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THINKING ROUTINES IN VIDEOGAMES AND PROJECT-BASED LEARNING IN SECONDARY SCHOOL

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Abstract: Nowadays, videogames have been treated as the antithesis of learning, considering them as a challenge rather than an opportunity. That was why, the project was made to have a common point between the motivation provided by video games and an educational context that Project Based Learning with the Thinking Routines gave us. Moreover, the project was designed for the 2nd year of Secondary school. The project based on pandemics that happened and percentages to design the videogame. Also, each phase of the PBL had its routine for data analysis, encouraging students to do cognitive thinking at the same time. Due to the COVID-19 pandemic, Results has been changed to a hypostatization. Not only was each phase of PBL with its routine do, but also the apk of the developed video game was made as a simulation of what a class could generate or answer. Taking everything into consideration, the project provided us different conclusions to think about: the intrapersonal factor in the creation of the project, the importance of the interconnection of the PBL, the approach to reality provided by the PBL, the importance of diversity of thinking, the motivational factor of the video games and the synchronization between the PBL and the thinking routines.

Keywords: Thinking routines, Videogames, Project Based Learning.

APLICACIÓN DE LAS RUTINAS DE PENSAMIENTO EN LOS VIDEOJUEGOS Y EL ABP EN LA EDUCACIÓN SECUNDARIA

Resumen: En la actualidad, los videojuegos han sido tratados como la antítesis del aprendizaje, considerándolos más como un desafío, en vez de una oportunidad. Por ello, se ha buscado un punto de encuentro entre la motivación aportada por los videojuegos y un contexto educativo formado por el Aprendizaje Basado en Proyectos junto a las Rutinas de pensamiento. Para ello se diseñó una programación para el 2º curso de Educación Secundaria Obligatoria, basada en la elaboración de videojuegos como proyecto, cuyo tema fue las pandemias que han surgido en la historia y los porcentajes. Teniendo cada fase del ABP su rutina correspondiente para el análisis de datos, buscando a su vez fomentar el ejercicio de razonamiento en el alumnado. Debido a la pandemia COVID-19, se ha llevado a cabo un supuesto del apartado "Resultados", en vez de su propio procedimiento, desarrollando cada fase en su totalidad, así como un producto final. Generando cada rutina de pensamiento y el apk del videojuego desarrollado.

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Desembocando en el factor intrapersonal en la creación del proyecto, la importancia de la interconexión del ABP, el acercamiento a la realidad aportada por el ABP, la importancia de la diversidad de pensamiento, el factor motivacional de los propios videojuegos y la sincronización entre el ABP y las rutinas de pensamiento.

Palabras clave: Rutinas de pensamiento, Videojuegos, Aprendizaje Basado en Proyectos.

Introduction

Video games are a very present source of entertainment nowadays, not only because of the time spent on them, but also because of the large number of events focused on them.

Unfortunately, video games have been treated as the antithesis of learning. Moreover, in some approaches to the educational field, they have resulted in a distancing of the youth audience, due to the misconception that the words video games and education are incompatible.

At the same time, it should be noted that video games need an educational context to give them that didactic quality. In order to bring this meaning to video games, the innovation project focused on a combination of project-based learning and the use of thinking routines.

It is important to contextualize the situation in which this project has been carried out. Because of the state of forty due to the COVID-19 pandemic, an assumption of the "Results" section has been carried out, instead of its own procedure.

Before starting, in order for the student to acquire an internalization of the contents that culminates in meaningful learning, it is necessary to first define those concepts that are included in this procedure. According to Swart *et al.* (2013), for the thinking process, the following terms should be considered:

- Knowledge: the ability to recall specific and general facts without any applied changes any applied change.
- Comprehension: the incorporation of knowledge or ideas perceived in their totality totality.
- Analysis: process of breaking down a problem for its future resolution.
- Synthesis: process of combining various elements into a single mental structure mental structure.
- Infusion: a process of merging the various techniques to bring thinking into the classroom into the classroom.
- Thinking skills: process that employs reflective procedures, in order to perform a given thinking exercise in order to perform a specific thinking exercise.
- Habits of mind: process focused on reflective behaviors through routine procedures routine procedures.

In addition, it is necessary to consider the different learning strategies, which, according to

Valle *et al.* (1998) are:

- Cognitive strategies: which focuses on the incorporation of new knowledge with previous knowledge knowledge with previous knowledge. Supported by strategies of repetition, elaboration and organization.
- Metacognitive strategies: based on the assessment of the learner's own cognition of the student himself.
- Resource management strategies: which focus on supporting different types of resources that contribute to task resolution types of resources that contribute to task resolution.

On the other hand, in order to achieve meaningful learning, it is necessary to take into account the agents involved in the student's learning process: the teacher and the student.

Palma *et al.* (2017) state that the teacher is an active processor of the information provided by the context, manipulating it through their cognitive skills to perform a reflective analysis of it, to then transport it to the classroom.

Therefore, meaningful learning is based on teaching practice, which, according to García *et al.* (2008), is understood as the set of actions within the classroom, determined by the teacher's intervention before, during and after an activity, which leads directly to student learning. Continuing with the other agent, the student is characterized by his role as an alchemist, being the active participant in the activities proposed by the teacher.

But in order to maintain the intervention of the students, it is necessary to take into account the motivation of the students. According to Gee (2004 cited in Bosco *et al.* 2017), young people allocate several hours of their time to video games, due to a great motivational potential. Also, according to Bosco *et al.* (2017), thanks to video games it is possible to transform tedious learning into interesting learning.

Likewise, according to Sampedro Requena and McMullin (2015), as a result of the attractiveness of the use of video games and digital games, greater student participation is achieved.

Furthermore, according to Méndez and Del Moral (2017), implicit learning is enhanced by video games, thanks to their attractive formula for the exercise of cognitive skills from different fields (observation, memory, problem solving, etc.), as well as catalysts of learning processes and learning contexts themselves.

Likewise, it is important to highlight the origin of video games, being the game itself, called by Mora (2013), as an instrument invented from the nature of the child with continues to acquire learning and reaches skills and abilities efficiently, achieving a more effective adaptation to the world around him.

In turn, it is important to highlight the term Serious games, which according to Méndez and Del Moral (2017), are those video games created with a clear educational purpose, currently used in different areas (companies, schools, universities, etc.), both to promote the development of specific skills and abilities, as well as to stimulate creative thinking processes, reasoning or problem solving.

However, some Serious games do not reach all educational demands, according to Dorado and Gewerc (2017), this is due to the lack of communication between video game development companies and the educational context, the poor ability to adapt to the environment or the low relevance of the perceived contents for the teaching and learning process of the student.

In addition, it is important to highlight the benefits of using video games in the classroom, according to Del Moral *et al.* (2015) are:

- Thanks to the video games, the student achieves a high level of development in high levels of of significance by achieving a concordance with their own interests,

producing an effective didactic tool.

- The very interactivity that a video game achieves and the time it takes to play it development resulting in the integration and engagement of the learner in the imaginary context produced from their own stories and actions.

- It makes it possible to train individual and personal skills, as well as the existence of some kind of monitoring and progress of some type of mechanism for monitoring and progress of the students by the teacher by the teacher.

- A self-evaluation of the different processes and strategies implemented is carried out strategies put into play.

Also, from a technological point of view, in the Spanish educational field, technologies are an important point at the curricular level, not only because of the BOE (digital competence), but also because of the different programs that support them:

- The Medusa Project: seeking to provide computer resources to all educational centers and to offer training to teachers, trying to and offer training to teachers, trying to achieve the main educational objectives educational objectives. (Area, 2009)

- The School 2.0 program: focused on the configuration of media (hardware, software and special (hardware, software and special interfaces) for the classroom and the technological implementation of technology, both formative and structural, in the center the center. This program is not currently in force, but nevertheless, it was the precursor of the advances in technological education of the following autonomous communities, these are: Andalusia, Aragon, Asturias, Cantabria, Castilla y León, Castilla La Mancha, Cataluña, Galicia, Extremadura, Balearic Islands, Canary Islands, La Rioja, Navarra, Murcia, Basque Country, as well as in the autonomous cities of Ceuta and Melilla. (Area *et al.*, 2014)

The root of this, according to Parra *et al.* (2014), is that students who use computers achieve faster learning, reflecting more positive attitudes toward the courses.

In addition, ICTs make classroom activities more dynamic, helping students to develop fundamental competencies for effective and adequate performance in personal, social and work-related fields.

In agreement with Nuñez *et al.* (2015), the advantages of using ICT are:

- Encourage creativity.
- Increase the information available.
- Provide research activities.
- Versatile use of information
- Attracting students' attention

Also, according to Area (2009), students are more accustomed to the use of technologies than teachers, due to the fact that these technological tools are part of the students' own generational identity.

This makes it evident that students are more easily able to handle technologies and have clear digital competencies, and it is inconsistent to keep them away from these deep-rooted skills.

Parra *et al.* (2014) point out that success in the application of ICT in curricular plans is conditioned to new approaches that teachers make in their daily work, but with a traditional and rigid thinking, the implementation of this pedagogical alternative will surely not reach the desired goal.

Taking into consideration the above aspects, it can be assessed that the use of video games in the classroom is a driver for students to achieve meaningful learning.

Even if there is a motivational aspect, without a solid educational method, meaningful learning will not occur in the students.

Therefore, we are now going to look at project-based learning, emphasizing its link with constructivism. Emphasizing the relevance of action in student learning and, in addition, focusing on the student's protagonism in the process of his or her own learning.

According to the Spanish Ministry of Education, Culture and Sport, project-based learning is defined as: "a methodology that allows students to acquire key knowledge and skills in the 21st century through the development of projects that respond to real-life problems." (2015, p10)

In turn, according to the Spanish Ministry of Education, Culture and Sport (2015), a project is considered suitable when it incorporates the following elements:

- Meaningful content
- The need to know
- The research question
- Student voice and vote
- 21st century competencies
- Research leading to innovation
- Evaluation, feedback and review processes
- Exposure of the final product to an audience

In addition, project-based learning values the roles of the learner and the teacher in the learning process. According to González *et al.* (2017), students and teachers are defined as:

Student

- Holder of the content and the objective.
- Employ a real assessment.
- The teacher is a facilitating companion.
- It has explicit educational goals.
- The use of constructivism to strengthen their mental maps.
- The teacher also learns from the student.

Teacher

- Focused on the student and promoting intrinsic motivation.
- Promotes autonomous, collaborative and cooperative learning.
- Seeks continuous improvement in its products for learners, presentations or performances.
- Their role is focused on the student being actively engaged in the solving real and authentic problems.
- Requests a product, presentation or performance from the student.
- It is focused on the development of higher order skills through a critical approach
- critical approach.
- Transfers what has been learned to new situations.
- Encourages scientific inquiry, discovery and satisfaction from knowledge accumulated.

Continuing with the theme, a convenient tool for project-based learning are learning routines, which according to Pinedo *et al.* (2017, p.2) indicate, thinking routines can be defined as: "specific tools to aid thinking; structures with which students can explore and discuss knowledge; and aids to encourage thinking, the use of reason and reflection."

This is why the use of thinking routines and project-based learning is so valuable with the use of technology, since, thanks to its orientative nature and constructivist basis, meaningful learning can be achieved, supported by the motivation and versatility provided by the technological domain.

Taking into consideration the different points discussed, thanks to the educational basis provided by PBL, together with the structuring of thought offered by thinking routines, added to the motivational factor of video games, it is possible to achieve significant learning by students.

Method

The project focuses on the creation of video games based on thinking and the organization of ideas, through a series of thinking routines, whose objective is to "Learn to think" and connect in a more effective way the knowledge taught in the classroom.

Being under the approach provided by project-based learning (PBL), typical of the center where this innovation project would have been developed. This method focuses on the acquisition of knowledge and skills by students through the development of projects that respond to real-life problems.

This study would have been put into practice during the subject of Mathematics in the 2nd year of Compulsory Secondary Education, whose content to be worked on would have been percentages and pandemics that have occurred in history. In turn, it would have been carried out in other classrooms and subjects to have other perspectives, since the creation of video games is a tool that brings benefits in any subject, due to the fact that, in all subjects of compulsory primary education, motivation, thinking and reasoning should be prioritized as a bridge between the various concepts that are worked on in the classroom.

The main benefit is the ease with which the proposed activities enable students to concentrate on ordering their ideas and newly acquired knowledge, assimilating the new information in their mind map. In addition, it favors the practice of critical thinking at each stage.

Linked to the previous point, by practicing critical thinking, students will not allow themselves to be manipulated by other thoughts that are alien to the democratic ethical-moral bases that are worked on in schools, making them free entities with the ability to contrast other ideals.

At the same time, the union between the concepts taught and the current culture of the students is achieved, resulting in a distancing from the feeling of alienation that is currently very present in the classroom, seeking to conceive these two elements as one.

This project would have been aimed at students in the 2nd year of secondary school at IDEO SCHOOL, the age of these children is between 13 and 14 years old.

It should be noted that students in this time period are characterized by (Marina, 2019):

- The labeling of their parents and the teacher as an authority figure within their respective contexts.

- The valuation of their own siblings as a commanding authority.
- The consideration of their own friends as figures of dominance.
- The capacity for positive self-criticism through humor.
- The development of rebelliousness against authority, due to fear of maturity and the acquisition of new responsibilities, as a result of attachment to their childhood.
- The absence of the authority figure due to their own egocentrism and other act of previous rebellion.
- Membership in the iGen (the generation of students born at the same time of development of the Internet), being educated for their growth in society digital.

In turn, for this project, the objectives to be achieved are:

- Use logical reasoning to solve problems similar to your own Future working life.
- Apply the use of ICT for the acquisition of work-focused habits individual and teamwork, based on effort and responsibility in the study.
- Discovering their own potential, through autonomous work, leading to in self-confidence and self-satisfaction for the achievements made

individually and collectively.

- To value the different attitudes and aptitudes of each individual for the distribution of tasks.

- To use video games as a motivational means for the creation of contents.

For its development, each phase involved in the Project Based Learning method would have been covered:

- Initial question: in this section you will find the question to be answered and those routines of thought whose objective is the activation of knowledge.

- Collaborative team building: in this section, the teams are defined as follows and those thinking routines whose purpose is the comprehension of the aptitudes and attitudes of individuals.

- Definition of the final challenge (with ICT): at this stage, the product to be produced is specified

- and those thinking routines whose objective is to facilitate this process specification.

- Organization and planning: this period includes the allocation of and the definition of tasks and those routines of thought whose purpose is the visualization of the planning.

- Search and collection of information: this phase is where the process of and those thinking routines whose objective is the collection of materials and those thinking routines whose objective is the source filtration.

- Analysis and thesis: in this section we find the contrast of information and the those thinking routines whose purpose is the comprehension of knowledge.

- Workshop and production: in this section, the application and development of the and those thinking routines whose objective is the elaboration of a project and those thinking routines whose objective is the elaboration of a project Contents.

- Presentation of projects: at this stage, the presentation of the project is developed product and those thinking routines whose purpose is to facilitate the understanding of the characteristics of the result obtained.

- Collective answer to the initial question: this is the period in which the conclusions reached and those thinking routines whose objective is the understanding of knowledge.

- Evaluation and self-assessment: this phase reflects the self-reflection of the work done and those thinking routines whose purpose is the evaluation of of knowledge.

In order for students to develop their own video games, the use of the Gdevelop program is proposed. This is a video game generator program, focused on 2D video games, with programming based on action and consequence. At the same time, this tool allows the creation of mobile games, promoting the public factor of the final product, a characteristic concept of PBA.

In addition, a support web page was developed (<https://sites.google.com/view/manual-gdevelop/página-principal>), to review or expand their knowledge, which includes video tutorials and images of the commands, the latter being the most complex part of the development of the project.

It also offers a creative point for the design of your video game, by

the Piskel tool, focused on pixel art-based graphic elaboration, allows students to elaborate their own sprites without the need for high artistic skills.

The development of each PBL stage for the elaboration of the video game with its respective thinking routine is detailed below. The latter is our evaluation instrument, providing us with the data to be analyzed in order to verify its effectiveness.

Because, thanks to the thinking routines, it is possible to capture the different reasoning processes of the students, observing the relationship between the different ideas or concepts that they themselves generate.

Initial question

At this stage, the initial question, "How to control future pandemics through mathematics?" would have been presented through the "Timeline" thinking routine, taking a tour of the most important pandemics in history. Similarly, the "Rubric" thinking routine would have been offered and the first part of the "Did I used to think?" routine would have been done now I think?" for future phases.

At the same time, there would have been an introduction to the elements of Gdevelop, focused on the first steps for the development of the video game, the explanation of the buttons and the positioning of the camera.

Collaborative team building

During this phase, the idea was to form the work teams by means of the "Test" thinking routine, whose objective is to level the groups by means of a series of questions on the subject to be dealt with.

In addition, an input to the design of the sprites to be used would have been carried out using the Piskel tool.

Definition of the final challenge (with ICT)

In the course of this section, the category to be chosen in the universe of video games would have been defined using the "Hand Model" routine, whose purpose is to choose the genre of video games most in line with the written answers. Emphasizing the issues to be addressed with respect to the subject of Mathematics.

In addition, a lesson focused on the animations of the characters that will take part in the video game was also planned.

Organization and planning

Throughout this session, the distribution of tasks and the steps to be taken to achieve the proposed objective would have been discussed. The thinking routine to be used would have been "Kanban", with the objective of graphically capturing the evolution of the video game.

Likewise, a class oriented on the movement of the characters themselves would have been carried out.

Search and collection of information

During this period it was planned to carry out the information gathering process for the context and history of the video game, by means of the "Reliability of sources" thinking routine, whose purpose is the debugging of contents for a better contextualization.

Likewise, the steps to follow for the structuring of the movement and damage commands of the enemies in the videogame were also explained.

Analysis and thesis

During this stage he would have focused on defining the context and the story, through the "Compare and contrast" thinking routine, managing to synthesize the information collected from the previous phase.

Also, training was planned for the input of commands in the platforms, developing mobile platforms for later use in the video game.

Workshop and production

In the course of this phase, the development of the video game would have begun, using the "Generate-classify-connect-elaborate" thinking routine, to concretize the cohesion between the elements.

And using the "Storyboard" routine in order to capture the continuity to be followed by the production.

At the same time, an introduction would have been made to the scene change, the pause button and the protagonist's life bar.

Presentation of projects

Throughout this section, the results obtained by the teams would have been presented. Although the teams would not have had a fixed method of exposure, the "Gameplay" thinking routine would have been recommended for a better visualization of the video game and the concepts to be conveyed.

No explanation of the program would have been given in order to focus on the exhibits themselves.

Collective answer to the initial question

This session would have answered the initial question of "How to control future pandemics through mathematics?", using the Lino tool, in turn it was intended to complete the thinking routine that "Did you used to think?" now I think?" with the objective of contrasting what has been learned and responding with solid arguments on the topic to be discussed.

In addition, a lesson would have been given on the configuration of the video game to the field of mobile devices.

Evaluation and self-evaluation

During this stage it was intended to assess the results obtained by the students, and the "Rubric" thinking routine, offered at the beginning, would have been used to base this estimation of knowledge.

In addition, there would have been a class focused on the export of the video game.

In addition, for the project to meet its objective, it must have continuity, so a timeline (Table 1- Project timeline) was drawn up for one school term, focused on the creation of video games in the classroom, covering the following sections: dates, PBL phases, thinking routines, video game development and explanation of the program.

Table 1

Project Timeline

1st Quarter				
Date	PBA Phase	Routine of thinking	Development of the video game	Explanation of Gdevelop
September 15 (50 min)	Ask initial	Timeline (5 min) "Did you used to think? now I think?"	Ask about The video game (5 min)	Introduction from the elements of Gdevelop (First steps, buttons

	Formation of team collaborative	(5 min) Test (10 min)	Creation from equipment work (5 min)	and camera) y entrance to the design of sprites with Piskel (20 min)
September 29 (50 min)	Definition of final challenge (with ICT)	Hand Model (10 min)	Concretization of the subject of the video game (5 min)	Explanation of the animations y configuration of the protagonist (Movement) (15min)
	Organization and planning	Kanban (10 min)	Timeline and distribution of tasks (10 min)	
October 6 (50 min)	Search and compilation of information	Reliability of sources (15 min)	Process of collection of the context of the video game (20 min)	Structuring of the commands of enemies (Movement and damage) (15 min)
October 20 (50 min)	Analysis and thesis	Compare and contrast (10 min)	Process of study of the context of the video game (25 min)	Training in the commands for the platforms (Static and cell phones) (15 min)
November 10 (50 min)	Workshop and production	Generate-sort-connect-elaborate (10 min) Storyboard (10 min)	Generation of the video game (20 min)	Entrance to the parameter of life of the protagonist (10 min)
December 1 (50 min)	Presentation of projects	Gameplay (15 min)	Exposure of the video game (15 min per group)	Presentation of the project
December 15 (25 min)	Reply collective to the initial question	used to think? now I think? (10 min)	Sharing of the results obtained (10 min)	Configuration of the video game for devices mobiles y explanation of export of the game (10 min)
	Evaluation and self-evaluation	Heading (10 min)	Verification of the contents acquired (10 min)	

Results

Unfortunately, due to the COVID-19 pandemic, it was not possible to carry out a practical implementation, so a project assumption was made, developing each phase until the final achievement of the objective, being the video game apk.

(https://drive.google.com/file/d/19tbGdowx5BF122DBCQ_oQzyVnF34JYD/view?usp=sharing)

Initial question: in the course of this session, the initial question would have been presented through the "Timeline" thinking routine (Figure 1- Timeline thinking routine), making a tour of the most important pandemics in history. In addition, they would have been offered the "Rubric" thinking routine (Figure 13- Rubric Thinking Routine) and planned to perform the first part of the routine "Did I used to think?" now I think?" (Figure 2- Thinking routine Did you use to think? now I think?) for future phases.

Figure 1

Timeline thinking routine

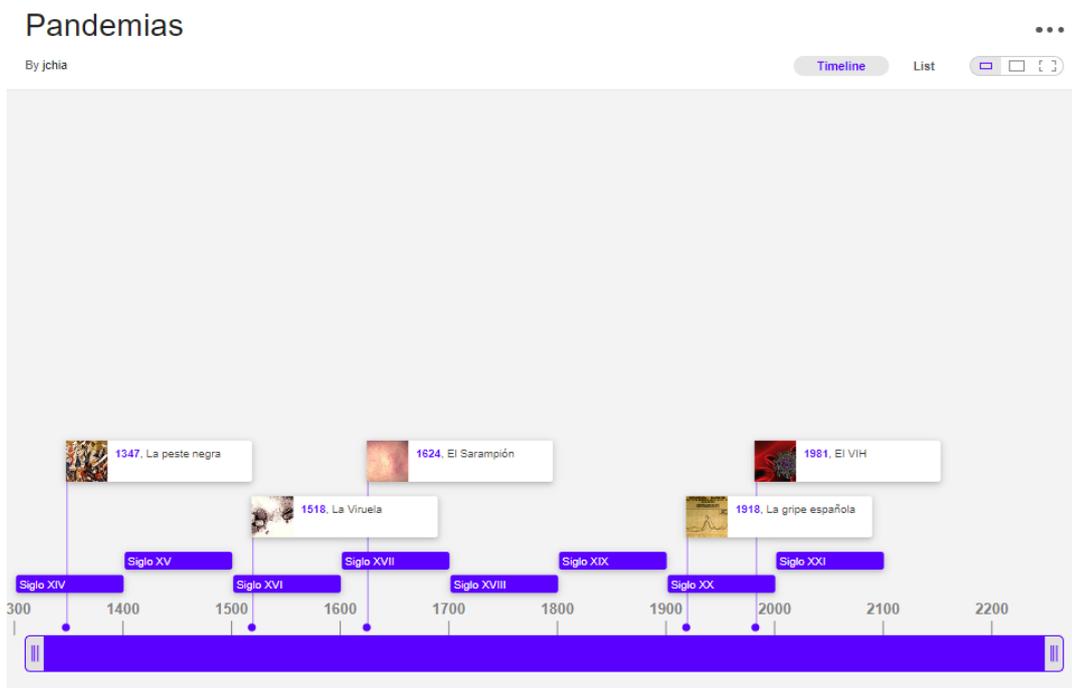


Figure 2

Thinking routine Did you use to think? now I think?

Solía pensar... Ahora pienso...

Nombre: Juan José Torres		Tema: Las matemáticas y las pandemias	
	Solía pensar...		Ahora pienso...
La pandemia es una enfermedad a nivel global. _____		_____	
El coronavirus es una pandemia. _____		_____	
Dibujo 		Dibujo _____	
Mi pensamiento ha cambiado debido a: _____ _____			

Thanks to these implementations, students would have been aware of their own prior knowledge and would have appreciated the importance of the historical journey, conceiving history as a way to take advantage of it in order to avoid previous mistakes.

Collaborative team building: during this stage, working groups would have been formed by means of the "Test" thinking routine (Figure 3- Routine Thinking Test), seeking to create balanced teams.

Figure 3

Thinking routine Test

*
Escribe tu nombre y apellidos

*
¿Qué es una pandemia?

Enfermedad epidémica aguda, acompañada de fiebre y con manifestaciones variadas, especialmente catarrales.

Enfermedad epidémica que se extiende a muchos países o que ataca a casi todos los individuos de una localidad o región.

Fenómeno patológico que se manifiesta por elevación de la temperatura normal del cuerpo y mayor frecuencia del pulso y la respiración.

Escribe las pandemias que recuerdes.

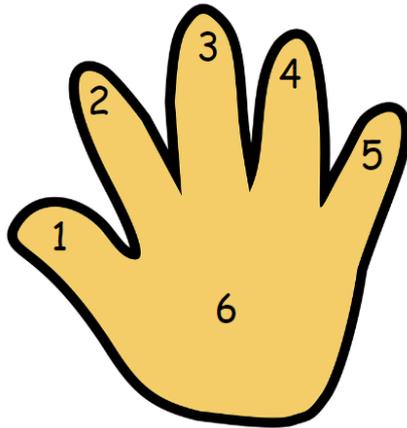
As a result of this activity, the students would have obtained equipment with greater diversity, gaining the opportunity for a learning cooperative, with the more advantaged students helping those who have more difficulties with the subject matter.

- Definition of the final challenge (with ICT): in this section, the groups should have chosen the category of their videogames, using the thinking routine "Hand Model" (Figure 4- Hand Model thinking routine). Highlighting the topics to be addressed with respect to the subject of Mathematics.

Figure 4

Hand Model Thinking Routine

HAND MODEL



Nombre: Juan José Torres

1. (Qué) Un videojuego de plataformas con caminos múltiples. basado en problemas de matemáticas.

2. (Cuándo) El videojuego estará ambientado en las diferentes épocas en las que surgieron pandemia.

3. (Cómo) El jugador ha de resolver el problema matemático, cuyas respuestas están en los carteles.

4. (Dónde) El videojuego estará basado en una ciudad lúgubre y invadido por los villanos.

5. (Quién) Existen tres personajes, Sparky (protagonista), los enmascarados y los villanos.

6. (Por qué) Los villanos han robado las vacunas y Sparky se va a encargar de recuperarlas..

Since the points to be addressed have been determined, the team would have clear objectives to be achieved, having a better management in their realization, avoiding change in the middle of the process and project delay.

- Organization and planning: during this period, it was thought that the teams would will carry out their approach to the work, relying on the routine thinking "Kanban" (Figure 5- Kanban thinking routine).

Figure 5

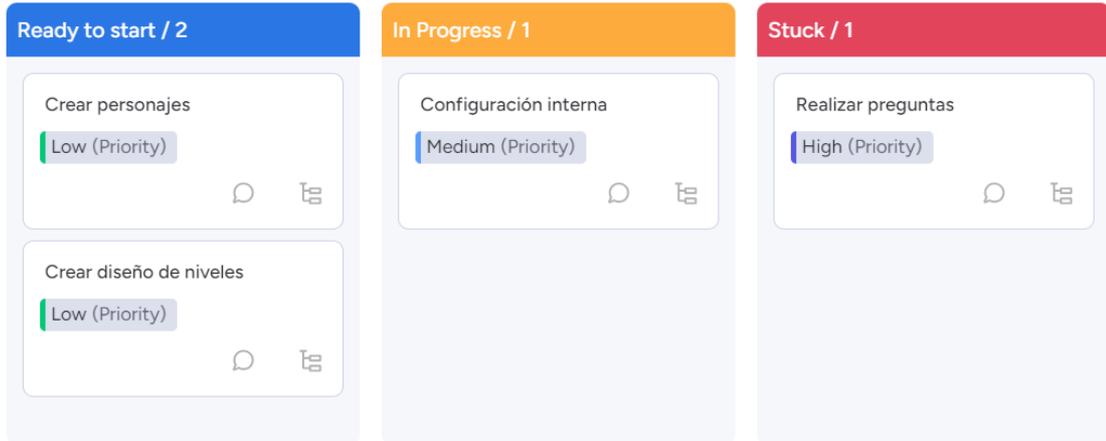
Kanban thinking routine

Videojuego

This is the committed plan for the team. [Ver más](#)

Kanban | Tabla principal | Default View | +

Agregar Tarea | Buscar | Persona | Filtrar | Ordenar | Ocultar



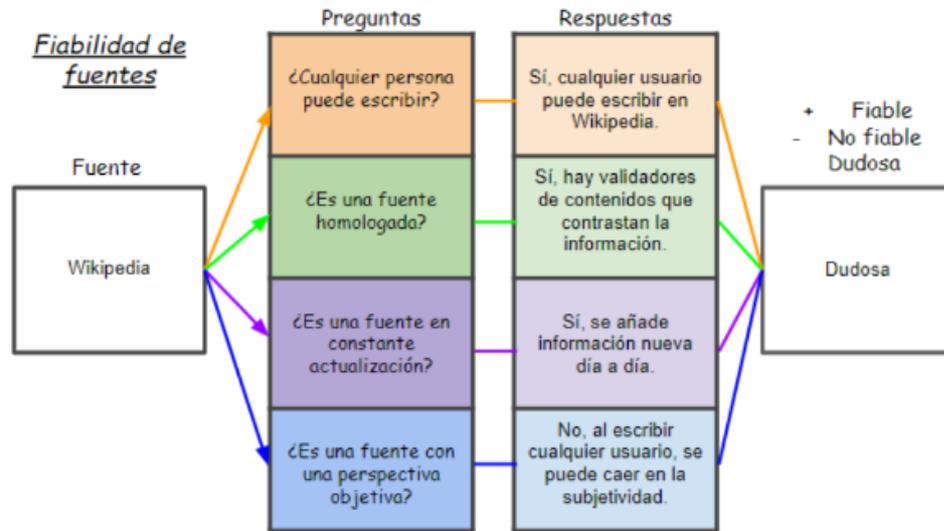
Due to a visual organization of the tasks, the groups appreciate the point they are at in the development of the project, assessing the number of steps to be carried out and leading to a constant and bearable.

- Search and collection of information: during this phase, the participants will be able to

groups would have conducted their information gathering processes for the context and history of the videogame, using the thinking routine "Reliability of sources" (Figure 6- Thinking routine Reliability of sources).

Figure 6

Routine thinking Reliability of sources



Thanks to these implementations, students would have become aware of the blind trust they have in some everyday sources of information, valuing contrast and veracity over ease.

- Analysis and thesis: throughout this session, the teams would have defined the context and history, relying on the "compare and contrast" thinking routine (Figure 7- Source Reliability Routine Compare and contrast).

Figure 7

Routine Reliability of sources Compares and contrasts

Pandemia	Compara y contrasta	Epidemia
¿En qué se parecen?		
Afectan a varias personas	Es la propagación de un enfermedad	Suelen ser causadas por virus
¿En qué se diferencian?		
Es a nivel global	Número de personas	El rango máximo es el de un país
Es un aumento de casos más rápido	Aumento de casos	Es un aumento de casos más lento
Patrones de semejanza y diferencia significativos Personas afectadas y propagación		
Conclusión e interpretación Las pandemias afectan a un número mayor y tiene un rango mayor que las epidemias		

As a consequence of this activity, the students would have been able to verify

the differences between the two concepts to be discussed, highlighting their similarities and differences avoiding future confusion.

- Workshop and production: at this stage, it was planned to start with the development of the video game, guided by the "Generate-classify-connect-Elaborate" (Figure 8- Generate-classify-connect-elaborate thinking routine) and "Storyboard" (Figure 9- Storyboard thinking routine). Implementing the agreed content based on the subject of Mathematics.

Figure 8

Thinking routine Generate-classify-connect-elaborate

Generar-clasificar-conectar-elaborar

Generar <i>Lista de ideas sobre el tema</i>	Clasificar <i>Colocar las ideas más relevantes</i>
<ul style="list-style-type: none"> - Plataforma móvil - Jefe final - Ninja - Agua - Bolas de fuego - Conducción de motos 	<ul style="list-style-type: none"> - Plataforma móvil - Jefe final - Agua - Bolas de fuego
Relacionar <i>Asociar las ideas comunes</i>	
<ul style="list-style-type: none"> - Personajes: las bolas de fuego y el jefe final - Entorno: la plataforma móvil y el agua 	
Desarrollar <i>Elaborar las ideas con otras relacionadas</i>	
<ul style="list-style-type: none"> - Las bolas de fuego pueden dañar al jefe final. - La plataforma móvil evita que nos caigamos al agua. 	

Figure 9

Storyboard thinking routine



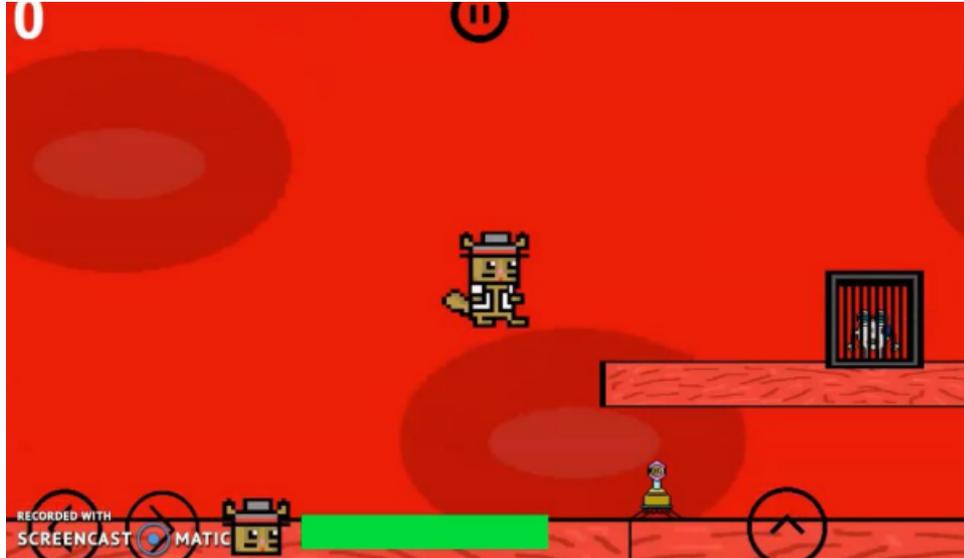
Since it has followed a common thread focused from a visual point of view, appreciating the previous and subsequent steps in the development of the project and assessing the sequentiality of the same. The students would not have deviated from their original idea, nor from the proposed objectives, adding the concepts to be dealt with from the Mathematics subject.

- Presentation of projects: during this section, the video games created would have been exhibited video games created. To see the potential of the video game, the

"Gameplay" thinking routine would have been used (Figure 10- Gameplay Thinking Routine) of the same Gameplay) of the same, by means of the Screencast-O-Matic tool.

Figure 10

Gameplay Thinking Routine



As a result of this activity, the students would have reflected their learning process to the rest of their classmates, having the suggestions of their classmates and the teacher as points to improve in their future projects, working at the same time on social skills such as listening, respect and tolerance.

- Collective answer to the initial question: over the course of this period, the initial question "How to control future pandemics through mathematics?" would have been answered (Figure 11- Answering the initial question, using the Lino tool and thought to complete the thinking routine)

"Used to think? now I think?" (Figure 12- Thinking routine Did you use to think? now I think? completed).

Figure 11

Answer to the initial question

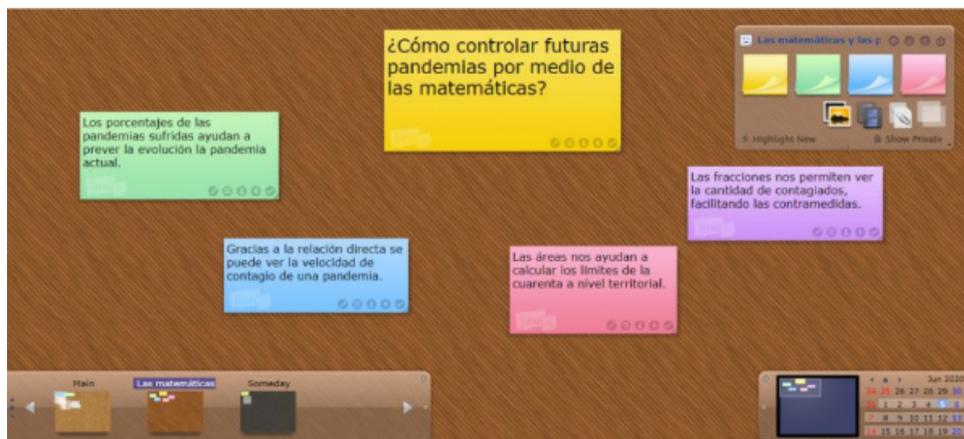
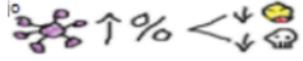


Figure 12

Thinking routine Did you use to think? now I think? completed

Solía pensar... Ahora pienso...

Nombre: Juan José Torres		Tema: Las matemáticas y las pandemias	
 Solía pensar...		 Ahora pienso...	
La pandemia es una enfermedad a nivel global. <hr/> El coronavirus es una pandemia. <hr/>		Gracias a los porcentajes se pueden simular las <hr/> variantes dentro de una pandemia. <hr/>	
Dibujo 		Dibujo 	
Mi pensamiento ha cambiado debido a: <hr/> Gracias a la cantidad de información buscada en el proceso de recolección y los problemas matemáticos que hemos <hr/> escrito, he visto la importancia de los porcentajes en el estudio de la evolución de una pandemia. <hr/>			

Due to a journey carried out in a unison way, prioritizing in the acquired experiences, the students would have appreciated their own collection process, leading to the development of their skills and those of their peers, reaching a meaningful learning, reflected in the thinking routine.

- Evaluation and self-evaluation: during this phase, the following would have been evaluated results obtained, based on the "Rubric" thinking routine (Figure 13- Thinking Routine Rubric) offered at the beginning.

Figure 13

Thinking routine Rubric

Haciendo un juego: Las matemáticas y las pandemias				
Categorías	4	3	2	1
Conocimientos adquiridos	Todos los estudiantes en el grupo pueden fácilmente y correctamente explicar varios aspectos sobre el tema usado para el videojuego sin mirar el proyecto.	Todos los estudiantes en el grupo pueden fácilmente y correctamente explicar 1-2 aspectos sobre el tema usado para el videojuego sin mirar el proyecto.	La mayoría de los estudiantes en el grupo pueden fácilmente y correctamente explicar 1-2 aspectos sobre el tema usado para el videojuego sin mirar el proyecto.	Algunos los estudiantes en el grupo no pudieron explicar correctamente los aspectos sobre el tema usado para el videojuego sin mirar el proyecto.
Creatividad	El grupo puso mucho esfuerzo en hacer el videojuego interesante para jugar, como fue demostrado por las preguntas creativas, piezas del juego y/o juego mismo.	El grupo puso mucho esfuerzo en hacer el videojuego interesante y divertido para jugar usando texturas, escritura elegante y/o personajes interesantes.	El grupo trató de hacer el videojuego interesante y divertido, pero algunas de las cosas hicieron el videojuego difícil de entender y/o disfrutar.	Poco esfuerzo fue puesto en hacer el videojuego interesante o divertido.
Atractivo	Colores contrastantes y lo menos 3 gráficos originales fueron usados para dar al videojuego un mayor atractivo visual.	Colores contrastantes y lo menos 1 gráfico original fue usado para dar al videojuego un mayor atractivo visual.	Colores contrastantes y gráficos públicos fueron usados para dar al videojuego un mayor atractivo visual.	Poco o ningún color fueron incluidos
Presición del contenido	Toda la información hecha para el videojuego es correcta	Casi toda la información hecha para el videojuego es correcta	La mayor parte de la información hecha para el videojuego es correcta	La información ofrecida es incorrecta

Thanks to the fact that the student had the evaluation criteria available, he would have known which points of the video game to cover more rigorously, being able to adapt to the teacher's requirements without losing originality.

Discussion and conclusions

After completing this innovation project, a series of conclusions have been reached:

The intrapersonal factor in the creation of the project: in the elaboration of the assumption, a high level of personalization has been appreciated during the realization of the project, leading to significant learning, as the result is part of the individual himself, moving away from the alienation of the contents and incorporating the knowledge to his own mental scheme.

The importance of PBL interconnection: in each phase to be developed, it can be observed that each step to be taken is linked to the previous one, having the sequencing itself a relevant role in the elaboration of the project, taking a bidirectional function, being an important educational factor, due to the importance of the detection of the previous error to achieve a solid base for the new knowledge and vice versa.

The approach to reality provided by PBL: Project Based Learning, has as its pillar to shape the work process, bringing to the classroom the different stages that students will see in their future jobs. This results in meaningful learning, as the student appreciates that the effort made has a logical end for his or her future.

The importance of diversity of thought: during each phase of PBL, the opinion of each component of the team is taken into account, seeking convergence for the completion of each task and the approach to the next step, encouraging cooperation and accustoming students to live together in society, this being an important factor in the education of students, understanding that their opinion is valid, just like the opinions of their peers, working on tolerance.

The synchronization of PBL and thinking routines: thanks to the versatility of the thinking routines themselves, there is an appropriate incorporation in their use, managing to be annexed to the phases of PBL, without altering the flow or nature of both. Encouraging the use of reason as a way to incorporate knowledge through empirical work.

The motivational factor of the video games themselves: by being so present in the students' own context and the attractiveness that they themselves bring, they encourage student participation in the activity, highlighting the personalization of the activity, encouraging students to characterize their work with their own interests.

From a future point of view, it would be advisable to take the implementation to the classroom, because better answers could be obtained from the reality itself, in turn, its operation would be checked and future countermeasures to be carried out would be taken.

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