.1 System Interaction

To access the virtual environment, it is necessary to take into account the specifications that the mobile device must meet, such as 6GB of RAM, Android version 10 or higher and 450MB of available space. Next, the teacher in charge will send the application to the student for installation. Once the user accesses the application, he/she must click on the "Login" button to start the interaction. The application is designed to work with children between the ages of 7 and 12 (1) The application has an adaptation area for the user/visitor to explore and adapt to the functionalities and mechanics implemented in the environment. Once familiarized with the environment, (2) The student and the teacher will be able to carry out the activities proposed, obtaining recognitions through the tour, applying gamification principles in teaching. (3) Finally, the results

can be obtained, which can be reviewed by both the teacher and the student's tutor (See Figure. 5).

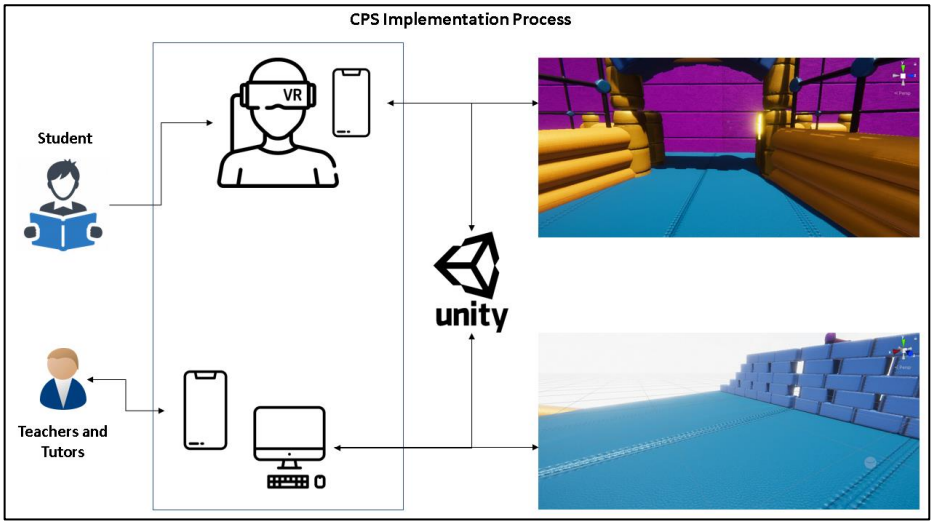

Figure 5 - CPS Implementation Process

The environments designed for the realization of the test seek to emulate those similar to the games present today, in order to give users an environment according to their current expectations, for this several rooms were designed in which students can interact a) Labyrinth: allows the student to move through the environment in search of the exit, asking different questions to advance, b) environment area: allows users to adapt to the systems, c) recreation area: allows users to perform various activities that motivate the physical work of the body, d) world area: allows users to present three-dimensional elements, for better absorption of knowledge (See Fig 6).

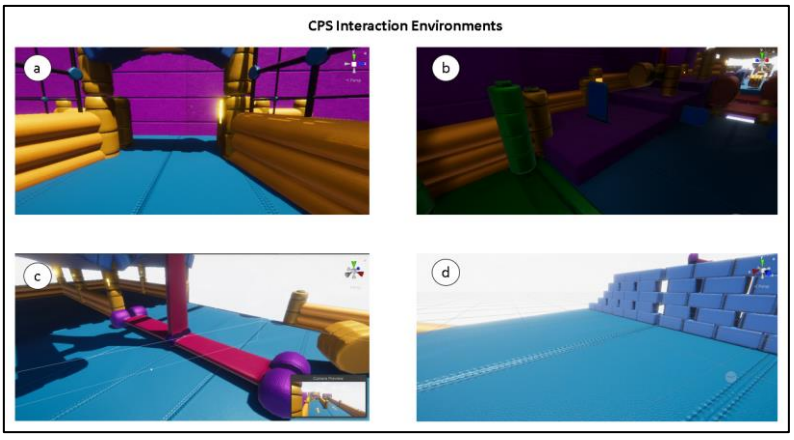

Figure 6 – Interaction environments

The connection model seeks to reduce response times between user and system, combining video game modeling techniques with programming by routines, we obtained an adequate execution time management for each action, where the execution of a function only happened if it was used, and the same case for each of the textures and models, applying mesh only in case of interaction, allowing an adequate use of memory and avoiding memory overloads in order to allow the system to be deployed on mobile devices such as PC. Finally, for the management of the application the respective configurations were made, applying tools of the IDE development, looking for the correct ergonomics in the location of each control where the user's comments were taken into account to create a better experience.

5.2 Validation

Experimental Results. Using the convenience sampling technique, 30 users, including teachers and students, were selected as respondents. After a brief general introduction to the application, each user uses the devices that already have the application. The participants begin to have a pleasant experience in the realization of the academic activities. The test session ranges from 20 to 30 minutes. At the end of the test in each of the educational environments, users are asked to perform an aptitude test.

To give consistency to the aptitude test, a reliability analysis was first performed using Cronbach's alpha, which yielded a value of 0.8016, indicating that the measurement items were positively correlated, therefore they are reliable constructs.
The formula applied was, by means of the variance of the items:

$$\alpha = \frac{k}{k-1}\left[1 - \frac{\sum V_i}{V_t}\right] \qquad (1)$$

$\boldsymbol{\alpha}$: Cronbach's alpha.

$\boldsymbol{k}$: Number of items.

$\boldsymbol{V_i}$: Varriance of each item.

$\boldsymbol{V_t}$: Variance of the total.

Next, the aptitude test was applied, designed to analyze the effects of the learning process and the levels of educational absorption, based on the interaction with each recreational activity. The results show that the general opinions of the users were as follows:

- The students' learning of general knowledge showed a moderate improvement ($\bar{X}$=3.6, SD=1.00).
- The path presented in the virtual environment was satisfactory ($\bar{X}$=4.0, SD=0.90).
- The usefulness of the application was considered quite good ($\bar{X}$=4.5, SD=0.49).
- The "enjoyability" of the application was considered good ($\bar{X}$=4.1, SD=0.79).
- The exposed contents were of great help to spread the teaching in the educational unit ($\bar{X}$=4, SD=0.70).
- The application helps students' learning and adaptation ($\bar{X}$=4.22, SD=0.59).
- The application met their expectations ($\bar{X}$=4.02, SD=0.62).

Additionally, SUS (System Usability Scale) was applied to measure the usability of the application. It has a questionnaire of 10 questions with five options. The results are tabulated and the usability score is calculated, with 100 as the maximum value and 0 as the minimum. If the value is above 80, the application has a high degree of usability for students/teachers, while if the value is below 68, it is considered to be below average.

The results shown in Table 1 detail the calculations made and it can be considered that the application is easy to use, since the average usability of the system is 85.02.

Table 1. Application usability evaluation

Evaluated parameters	Average	Weight	SUS Final Score
1. I think I would like to use the Designed System frequently.	4,20	x-1	3,20
2. I have found the Designed System to be unnecessarily complex.	1,12	5-x	3,88
3. I think the Designed System is easy to use.	3,54	x-1	2,54
4. I think that I would need the support of a technician to be able to use the Designed System.	1,22	5-x	3,78
5. I felt that the different functions of Sistema Diseñado were well integrated.	4,69	x-1	3,69
6. I felt that there was too much inconsistency in Sistema Diseñado.	1,10	5-x	3,90
7. I would imagine that most teachers and students would learn to use the Designed System very well.	4,33	x-1	3,33
8. I found Sistema Diseñado to be very cumbersome (uncomfortable) to use.	2,80	5-x	2,20
9. I felt very confident using Sistema Diseñado.	4,70	x-1	3,70
10. I had to learn a lot of things before I started using Sistema Diseñado.	1,20	5-x	3,80
Total Amount Sus Score			34,02 85,19

The results obtained show that the application of the system was successful, demonstrating that regardless of the social factor of the users, systems of this style will have great acceptance, as long as usability measures and the environment in which they work are taken into account, even so if we take into account the results of usability, the satisfaction obtained and the social environment, we can note the rapid adaptation and enjoyment of the system at the time of its use.

6 Conclusion and Future work

In this project, advanced learning techniques were applied, in addition we sought the implementation of development methodologies in the process of learning in-teaching as is the Design Thinking, methodology that allows adaptability to any work environment, allowing to adapt it to any field, demonstrating that the paradigm established in education can be changed by one focused on trial, error and learning, also used connection tool as was the case of Unity Connect, which allowed the interconnection between the application and users, allowing to improve communication between teachers and students. This allowed each of the students who participated in the tests to interact more freely, demonstrating that improving the teaching processes means a better quality of education. Finally, we must take into account that the tested users belonged to an Andean group, who were not accustomed to the use of technology, Even so, their adaptation to the environment and the success of the tests demonstrates that the attitude changes when the method is good, in addition to the fact that the teachers were facilitated the interaction with their students and took into account the lack of training that is lacking in the country in the technological area.

The objective of this project in the future is to implement processes in the improvement of teaching at the country level, allowing a better connection between the present entities and changing the paradigms established by the current society, for which it is planned to expand the system and improve it, taking the interaction to more realistic levels, applying gamification techniques in the established teaching processes, in addition, it is planned to improve the proposed interfaces, changing the current environment for a local network so that each environment launched into production is fully functional without the need for internet, making use of old computer equipment as base servers.

References

1. C. A. a. V. G. S. u. Rehman, Security Requirements Engineering: A Framework for Cyber-Physical Systems, Islamabad: IEEE, 2019.
2. A. A. a. A. Khelil, A Security Qualification Matrix to Efficiently Measure Security in Cyber-Physical Systems, IEEE, 2020.
3. B. Craggs and A. Rashid, Smart Cyber-Physical Systems: Beyond Usable Security to Security Ergonomics by Design, Buenos Aires: IEEE, 2017.
4. A. Andreas and K. Abdelmajid, A Semantic Model-Based Security Engineering Framework for Cyber-Physical Systems, Guangzhou: IEEE, 2021.
5. S. u. Rehman, C. Allgaier and V. Gruhn, Security Requirements Engineering: A Framework for Cyber-Physical Systems, Islamabad: IEEE, 2019.
6. OVTT, Metodologías ágiles de design thinking.
7. A. Smith, "Diferencias entre Design Thinking, Lean Startup," tentulogo, 2022. [Online]. Available: https://tentulogo.com/diferencias-design-thinking-lean-startup-design-sprint-agile-scrum-kanban/.
8. S. Constante, Ecuador: la educación online desde casa es imposible e injusta, Quito, Pichincha: El País, 2020.

9. P. Garcia, 10 Estrategias para aprender cualquier cosa más rápido ¡Así funciona tu cerebro!, 2016.
10. E. G. Maida and J. Paciencia, Metodologías de Desarrollo de Software, 2015.
11. I. Muñoz, Metodologias agiles para la innovaion educativa, 2020.
12. unir, "¿Cómo introducir las TICs en Educación Infantil?," unir, 28 01 2022. [Online]. Available: https://www.unir.net/educacion/revista/tic-educacion-infantil/.
13. S. Zavala, "El Telégrafo," 2020. [Online]. Available: https://www.eltelegrafo.com.ec/noticias/columnistas/15/la-educacion-virtual.
14. J. M. Romero, "Product-Based Learning Adaptation to an Online Autonomous Work Strategy in Restriction Conditions by Covid-19," IEEE, 2021. [Online]. Available: https://ieeexplore.ieee.org/document/9381164.
15. S. Constante, "El País," 2020. [Online]. Available: https://elpais.com/elpais/2020/06/12/planeta_futuro/1591955314_376413.html.
16. Z. Chaczko, C. Y. Chan and L. Carrion, "Haptic Middleware Based Software Architecture for Smart Learning," IEEE, 16 07 2015. [Online]. Available: https://ieeexplore.ieee.org/document/7287029.
17. R. Plasencia and G. Herrera, "Dissemination of Cultural Heritage: Design and Implementation of a VR environment for the preservation of art and culture in Pujilí - Ecuador," IEEE, 2022. [Online]. Available: https://ieeexplore.ieee.org/document/9726824.
18. M. Campoverde and S. Luján, "Empirical Studies on Web Accessibility of Educational Websites: A Systematic Literature Review," IEEE, 2020. [Online]. Available: https://ieeexplore.ieee.org/document/9092982.
19. M. Campos, "TACTIC," 2017. [Online]. Available: https://tactic-center.com/desarrollo-web/design-thinking/?locale=es.
20. eserp, "QUÉ ES EL DESIGN THINKING Y SUS FASES," 2021. [Online]. Available: https://es.eserp.com/articulos/que-es-el-design-thinking-y-sus-fases/.
21. J. C. Alcalde, "Economipedia," 2021. [Online]. Available: https://economipedia.com/definiciones/metodo-lean-startup.html.
22. Blender, 2022. [Online]. Available: https://www.blender.org/.
23. UNITY, "Unity," 2022. [Online]. Available: https://unity.com/es.
24. Microsoft, "Visual Studio," 2022. [Online]. Available: https://visualstudio.microsoft.com/es/.
25. Unity, "Arquitectura, Ingeniería y Construcción," 2022. [Online]. Available: https://unity.com/es/solutions/architecture-engineering-construction.