EUROPEAN DIVERSITY DESIGN FOR INCLUSIVE EDUCATION

MANUAL FOR THE DESIGN OF DIDACTIC UNITS IN AUGMENTED REALITY USING THE COSPACES EDU APPLICATION

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1ª VERSIÓN

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Disclaimer

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INTRODUCTION

This manual is created for teachers to learn how to design and create didactic units and materials in augmented reality, which they can take and implement in their classroom or outside it, through the use of the CoSpaces Edu application.

The CoSpaces Edu application is considered to be more than appropriate for integration into the teaching-learning process due to the high degree of accessibility, interaction and usability it offers; it allows you to develop your imagination and design material to adapt it to any content at any educational stage. Moreover, extensions can be added to the application, such as the Merge Cube. With CoSpaces you will create, explore and share three-dimensional spaces, making it an ideal application with which children and young people will give free rein to their thinking, express ideas, and improve their motivation towards certain subjects.

The manual is structured in six main sections. The first section explains step by step how to download and install the application on your device. The second section shows how to create an account on the application, and in the same vein, the third section illustrates the steps to follow to log in to the application. The fourth section is articulated around the CoSpaces Edu interface, in which a tour of all the sections in which the application is structured and which you will find when you enter the application is developed. The fifth section explains step by step how to design and create three-dimensional spaces by editing an infinite number of elements available in the application's library. Finally, the sixth and last section offers a series of methodological guidelines for teachers.

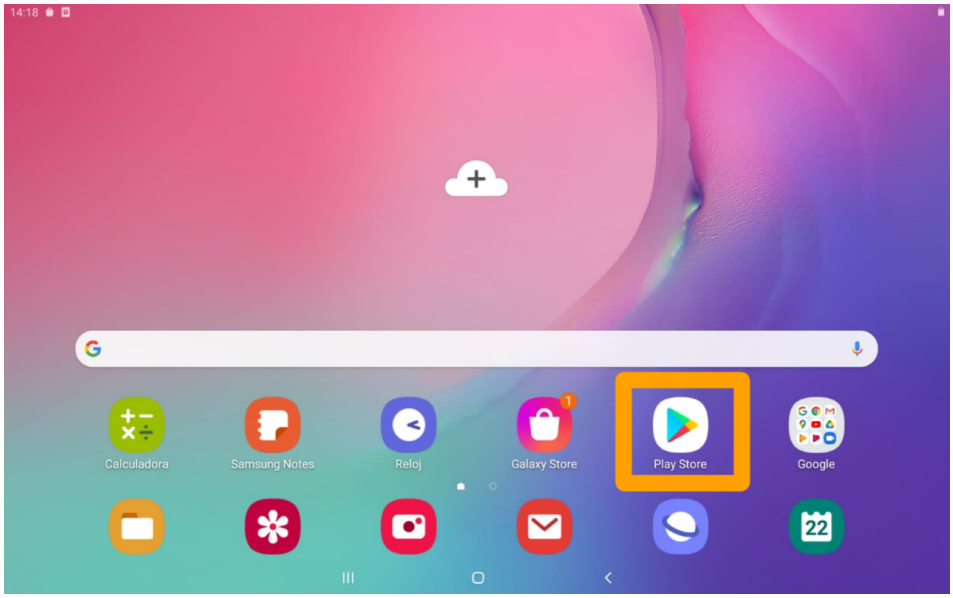
I hope that the manual will allow the design and development of didactic units in Augmented Reality, responding to the needs and characteristics of the students.

Rubén Sáenz del Amo

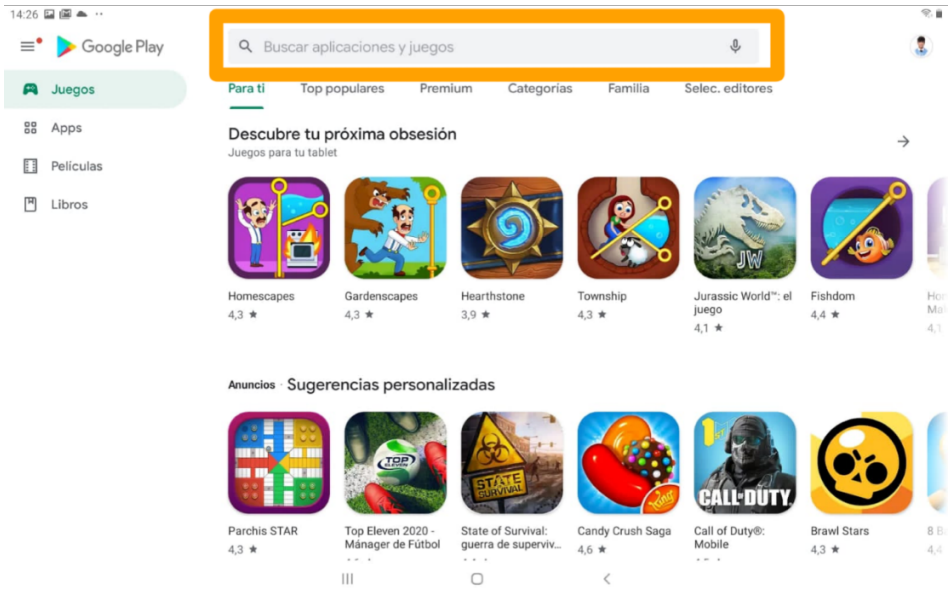
(All images in the manual are screenshots and illustrations created by the authors).

Download and installation of CoSpaces EDU

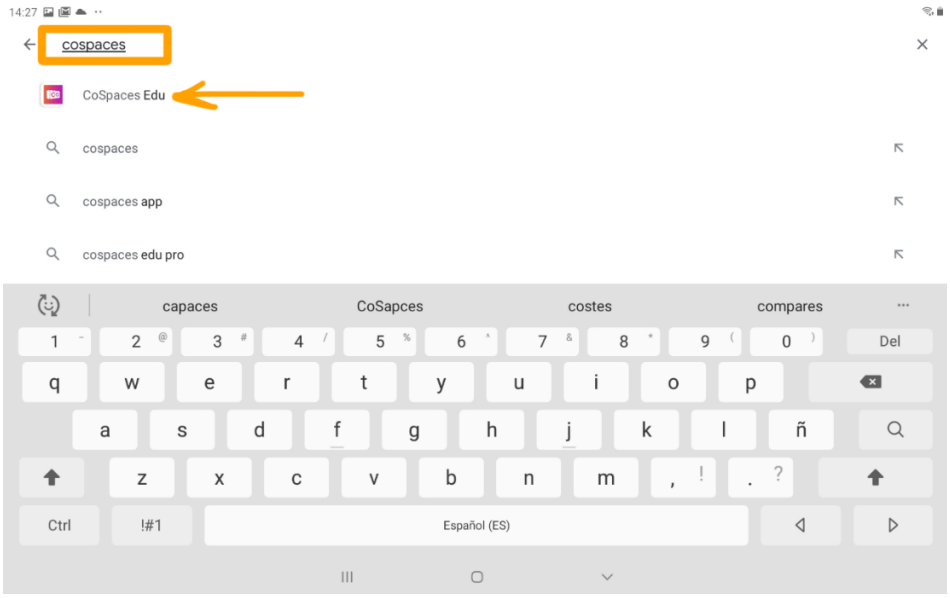
1. Click on the **Play Store** icon.



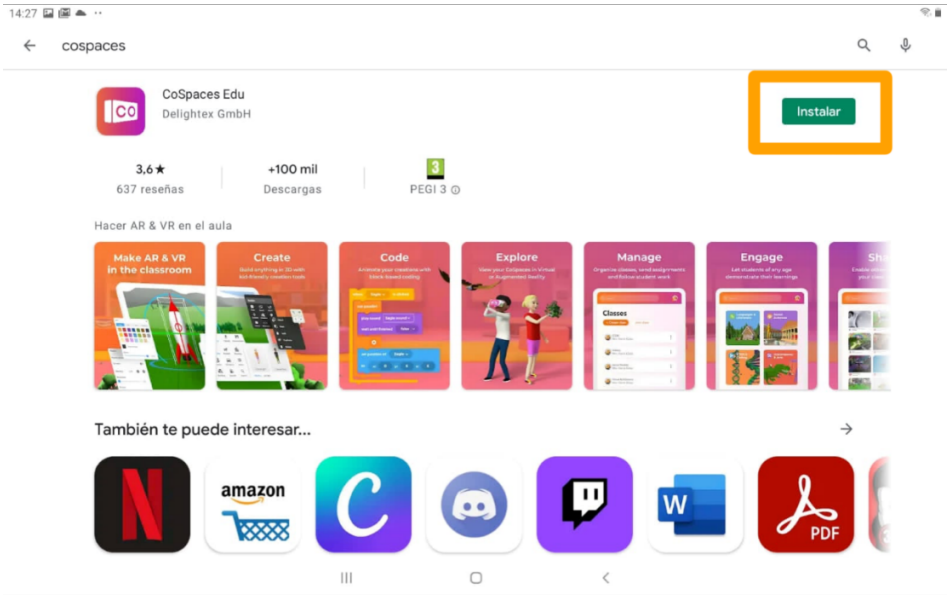
2. Once inside, click on the bar that says **Search for applications and games**.



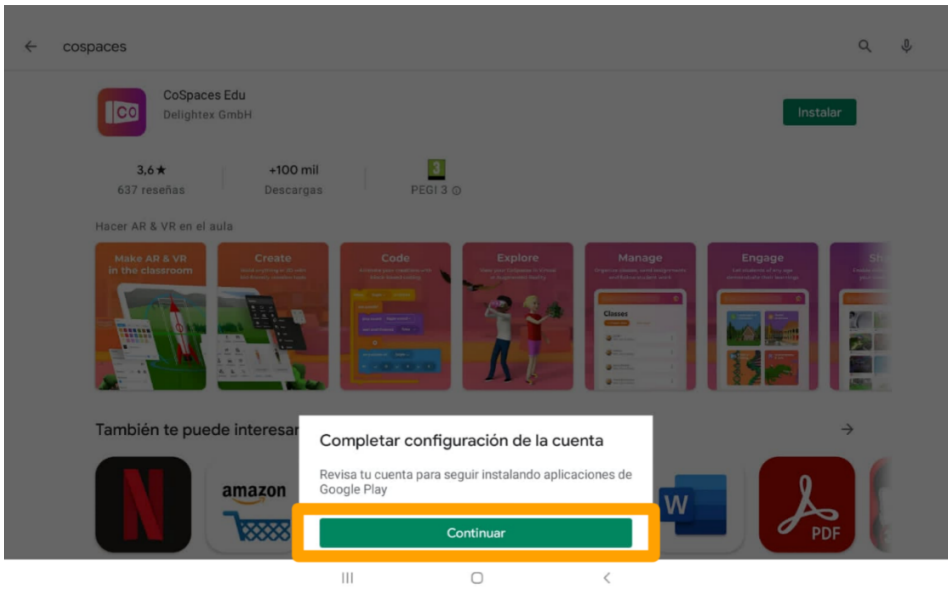
3. Search for the application by typing the words **CoSpaces Edu**.



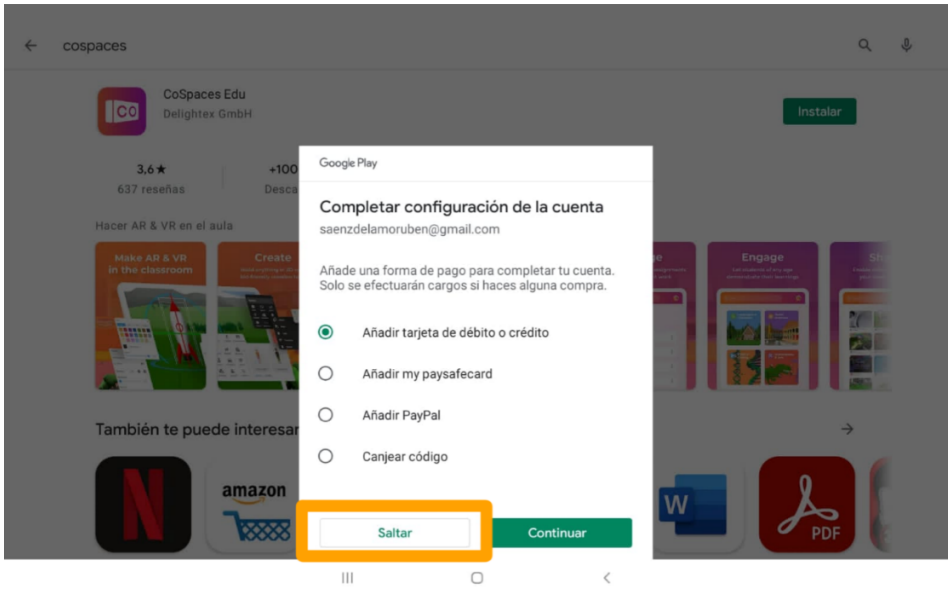
4. Once you have searched for the application, click on **Install**.



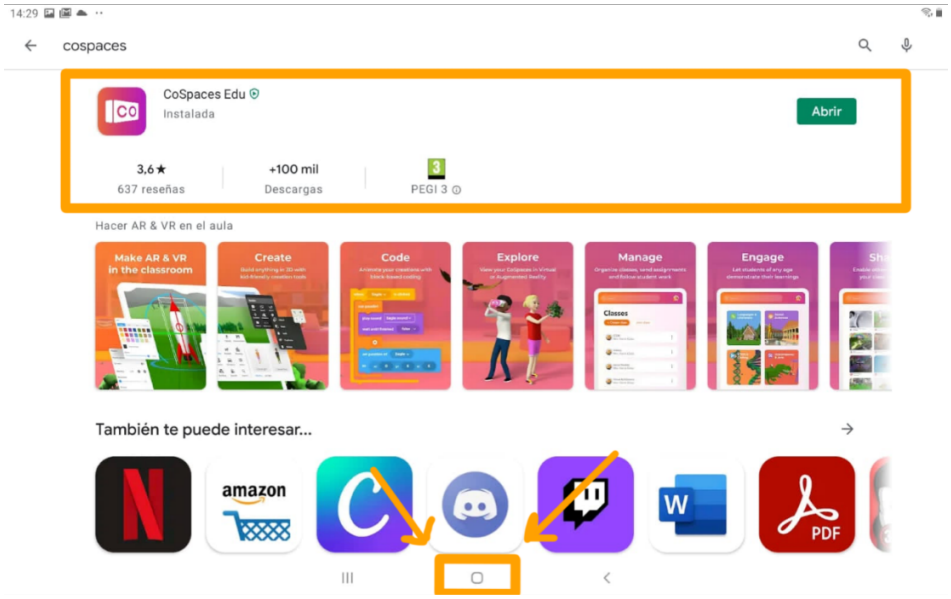
5. A pop-up window will appear below, click on **Continue**.



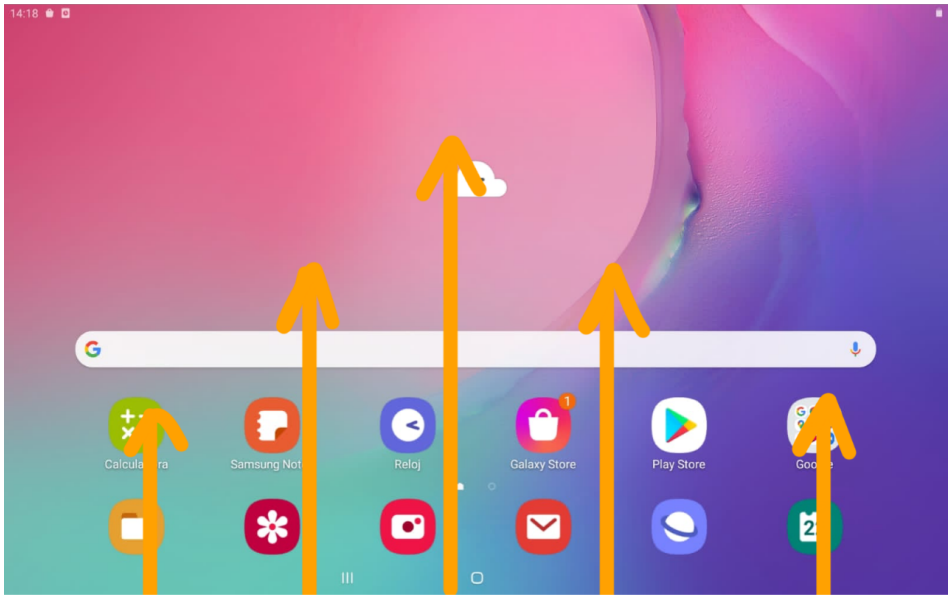
6. In the new pop-up window click on **Skip**.



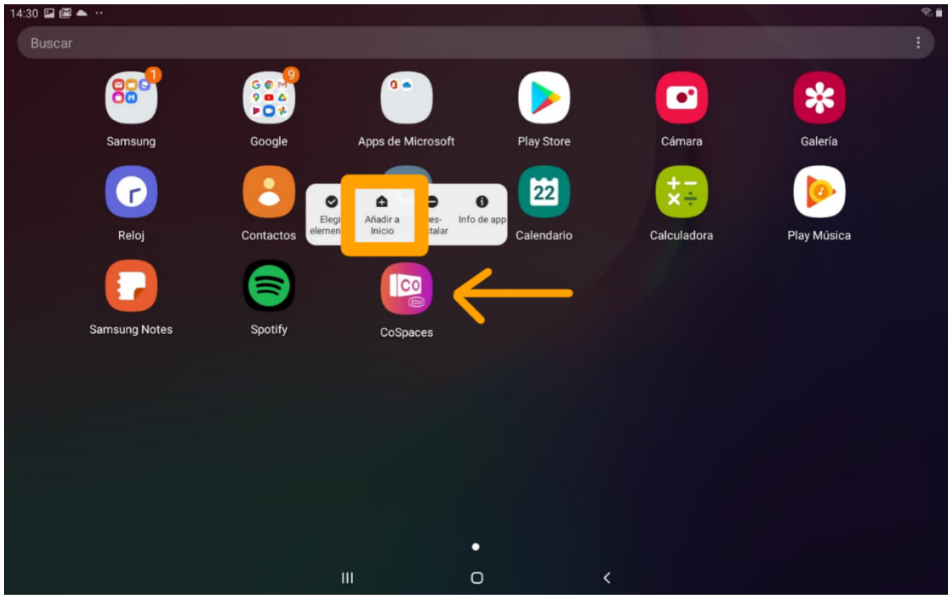
7. Once the application has been installed, the **Open** option will appear. Click on the button below to return to the home screen.



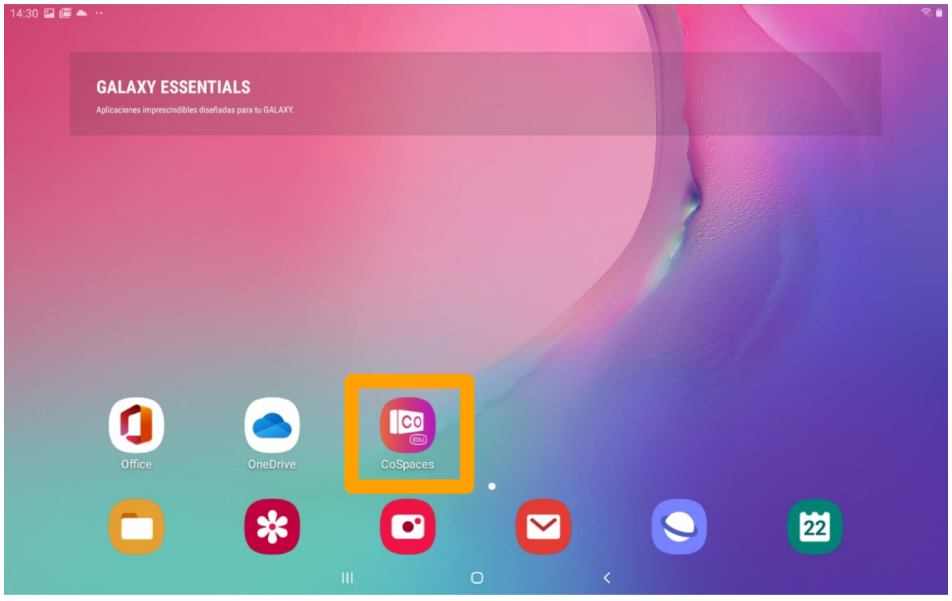
8. Swipe upwards with one finger to open the application gallery.



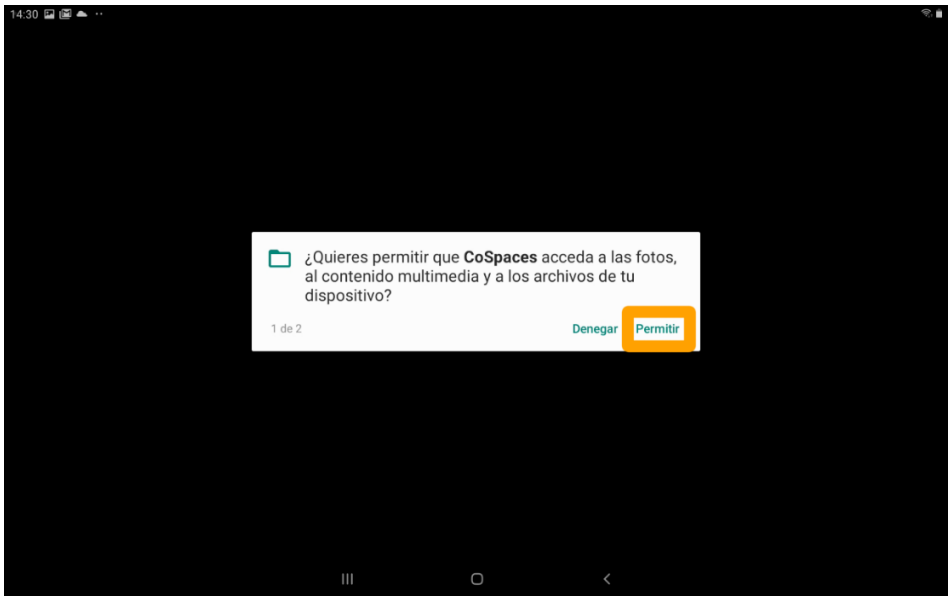
9. You can see the CoSpaces icon in the application gallery. Then, press and hold the icon for 2 seconds until the panel shown in the image is displayed. Click on **Add to start**.



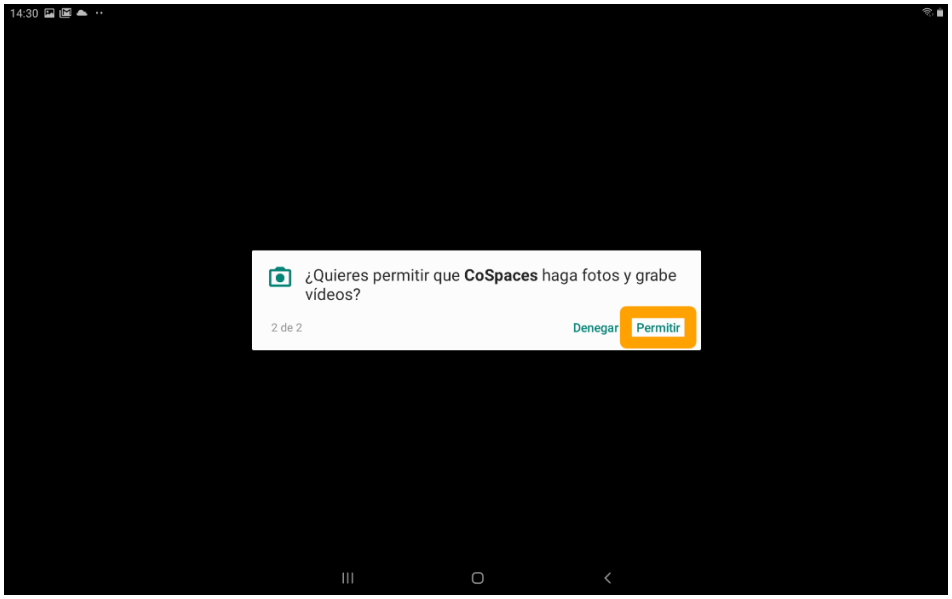
10. By returning to the home screen you can see that the CoSpaces application has been added. Click on its icon.



11. A pop-up window will appear, click on **Allow**.

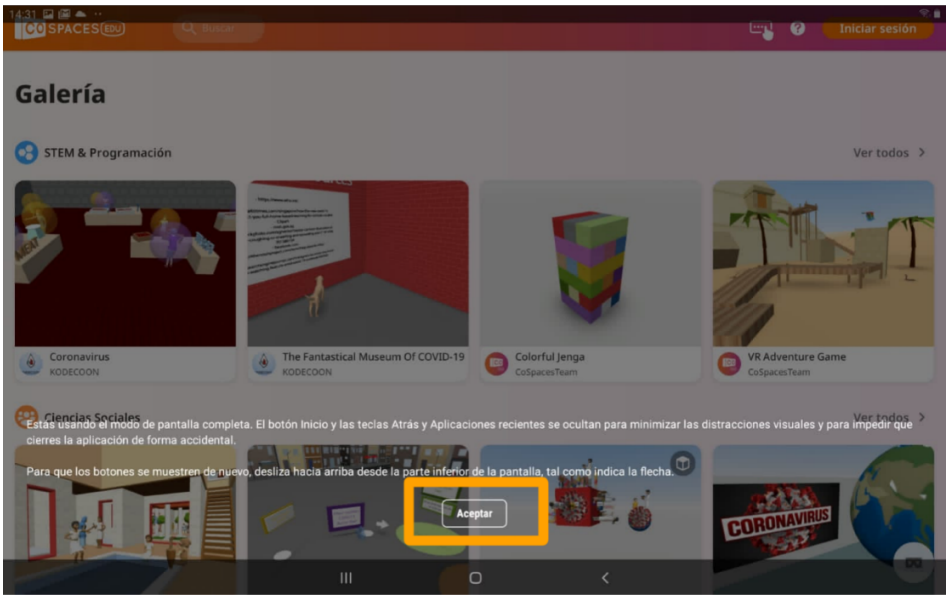


12. In the new pop-up window click again on **Allow**.

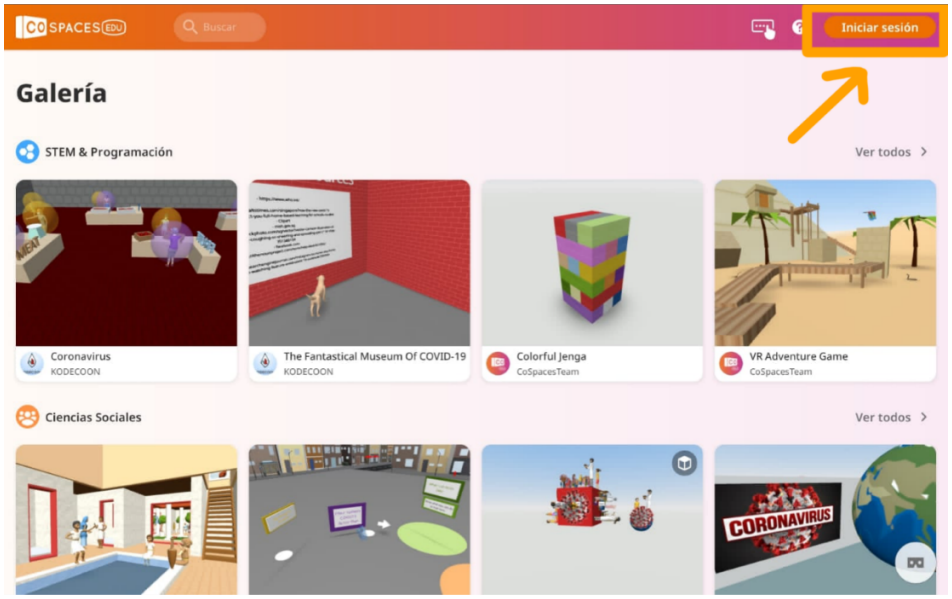


Creating a CoSpaces EDU account

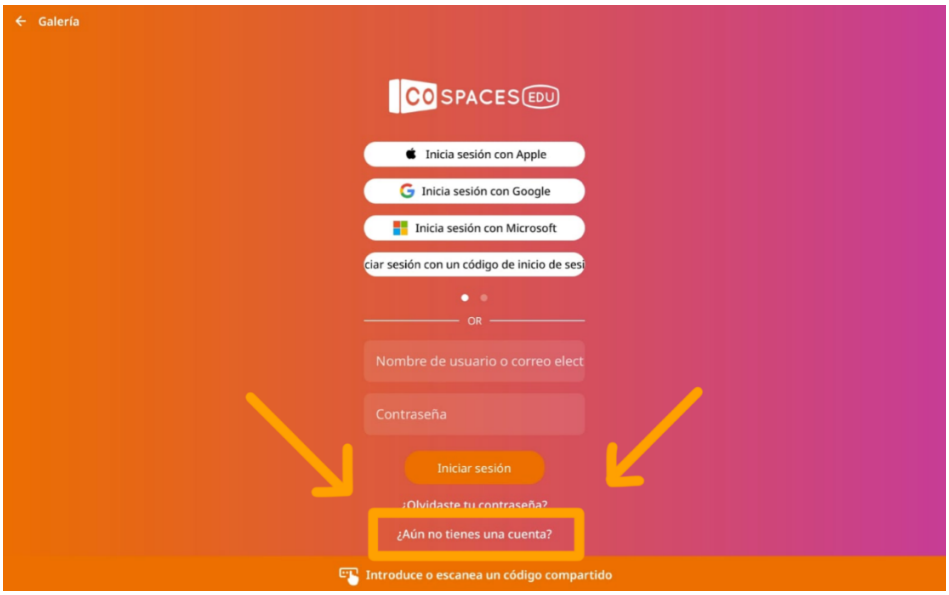
1. Once you have entered the application, you must read the pop-up text that appears and then click on **Accept**.



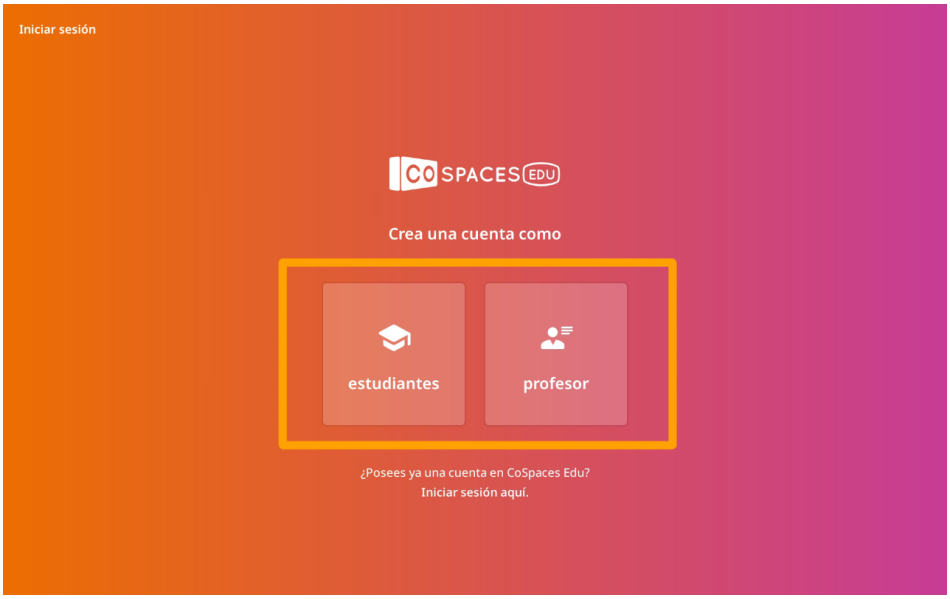
2. Click on the **Login** button.



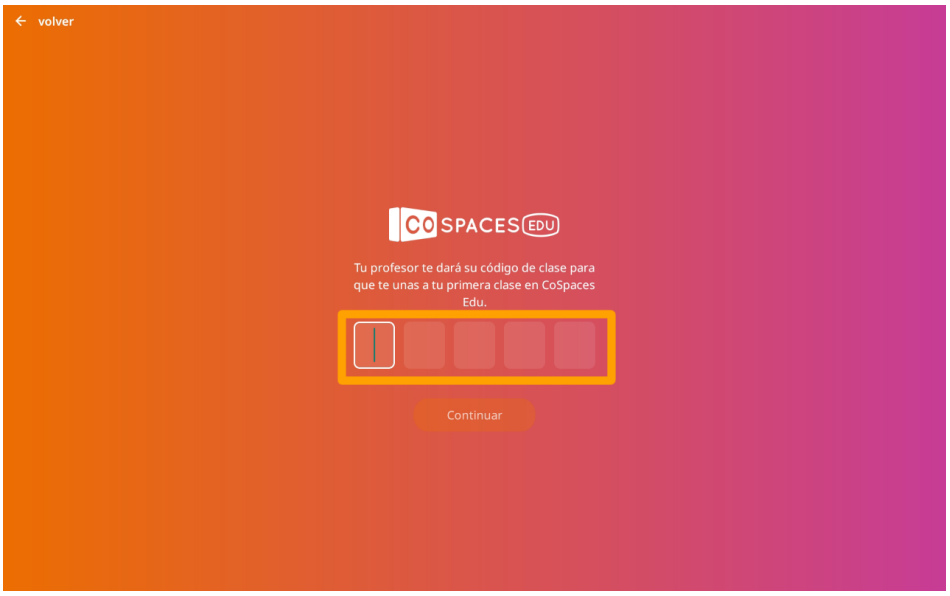
3. To register, click on **Don't have an account yet?**.



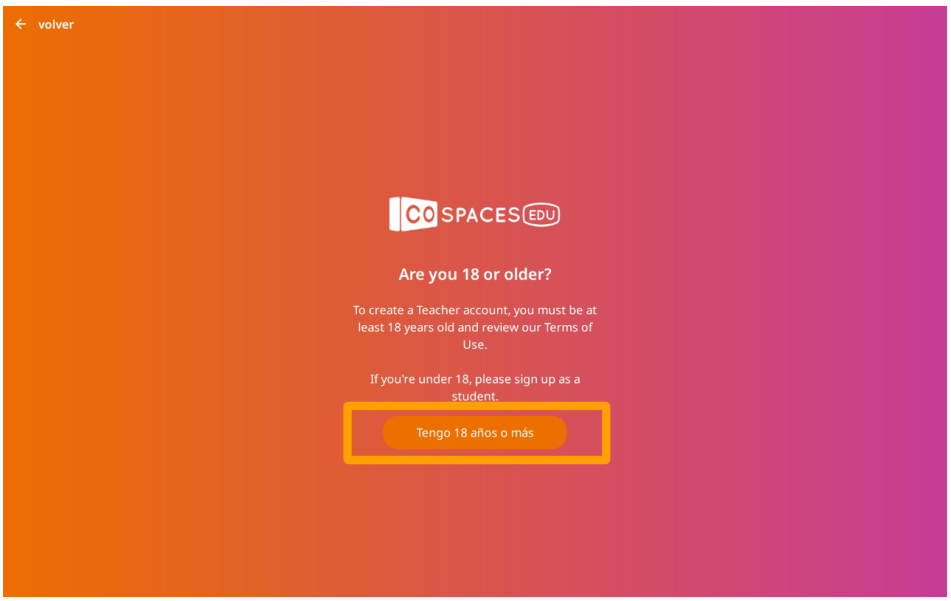
4. The application will offer you two ways to register: as a student and as a teacher. Click on the appropriate one.



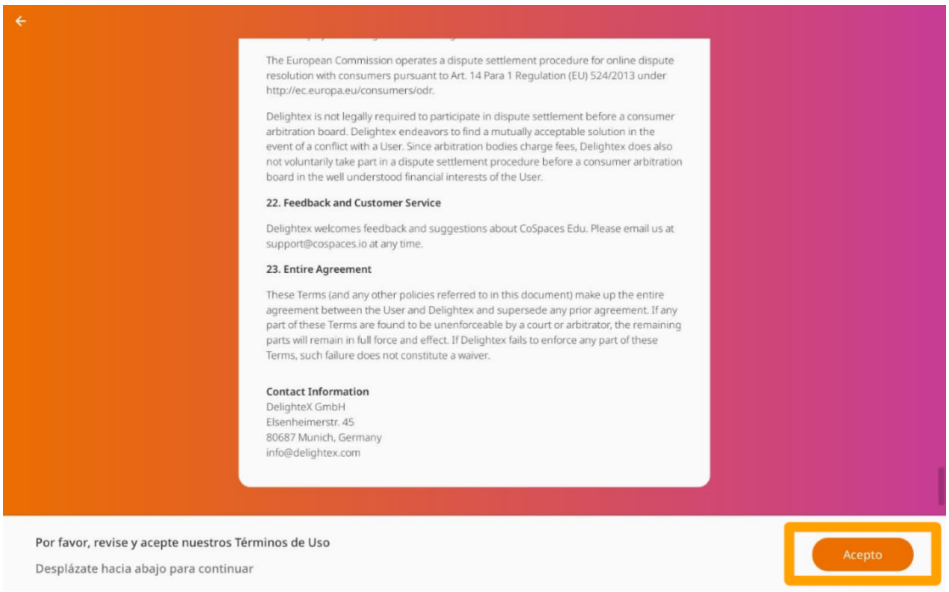
5. **STUDENT**: To access enter the class code provided by the teacher. Then click on **Continue**.



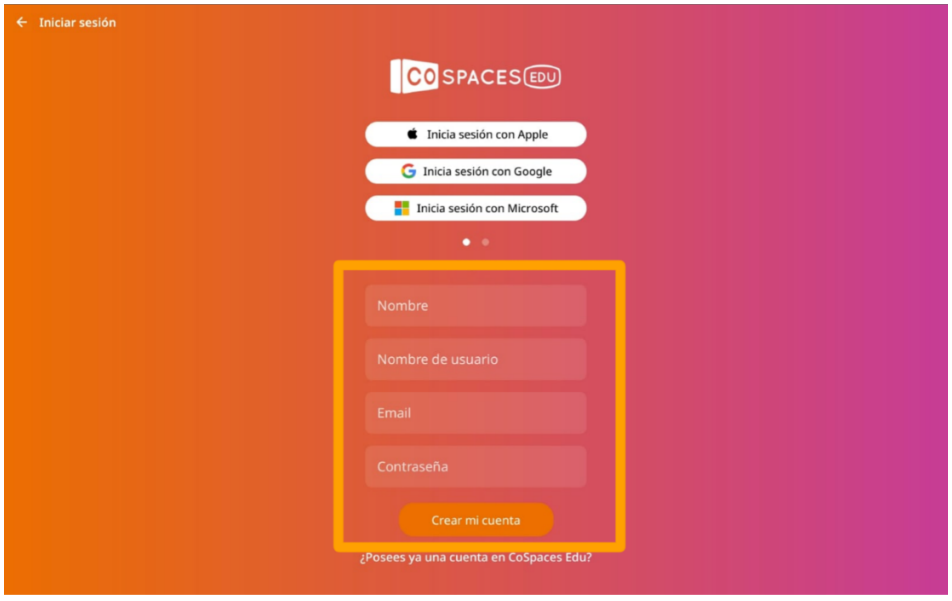
6. **TEACHER**: -1: Click on the **I am 18 or older** button.



7. **TEACHER**: Read the terms and conditions of the application and click on the **I accept** button.



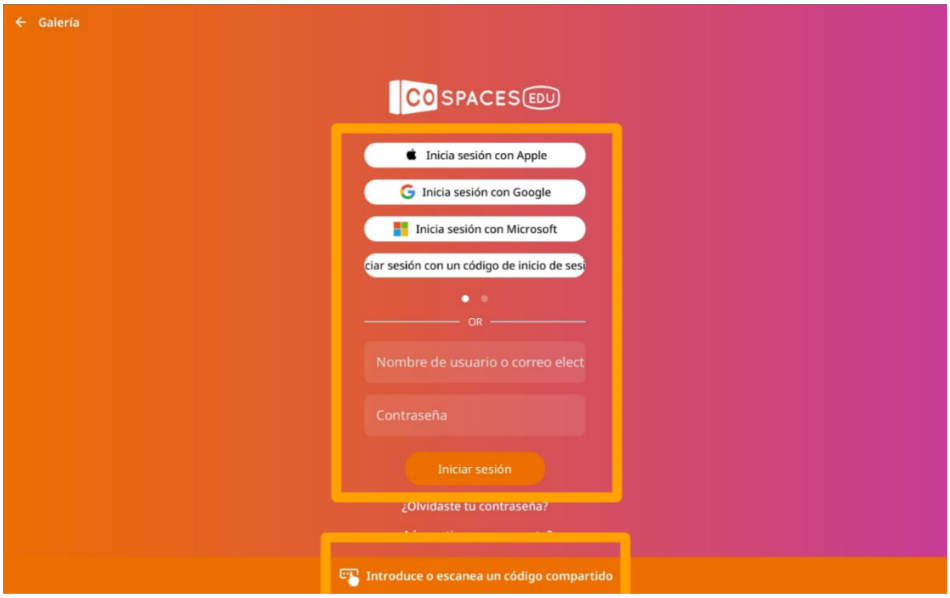
8. **PROFESOR**: Fill in the form to complete the registration. When finished, click on **Create my account** to be directed to the home screen of the application.



Login to CoSpaces EDU

The CoSpaces EDU application gives you the opportunity to log in through different pathways depending on your priorities:

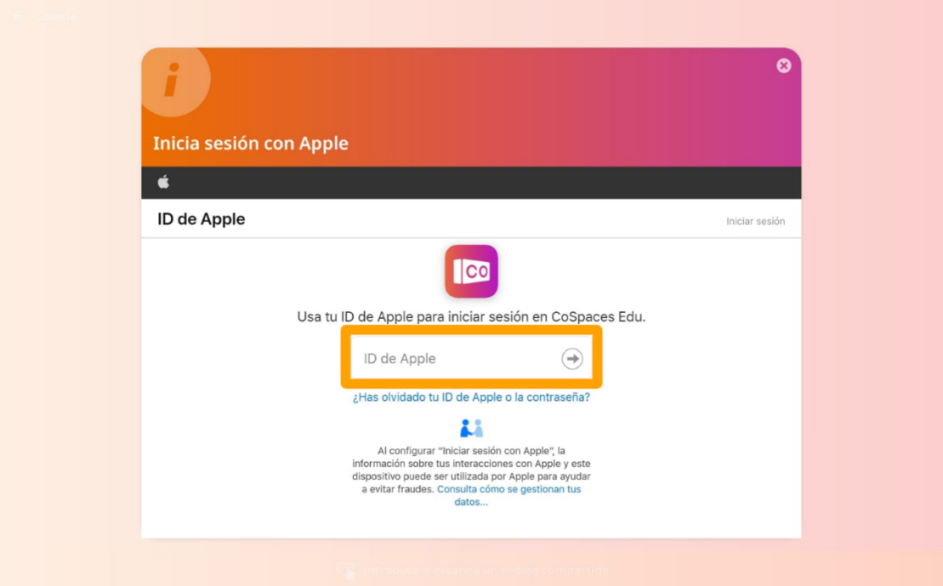
- Apple
- Google
- Microsoft
- Login code
- CoSpaces EDU account
- Shared code



Simply click on the preferred option and a pop-up window will appear, as shown below, allowing you to identify yourself and access the application.

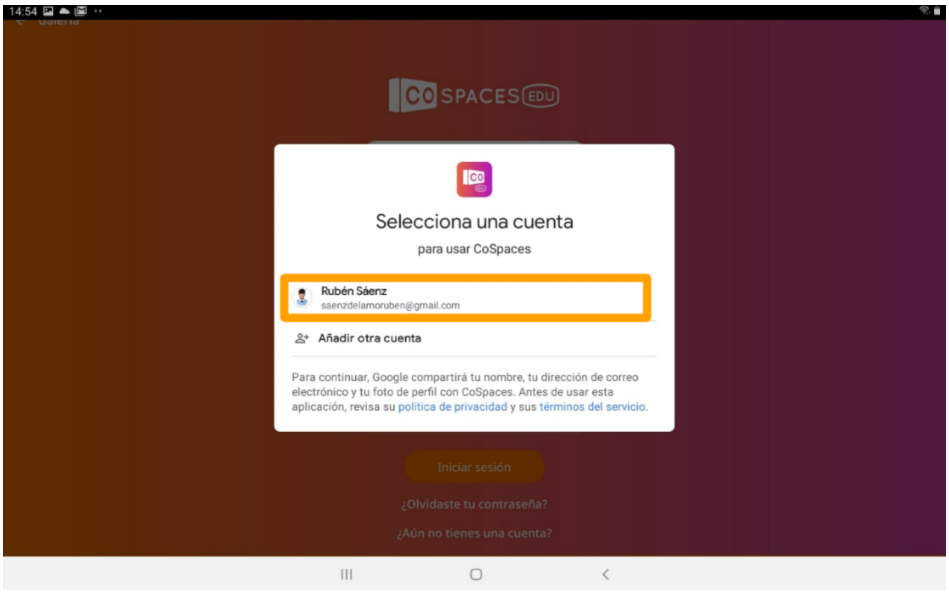
SIGN IN WITH APPLE

1. Enter your Apple ID. Then click on **Sign in**.



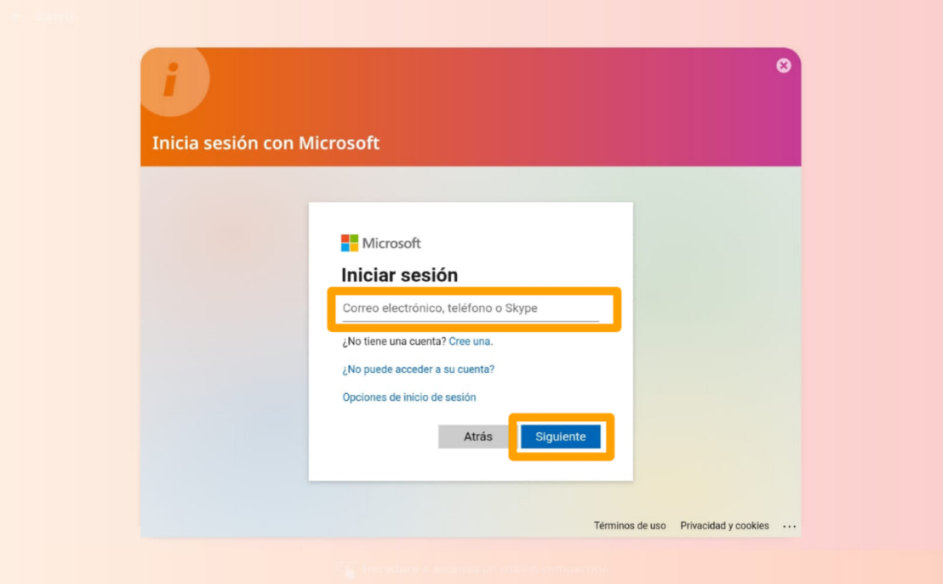
SIGN IN WITH GOOGLE

1. Select your Google account to use CoSpaces EDU.



SIGN IN WITH MICROSOFT

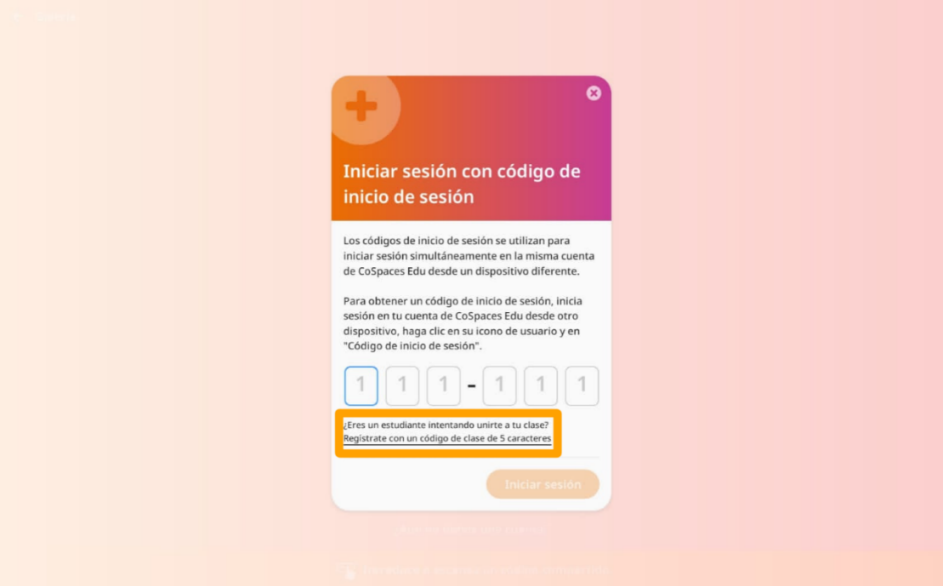
1. Enter your email address, phone number or Skype. Then click on **Next**.



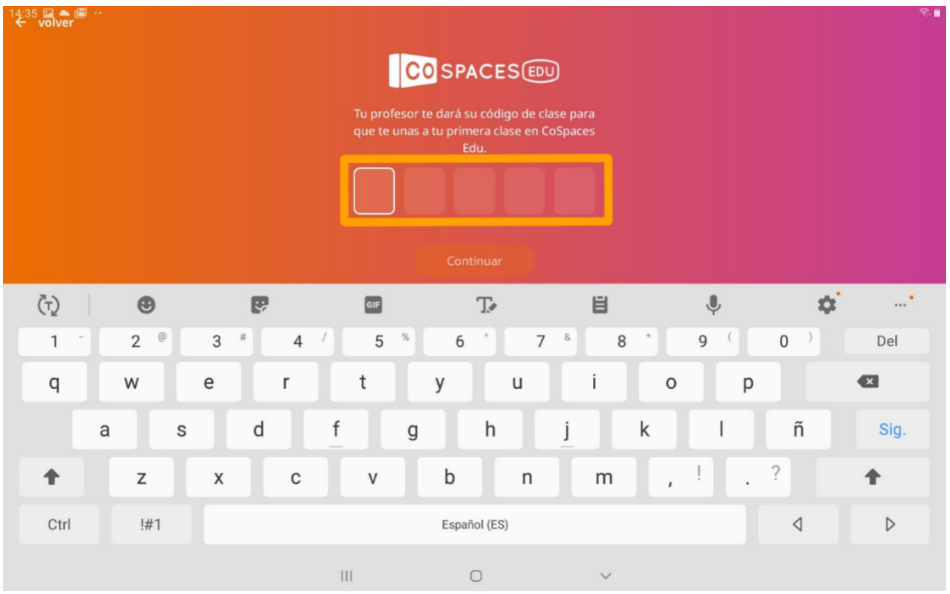
SIGN IN WITH A LOGIN CODE

1. Enter the corresponding login code and click on **Log in**.

2. You can also join a class as a student by clicking on **Register with a 5-character class code**.

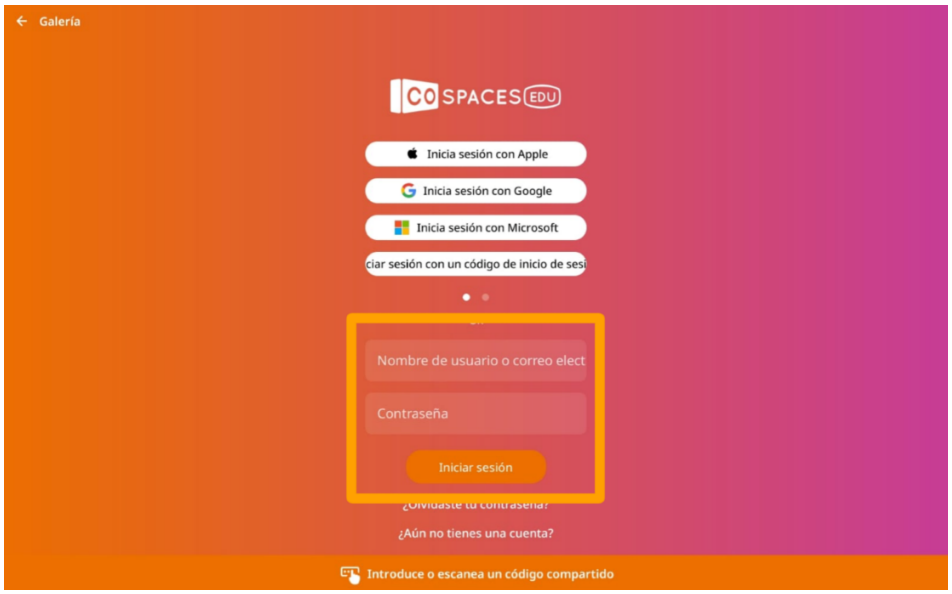


3. Enter the code provided by the teacher to join the class.



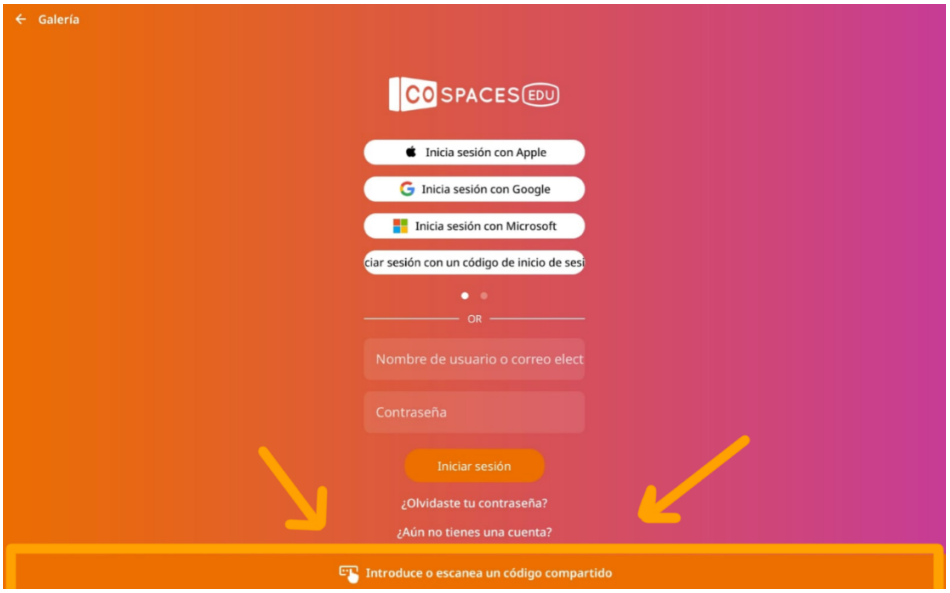
SIGN IN WITH A COSPACES EDU ACCOUNT

1. Enter your username or e-mail address and your password. Then click on **Log in**.

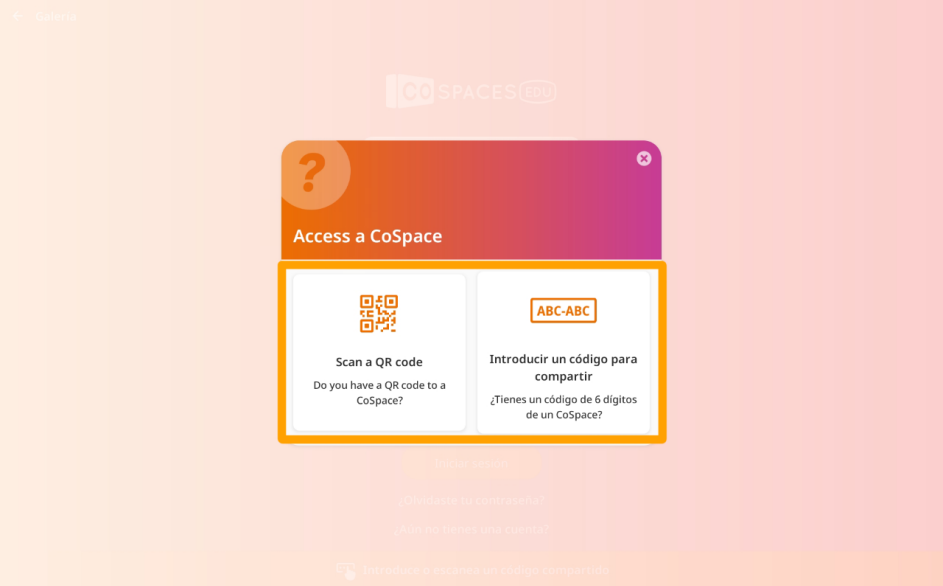


SIGN IN WITH SHARED CODE

1. Click on the **Enter or scan a shared code** button.

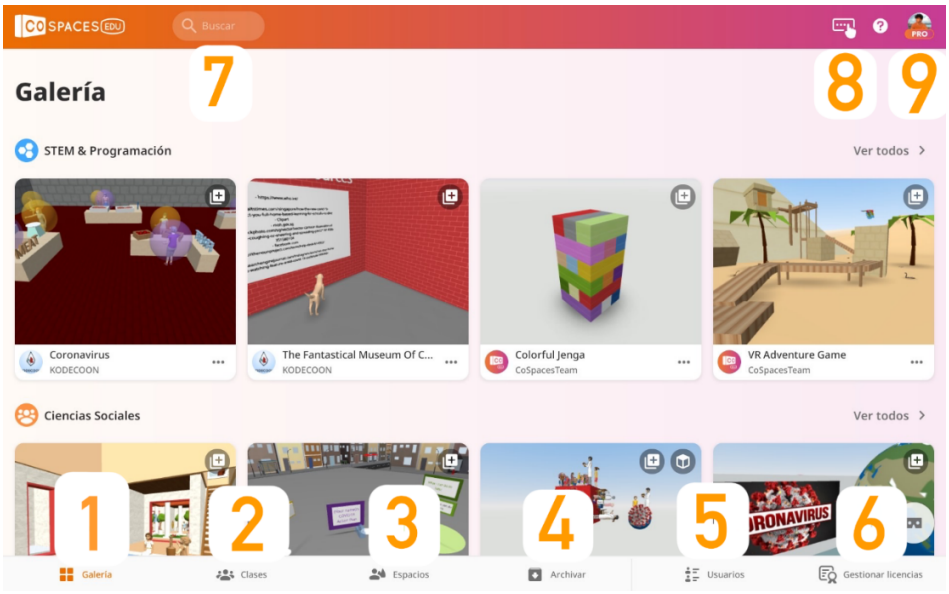


2. Tap on **Scan a QR code** to access a space through the recognition of a QR code; or tap on **Enter a sharing code** to access a space through a login code.



CoSpaces EDU interface

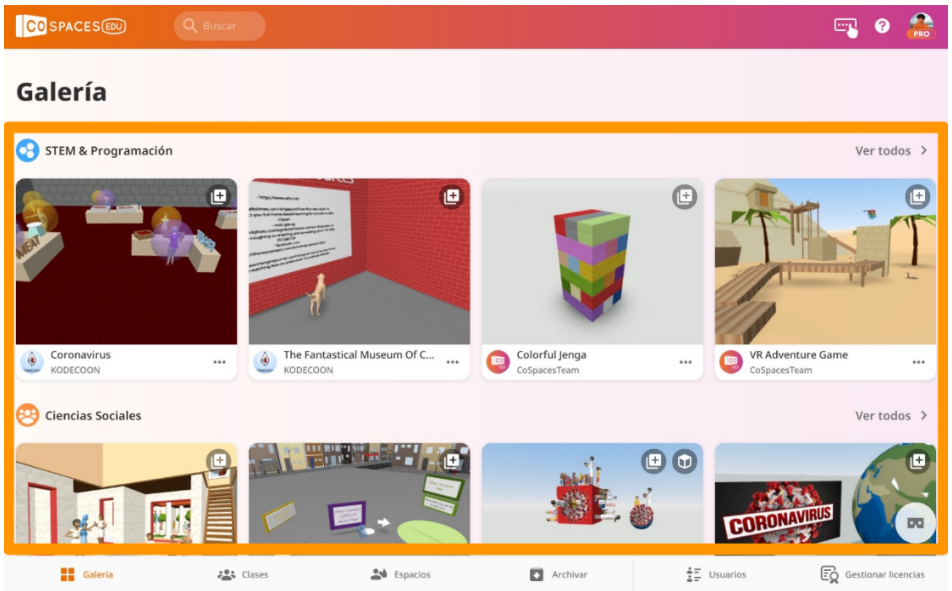
Once logged in, you will be presented with a home interface consisting of several sections. As shown in the image, these are presented below and numbered from 1 to 9.



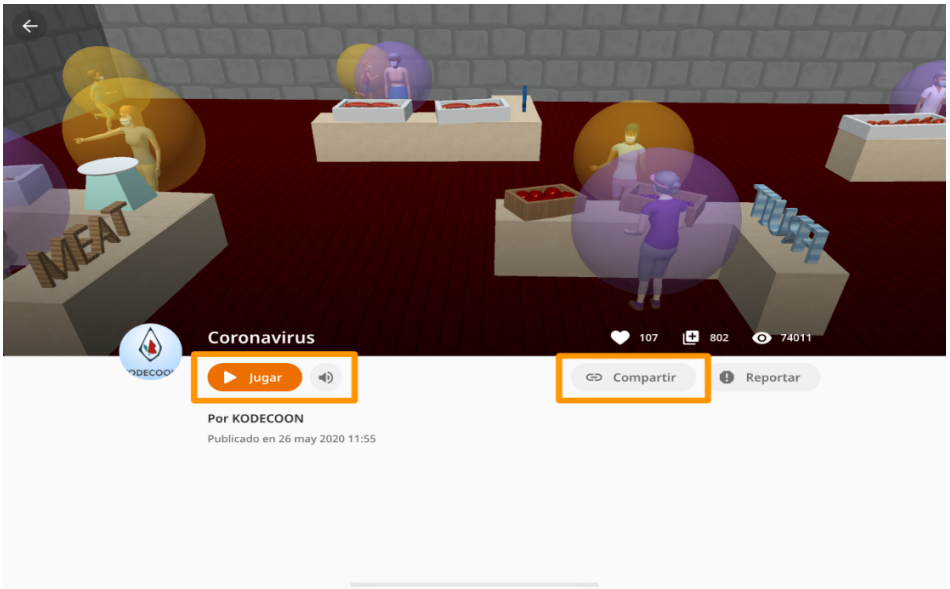
1. Gallery
2. Classes
3. Spaces
4. Archive
5. Users
6. Managing licenses
7. Search
8. Accessing space through code
9. Profile settings

GALLERY

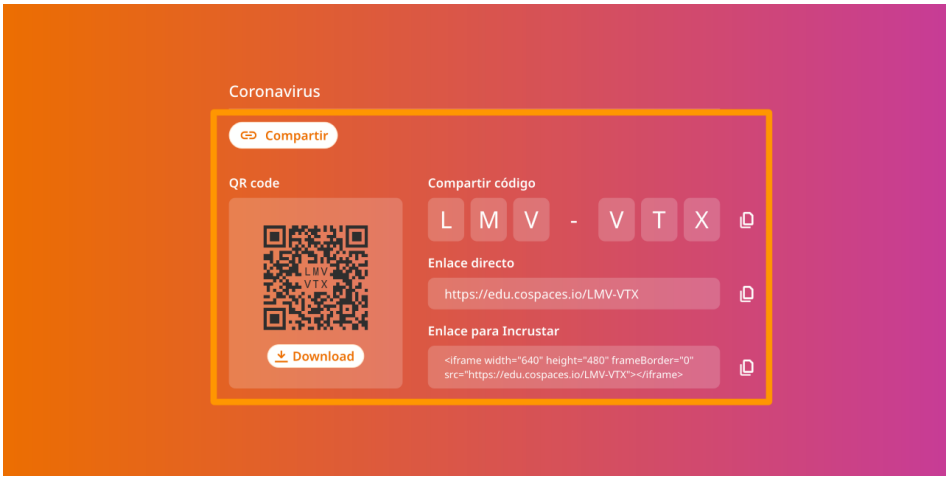
1. In the **Gallery** section, you can view a set of scenarios created by other users classified in several categories: **STEM & Programming**, **Social Sciences**, **Language and Literature**, and **Makerspace**. To access one of them, click on it.



2. To open the selected scenario, click on the **Play** button. If you want to share the scenario, click on the **Share** button, which will take you to another window.

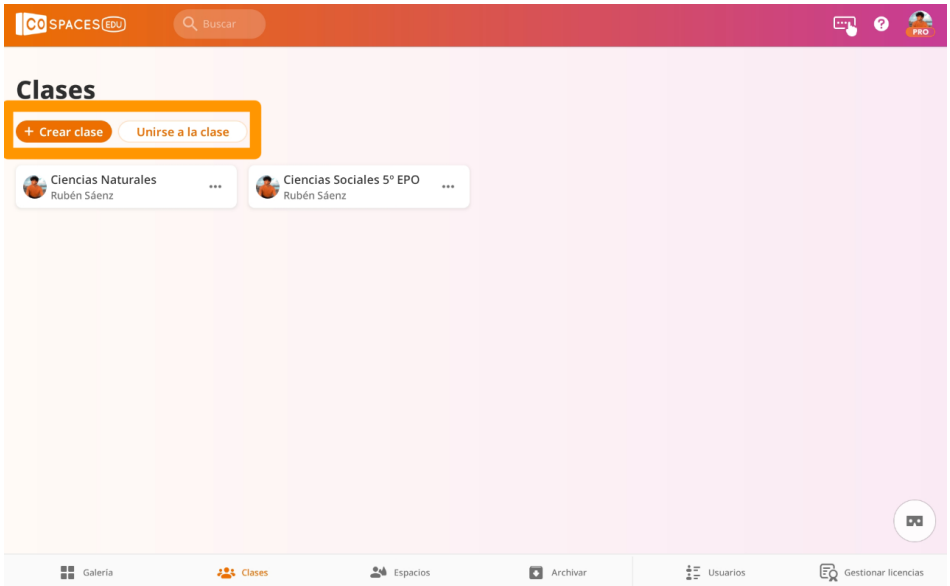


3. In the generated window, you will find several options for sharing the scenario: through a direct link or embedding, through QR code, and through code sharing.

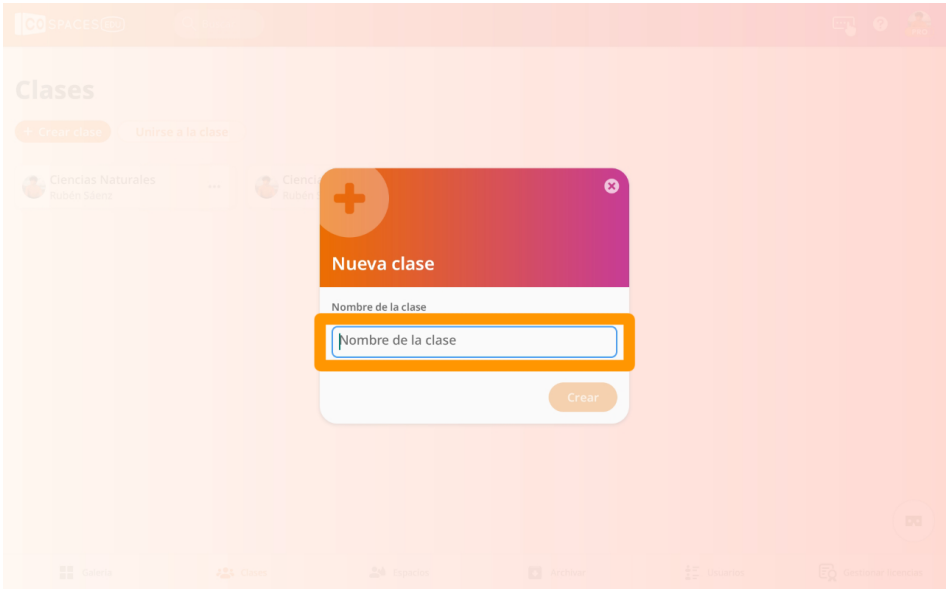


CLASSES

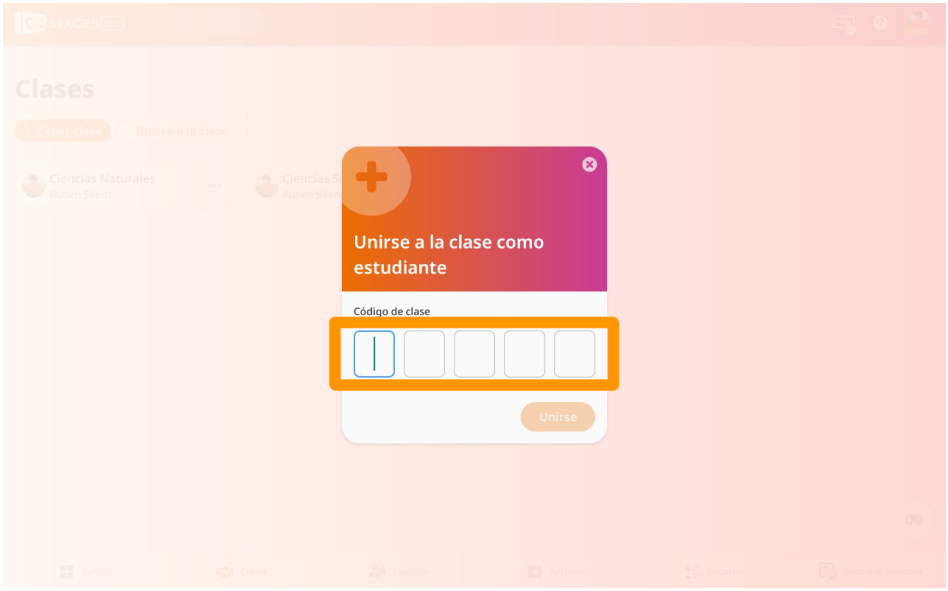
1. In the **Classes** section, you will be able to see all the classes you are enrolled in. From here you can carry out different actions by clicking on the buttons shown in the image below.



2. By clicking on the **+ Create class** button, the pop-up window shown in the image will appear. To generate a new class, choose and type the name, and then click on **Create**.

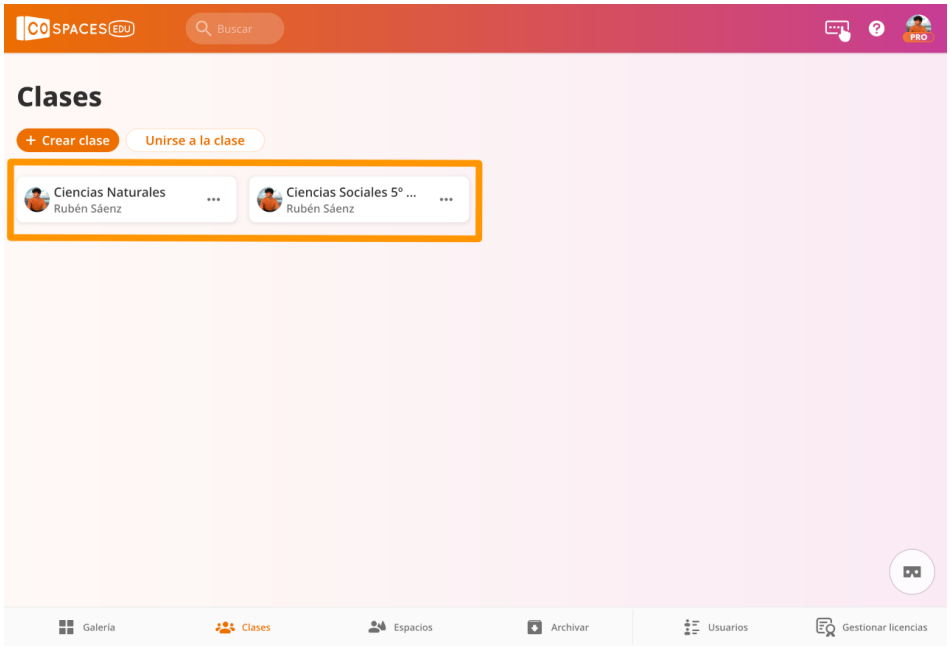


3. By clicking on the **Join class** button, the pop-up window shown in the image will appear. To join a class, enter the class code provided by the teacher, and then click on **Join**.

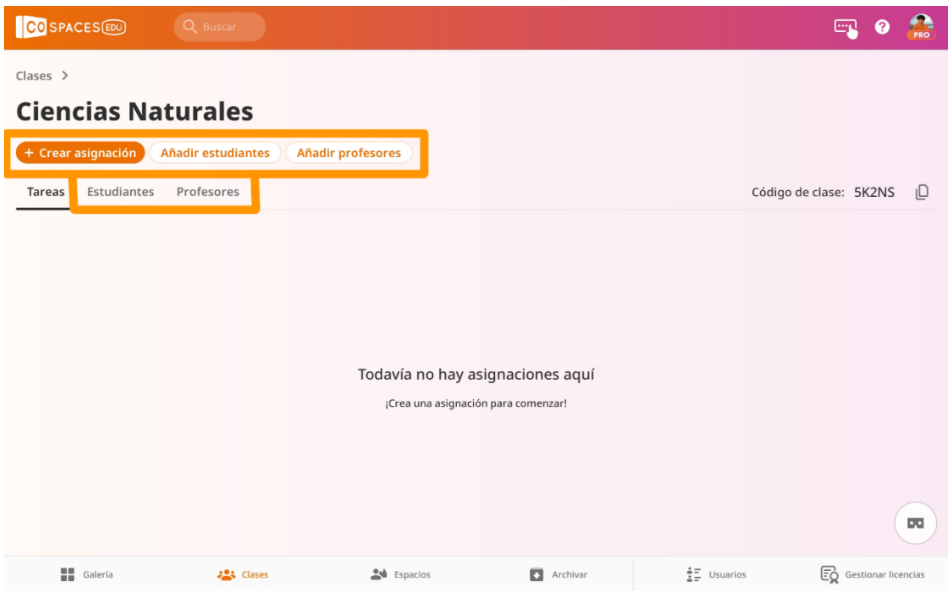


PARTICIPANTS

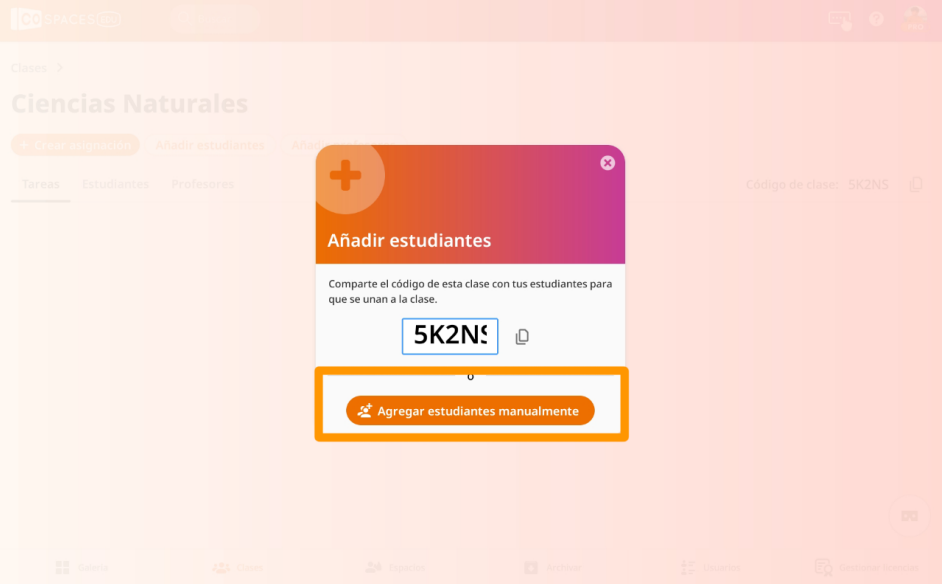
1. To view the participants of a class, click on the class name/icon button.



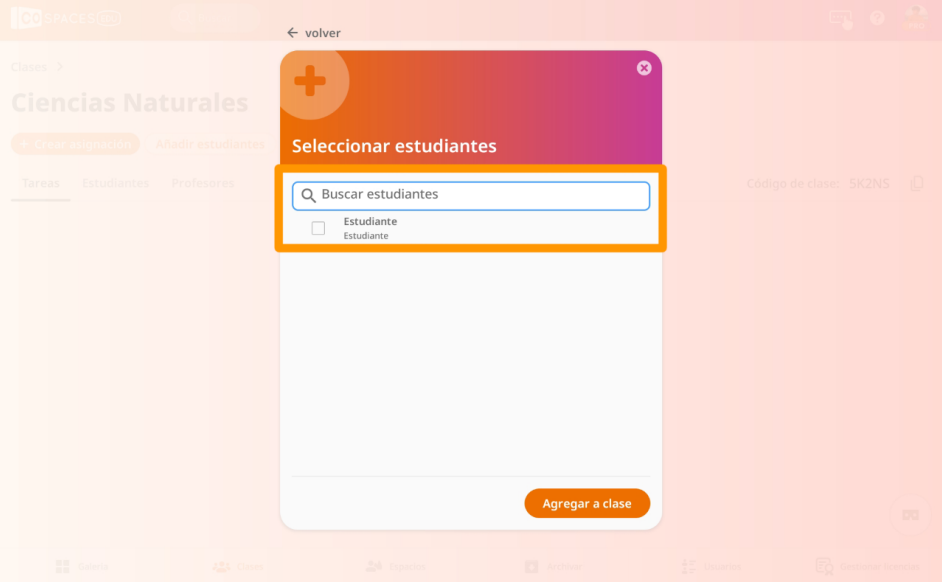
2. When you enter a class you will find the interface shown in the image. The buttons shown are then presented.



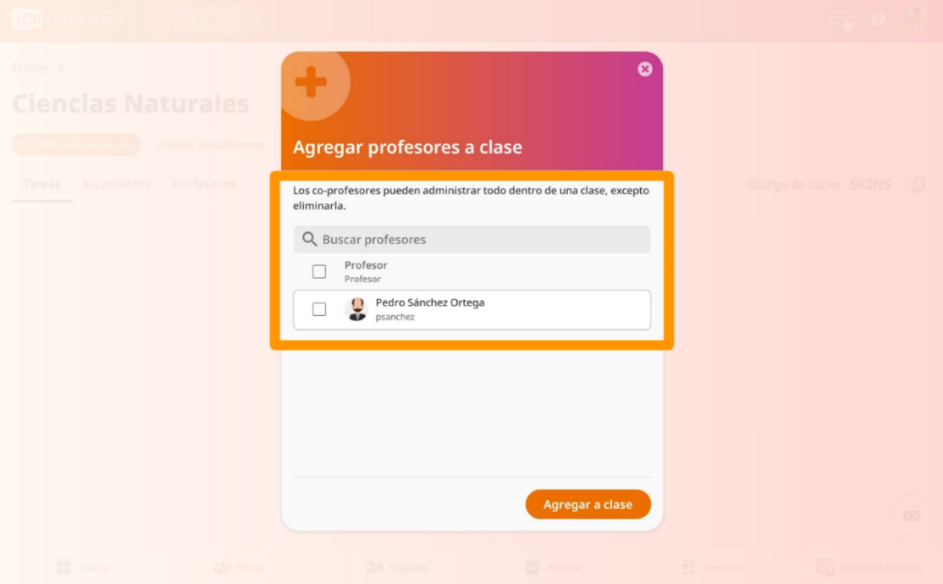
3. If you click on the **Add students** button, the pop-up window will appear. It presents a 5-digit code to share the class with the students. Another option is to add students manually by clicking on **Add students manually**.



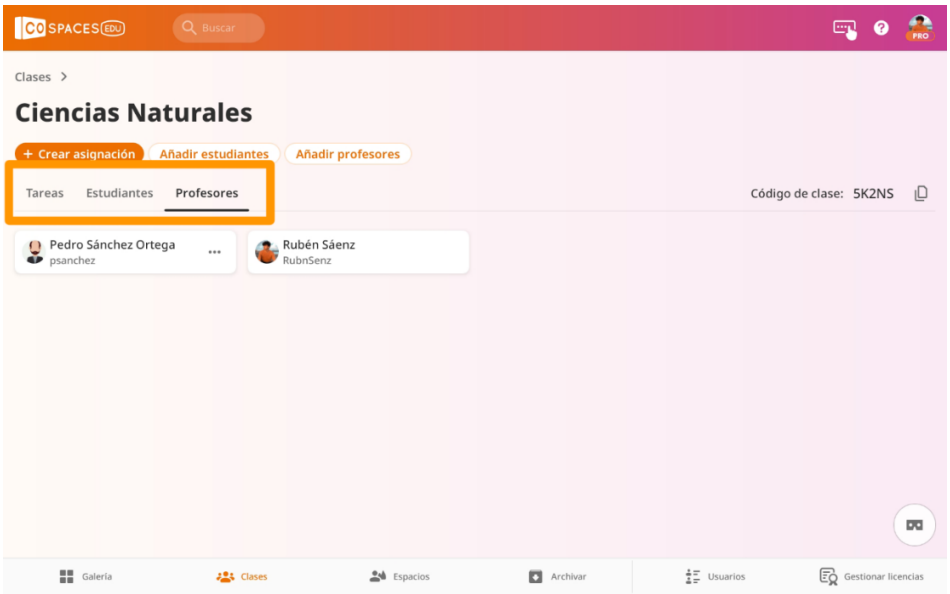
4. To manually add students to your class, search for them and click on **Add to class**.



If you click on the **Add teachers** button, the pop-up window will appear. Here you can see a list of teachers, and add the ones you want by selecting the ones you are interested in and clicking on the **Add to class** button.

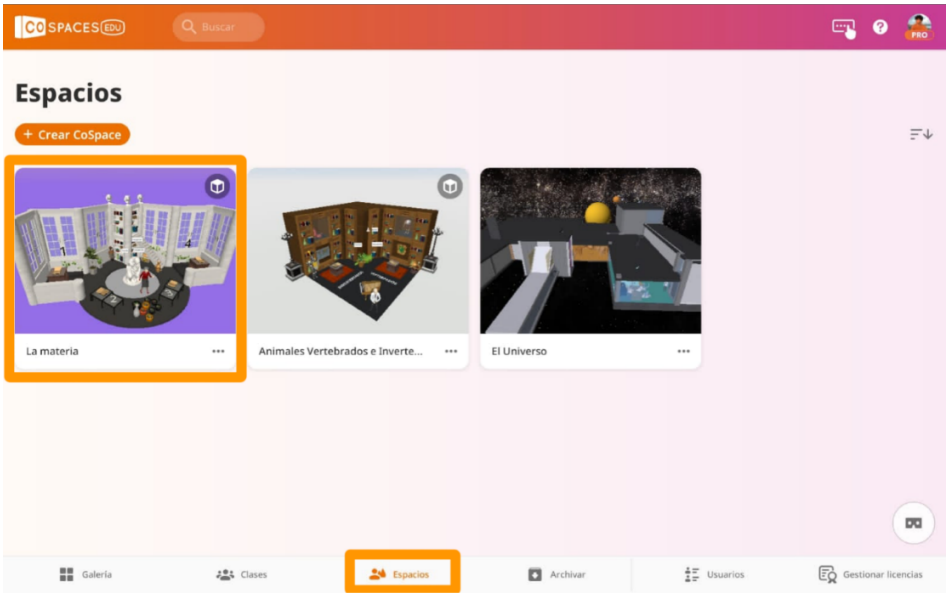


5. If you click on the buttons **Students** and **Teachers**, you will see a list of the members participating in the selected class.

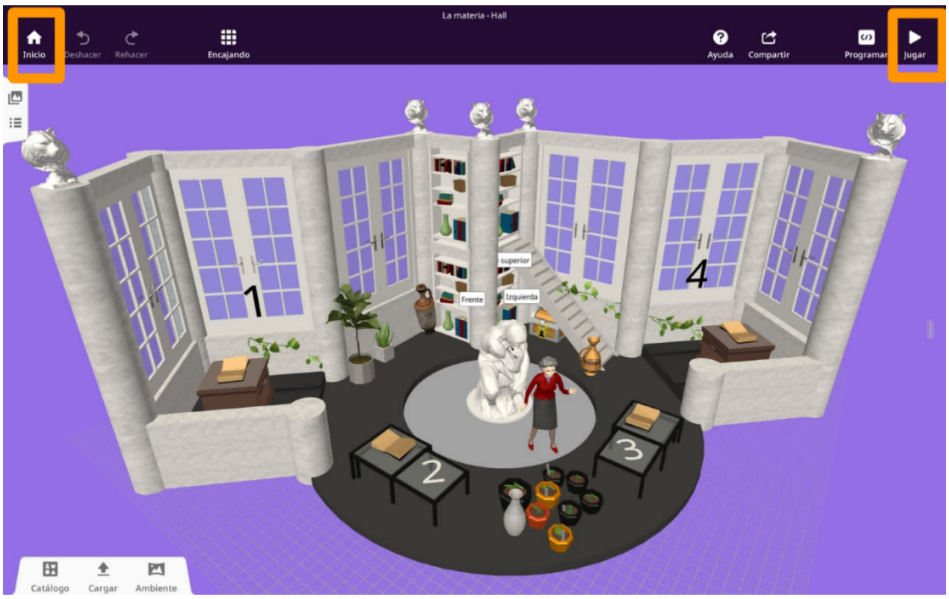


SPACES

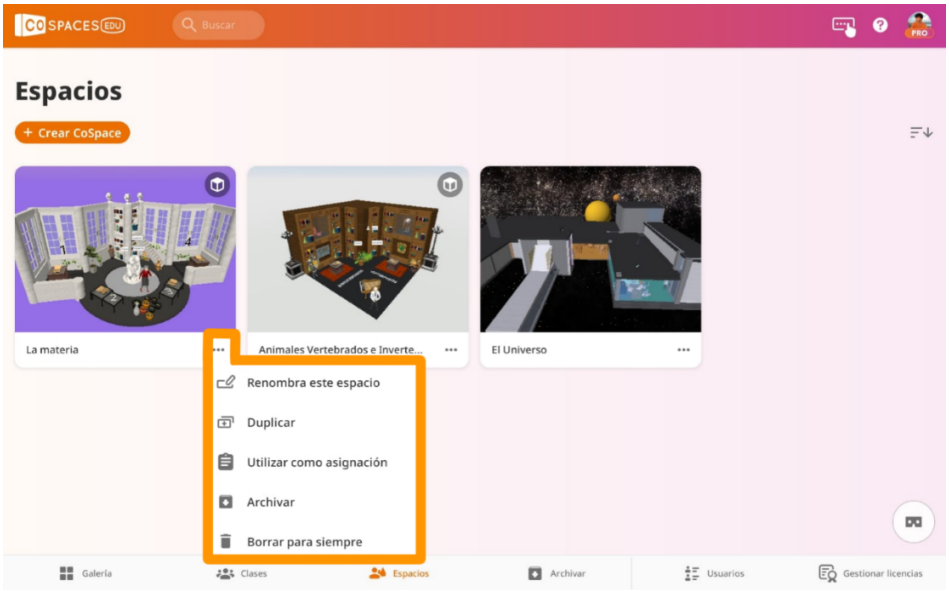
1. In the **Spaces** section you can view the list of spaces that you have designed and created. Here you will find the **+Create CoSpace** button, which is described in section 5.1 of the manual. To access a space, simply click on the image of the corresponding space.



2. Once you have accessed the scenario, you can view it by clicking on the **Play** button. To return to the **Spaces** screen, click on the **Start** button.

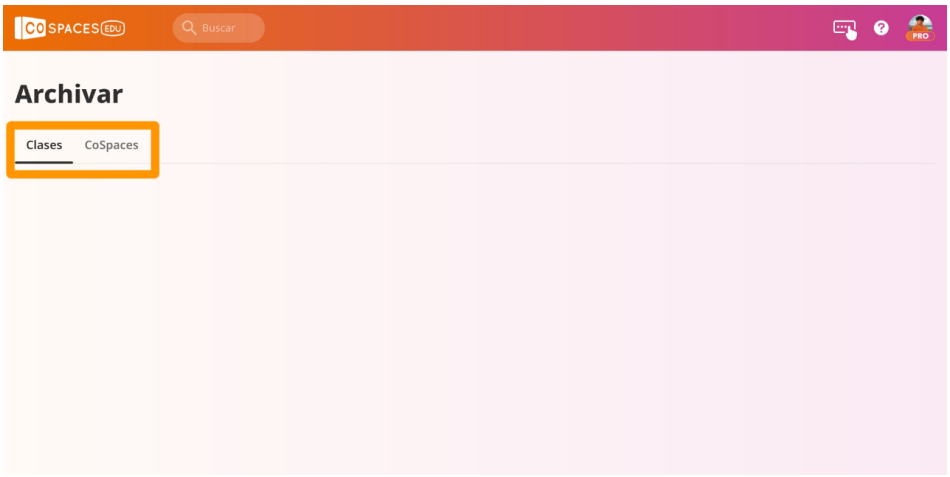


3. In the **Spaces** screen, if you click on the three dots to the right of a scenario name, a menu with different possibilities will be displayed: **Rename this space**, **Duplicate**, **Use as assignment**, **Archive**, and **Delete forever**.



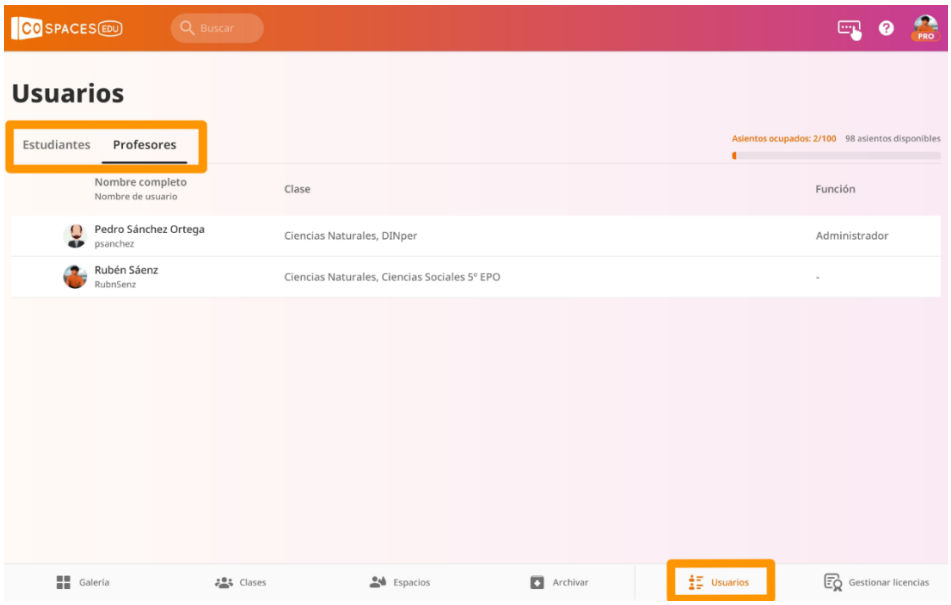
ARCHIVE

1. In this section you can view the list of classes and spaces that you have archived by clicking on the **Classes** and **CoSpaces** buttons.



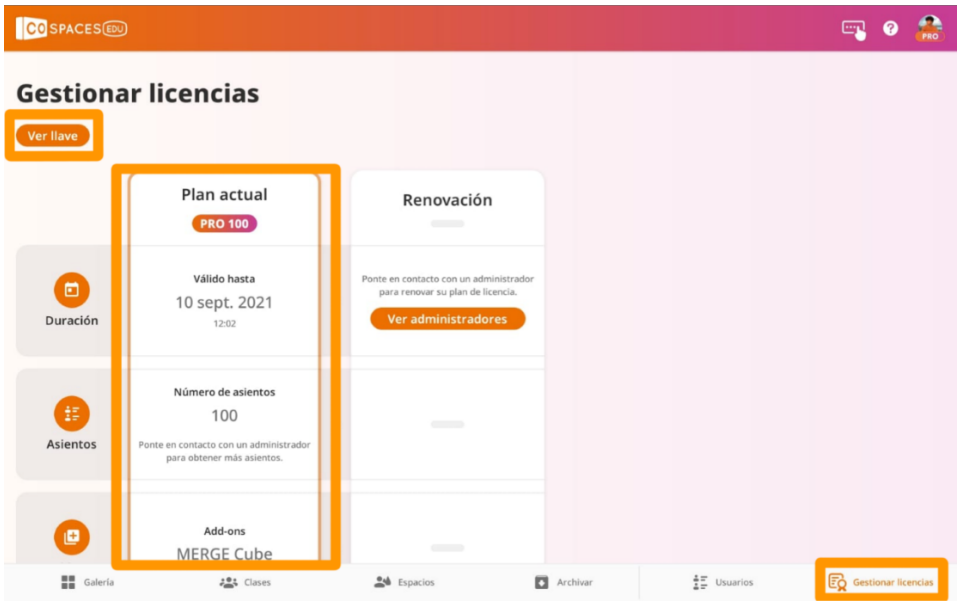
USERS

1. In this section you can see the list of students and teachers by clicking on the **Students** and **Teachers** buttons. In addition, you will also be able to see the role of each person and a bar showing the seats occupied and the available seats contracted.

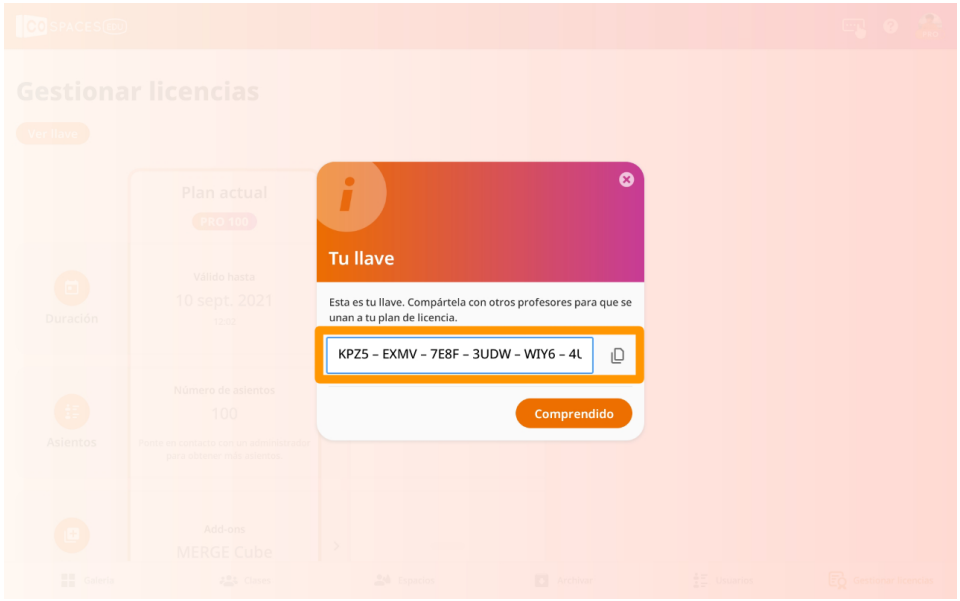


MANAGING LICENSES

1. In this section you can view the duration, seats and add-ons (extensions) of the plan or licence you have contracted.

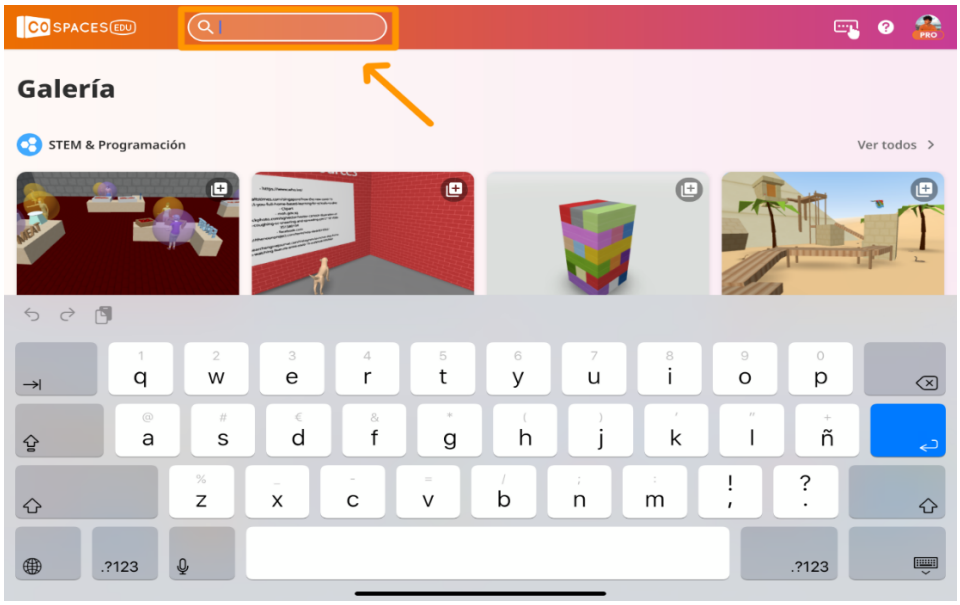


2. If you click on the **View key** button, a pop-up window like the one shown in the picture will open. It shows the code with which other teachers can join your licence scheme.



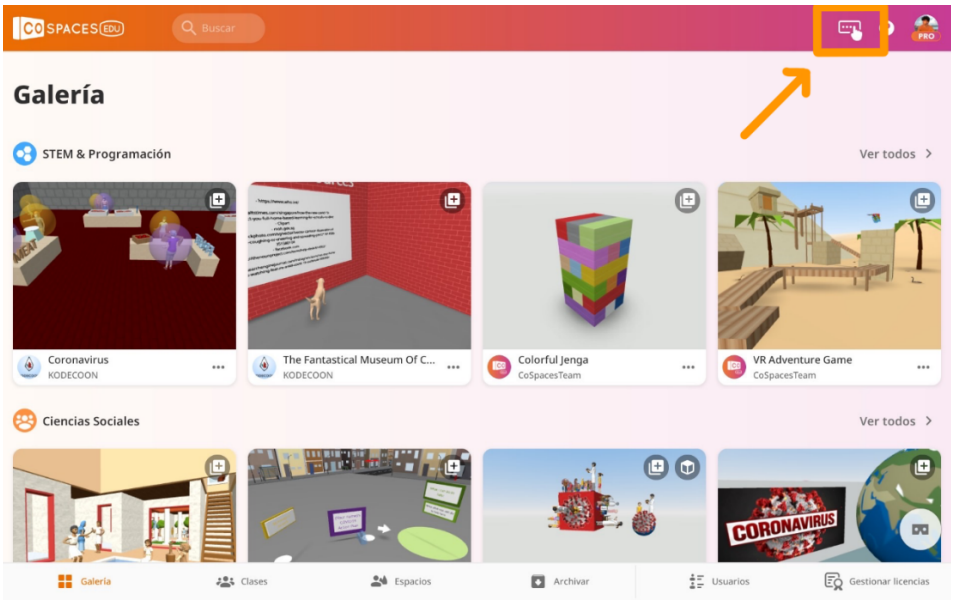
SEARCH

1. To search for a space created by another user or for a specific theme, you can enter in the search bar: the name of the user who created it, or words related to the theme you are looking for.

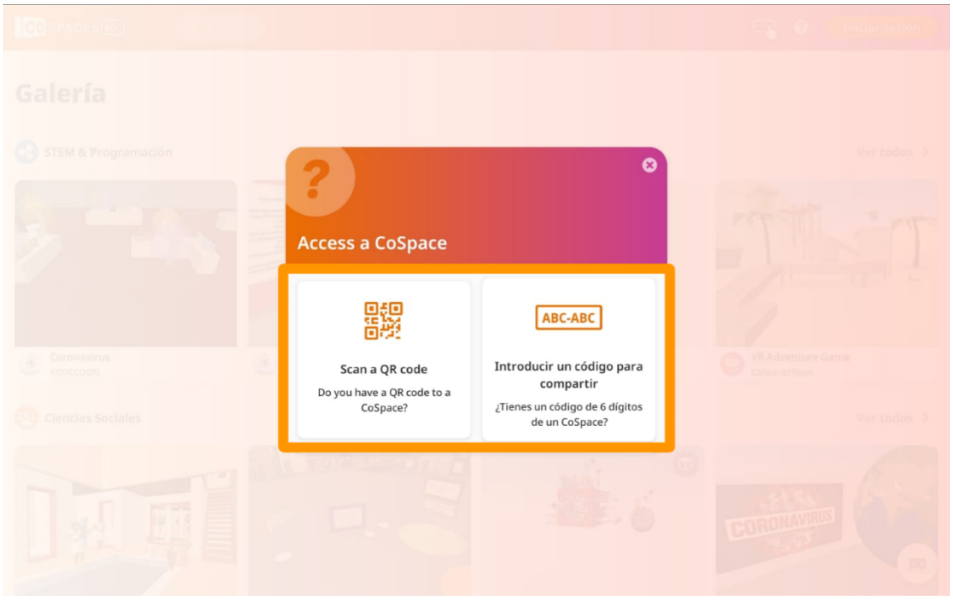


ACCESSING A SPACE THROUGH CODE

1. You can access an existing space by clicking on the button indicated in the image.



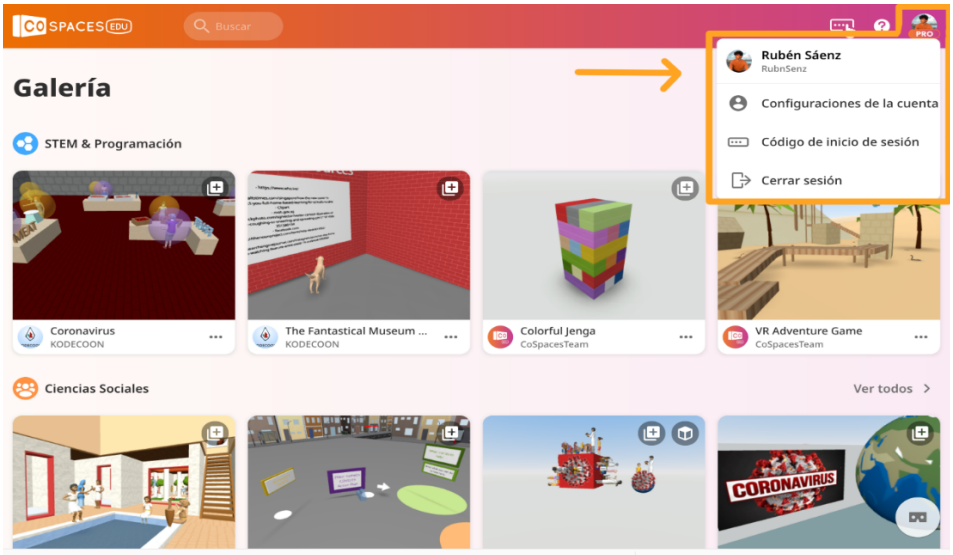
2. A pop-up window will open as shown in the image presenting two ways to access an existing space: by scanning a QR code (left), and by entering a 6-digit code (right).



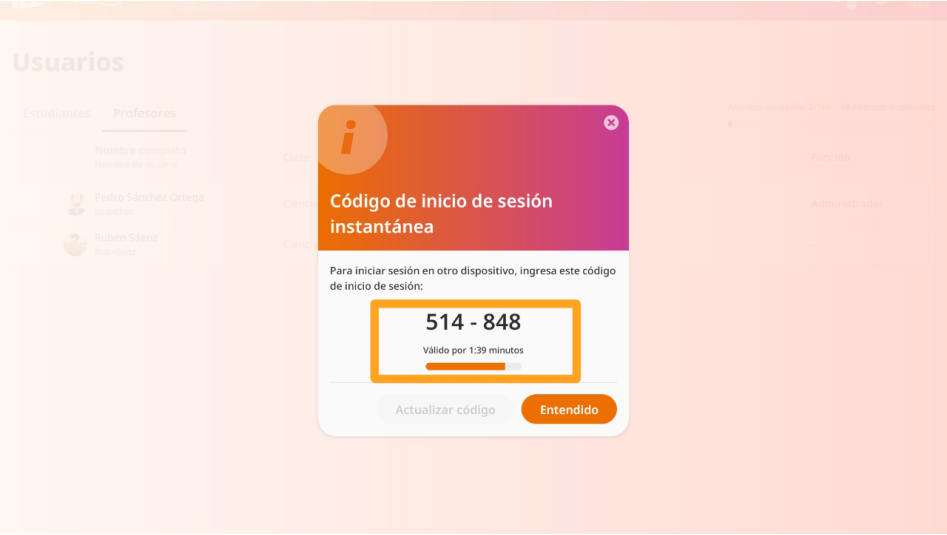
3. Once you have clicked on the **Enter a code to share** button, a new pop-up window will appear as shown in the image. You must now enter the 6-digit code corresponding to the space you wish to access.

PROFILE SETTINGS

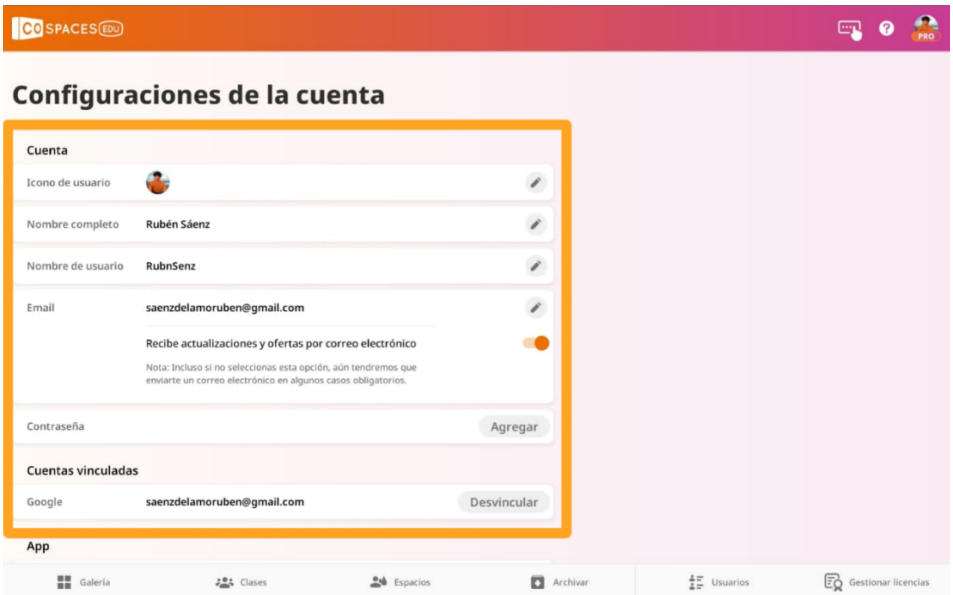
1. You can access your profile options by clicking on your profile icon as shown in the image. A menu with several options will be displayed: **Account settings**, **Login code**, and **Logout**.



2. If you have clicked on the **Login code** button, a pop-up window like the one shown in the picture will appear. It presents you with a 6-digit code for logging in on another device. Please note: the code is time limited.



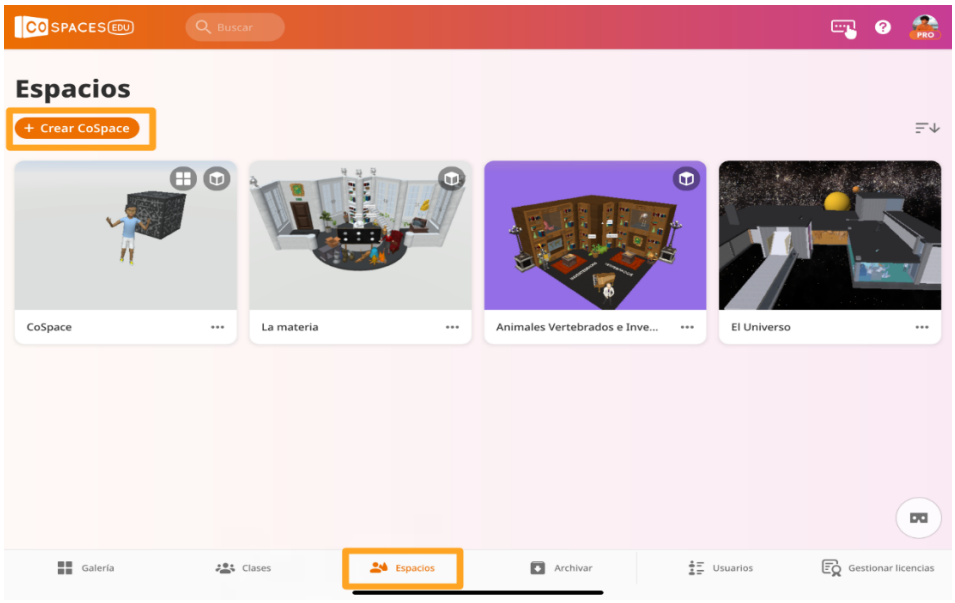
3. On the other hand, if you have clicked on the **Account settings** button, you will be directed to another screen like the one shown in the image. Here you will be able to edit aspects such as: user icon, full name, username, email, password, application language, linked accounts, convert to student or teacher account, leave or join a licence plan, and delete the account.



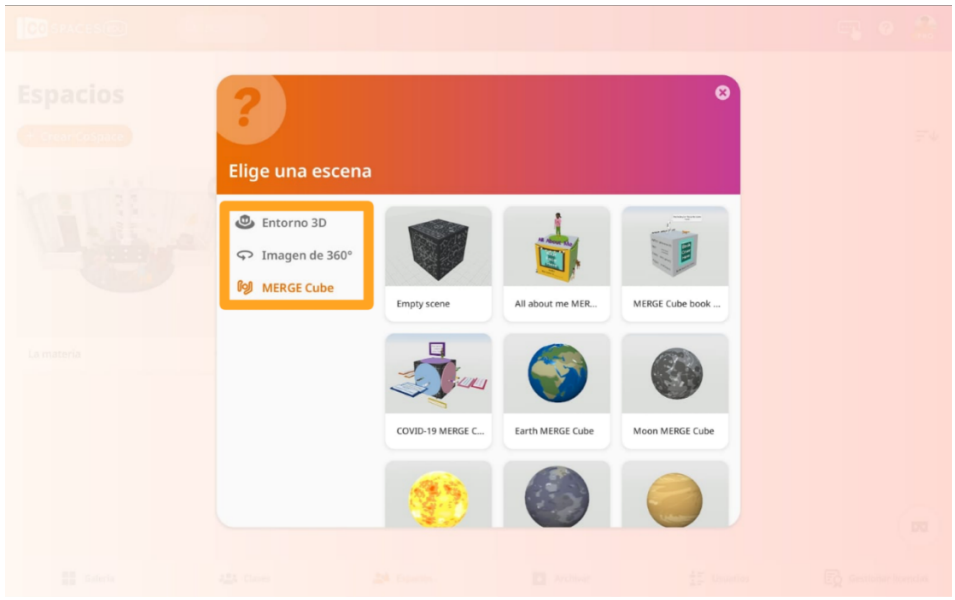
Design and creation of spaces in CoSpaces EDU

SETTING THE SCENE

1. In the **Spaces** section, click on the **+Create CoSpace** button.

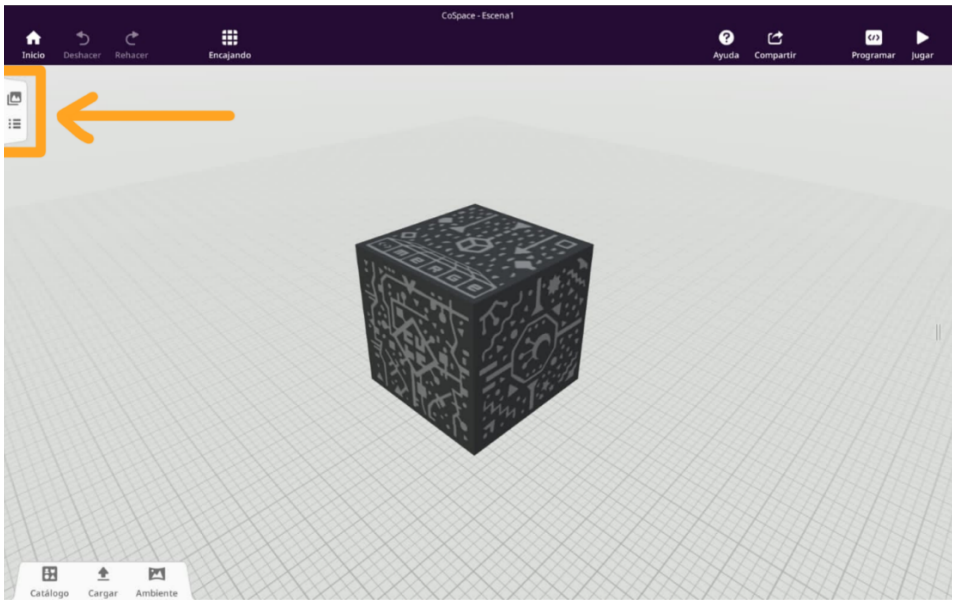


2. A pop-up window will appear as shown in the image. It offers the possibility to create 3 types of scenes: 3D environments, 360º images, and scenes with MERGE Cube. Click on the one you are interested in and select one from the default list.

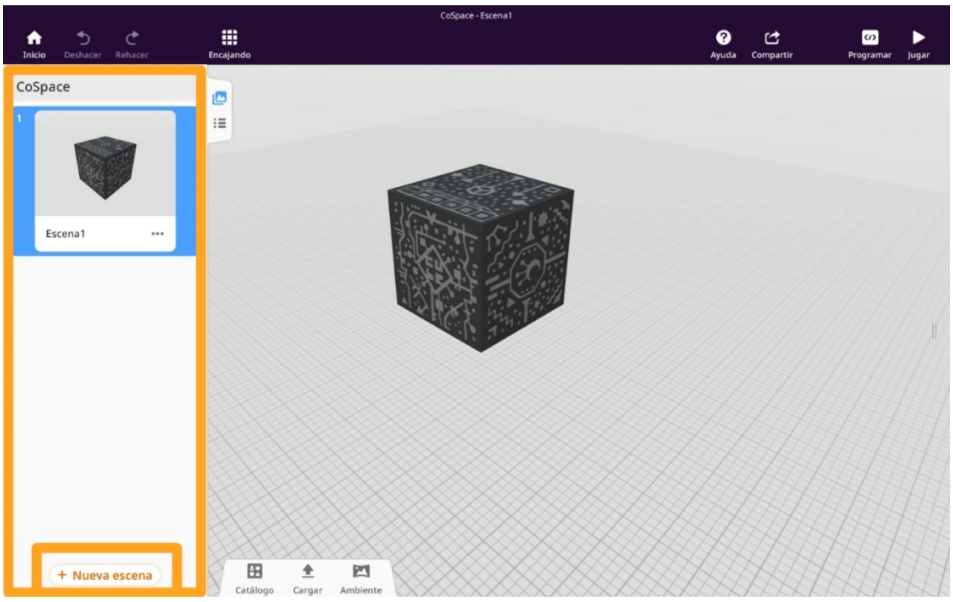


LIST OF ITEMS AND SCENES

1. To display the list of elements and scenes, click on the button on the left side of the editing screen as shown in the image.

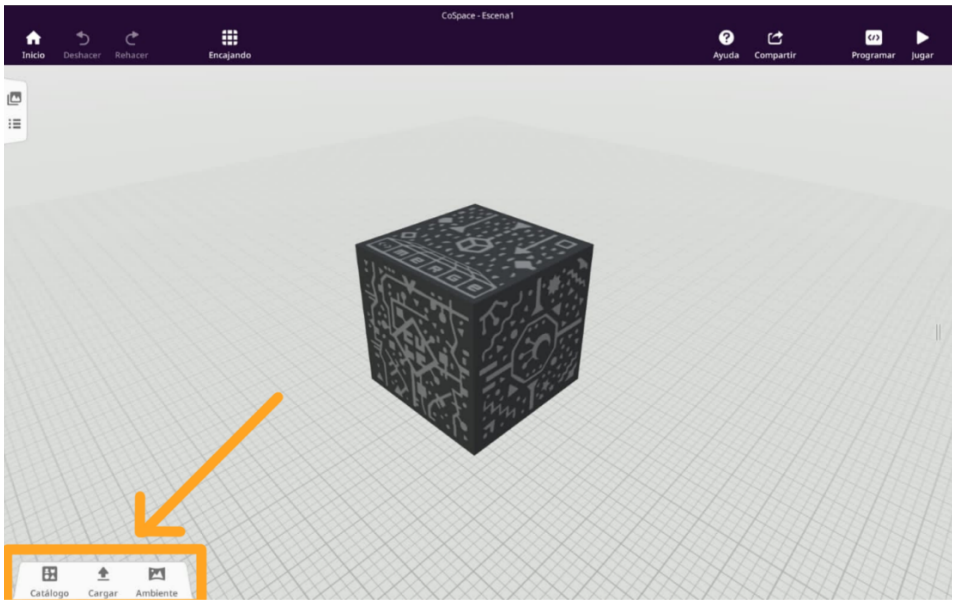


2. You can now view the list of elements and scenes that make up your space. In addition, you can create new scenes within your space by clicking on the **+New scene** button.



CREATOR'S LIBRARY

1. To display the creator's library, click on the button located in the bottom left corner of the editing screen as shown in the image.

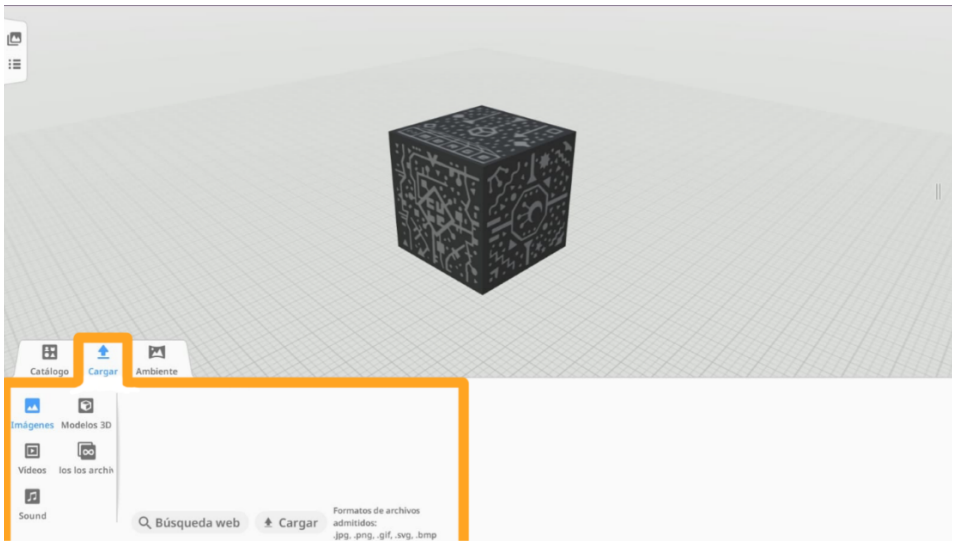


CATALOGUE

1. If you have clicked on the **Catalogue** category, a menu will open with the library of 3D elements that the CoSpaces EDU application has by default. These elements are grouped in different subcategories to facilitate your search: **Characters**, **Animals**, **Dwellings**, **Nature**, **Transport**, **Articles**, **Instruction**, and **Special**.

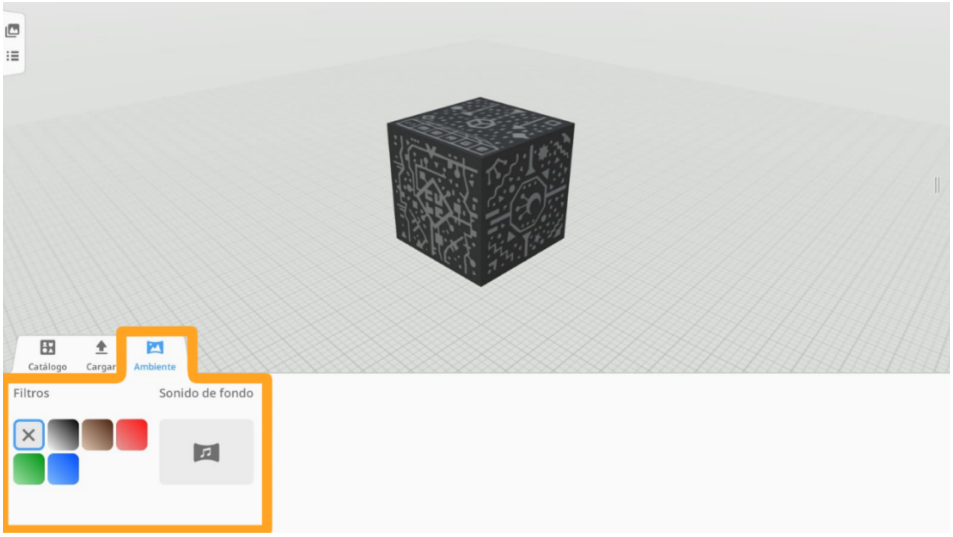
UPLOAD

1. If you have clicked on the **Upload** category, a menu will open with different subcategories corresponding to: **Images**, **3D Models**, **Videos**, and **Sounds**. CoSpaces EDU offers the possibility to import new multimedia elements from the web, or to upload them from a device.



ENVIRONMENT

1. If you have clicked on the **Ambience** category, a menu will open allowing you to: add a background image for your space, add a colour filter to the display of your space, and add a background sound that plays simultaneously while the space is displayed.

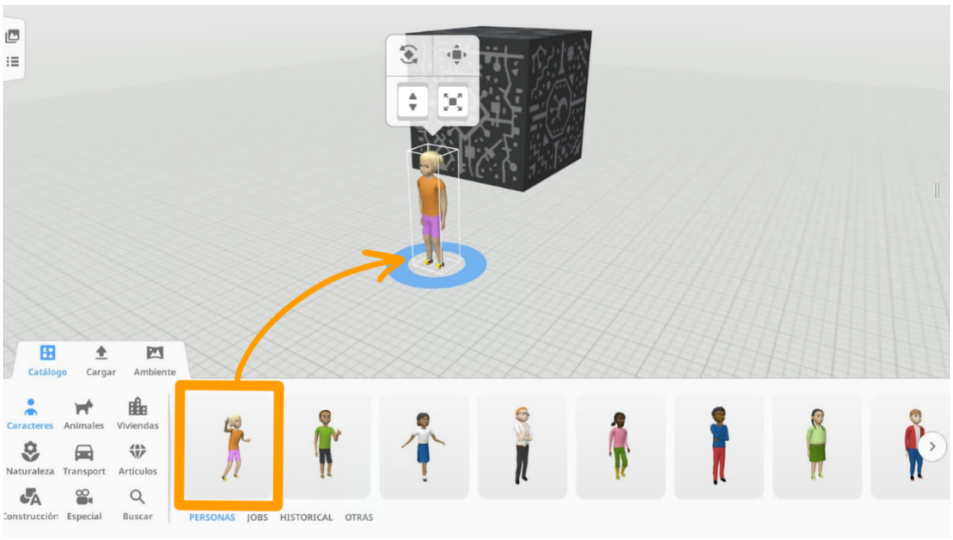


CONTROLS AND EDITING OF LIBRARY ELEMENTS

1. The following images briefly summarise graphically the different touch controls you will use when editing and creating a space, and the touch controls you will use to move around a space in game mode.

PLACEMENT OF ELEMENTS IN THE PLAN

1. Click on the element you want to place in the plane, and without releasing, drag it to the space to place it in the desired part of the plane.

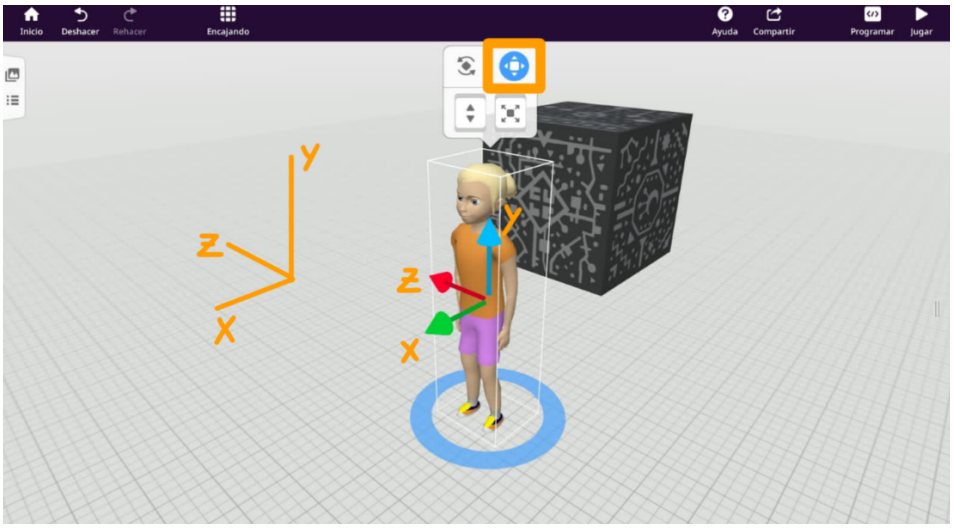


CHANGING THE SIZE OF ELEMENTS

1. Tap once on the item to display the menu shown in the image. You can change the size of the element either by clicking on the button indicated in the image and dragging your finger, without releasing, from top to bottom and vice versa; or by moving two fingers together and apart as shown in the diagram in section 5.4.

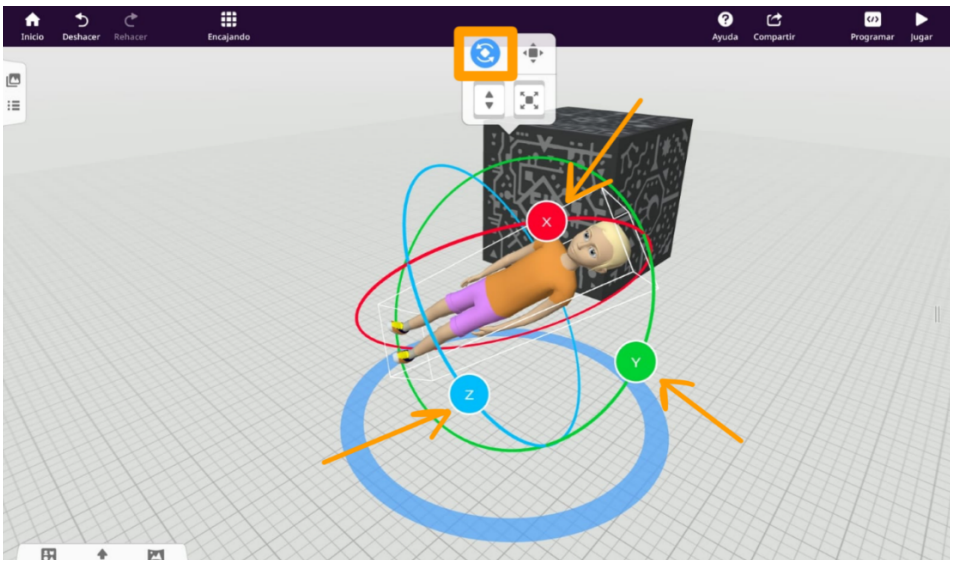
MOVING ELEMENTS AROUND THE PLANE

1. Click once on the element to display the menu shown in the image. You can move the element by pressing the button indicated in the image and dragging the element, without releasing, along the **x**, **y**, and **z** axes with your finger. This is shown in section 5.4.



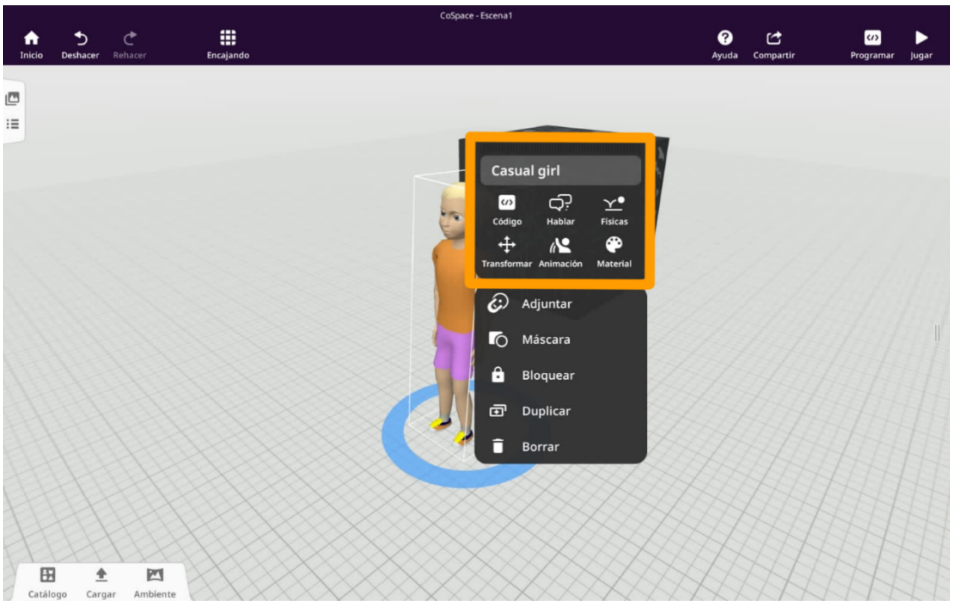
ROTATING THE ELEMENTS

1. Click once on the element to display the menu shown in the image. You can rotate the element by clicking on the button indicated in the image and manipulate the **x**, **y** and **z** planes with your finger without releasing it.

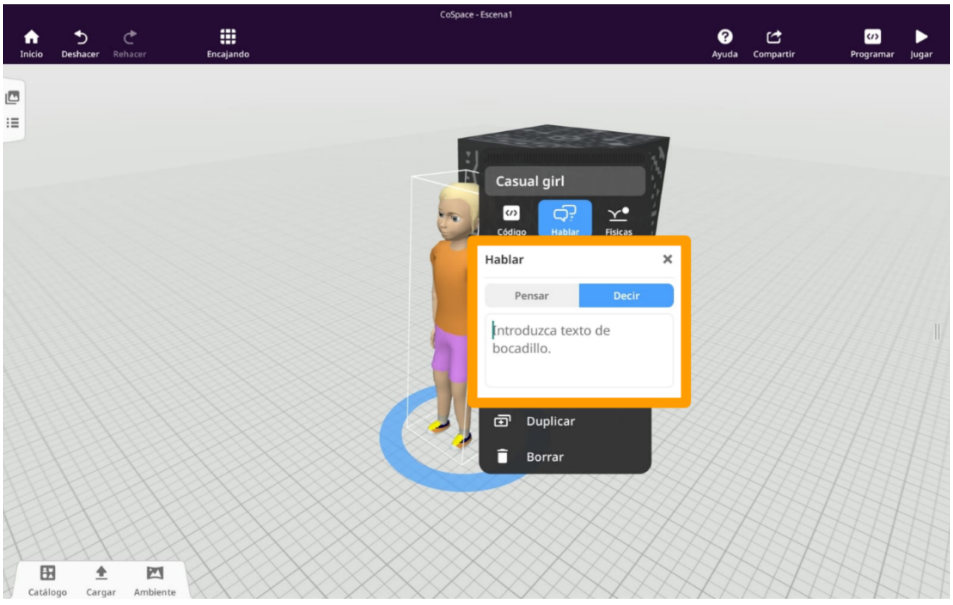


PROVIDING INTERACTION TO THE ELEMENTS

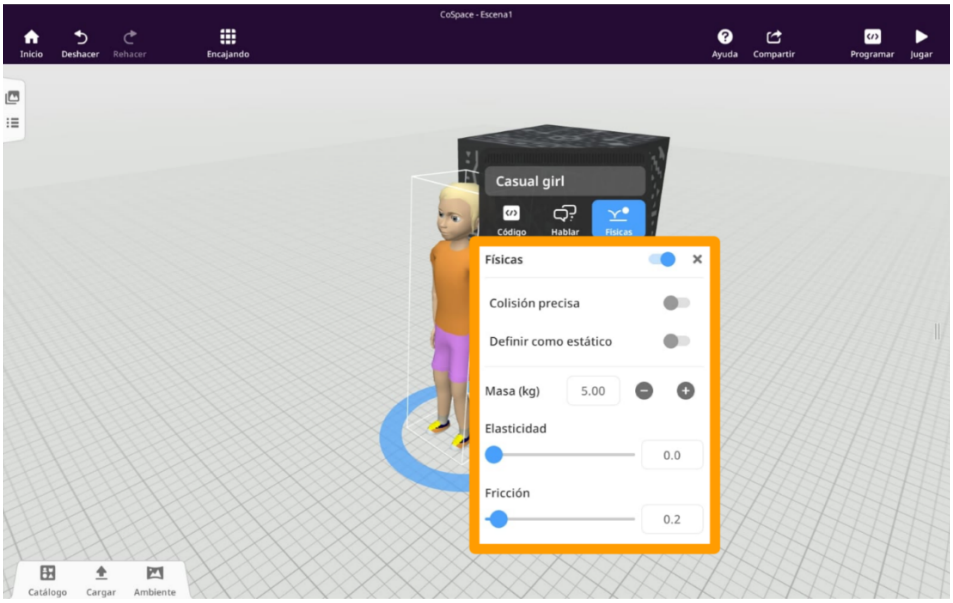
1. Double-clicking on the item displays a menu with options for that item, including: **Speech**, **Physical**, and **Animation**.



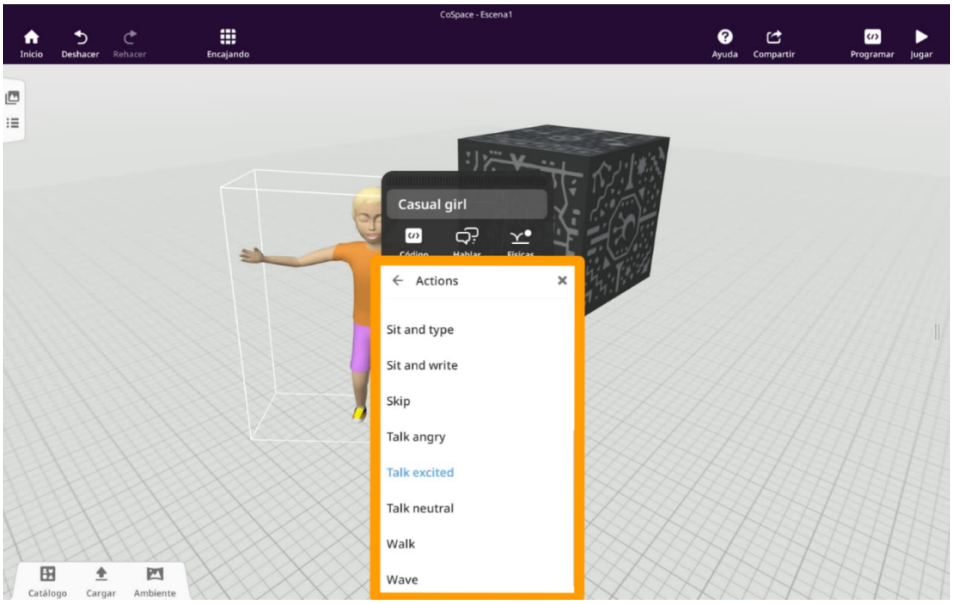
2. If you click on the **Speak** button, a new pop-up menu will appear as shown in the picture. Here you can enter a text for the target to say or think when you activate the game mode.



3. If you click on the **Physical** button, a new pop-up menu will appear as shown in the image. Here you can modify the physical properties (mass, elasticity, friction, etc.) of the elements.

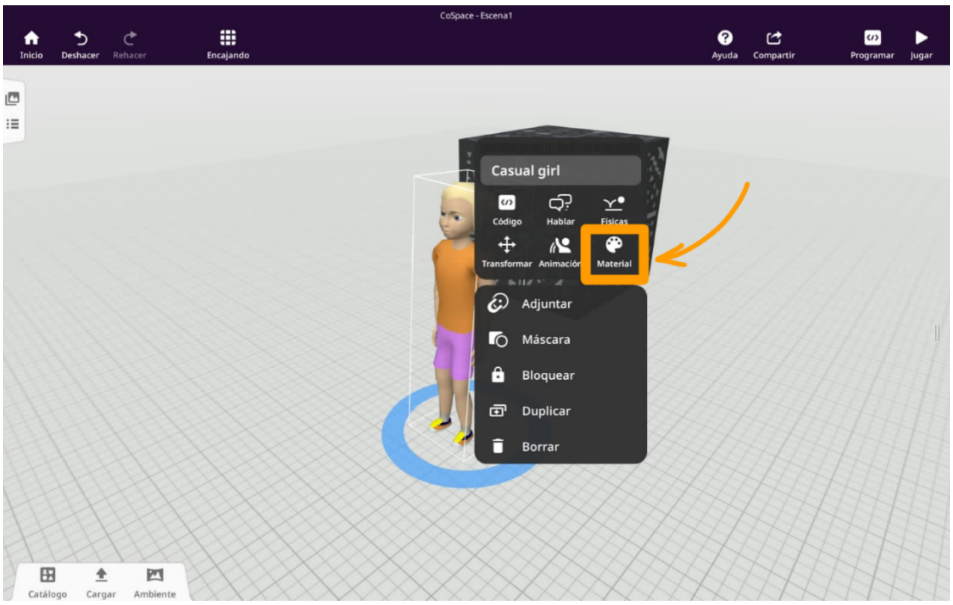


4. If you click on the **Animation** button, a new pop-up menu will appear as shown in the image. Here you can select from a list the different animations that you can associate to the element: **None**, **Postures**, **Reactions** and **Actions**.

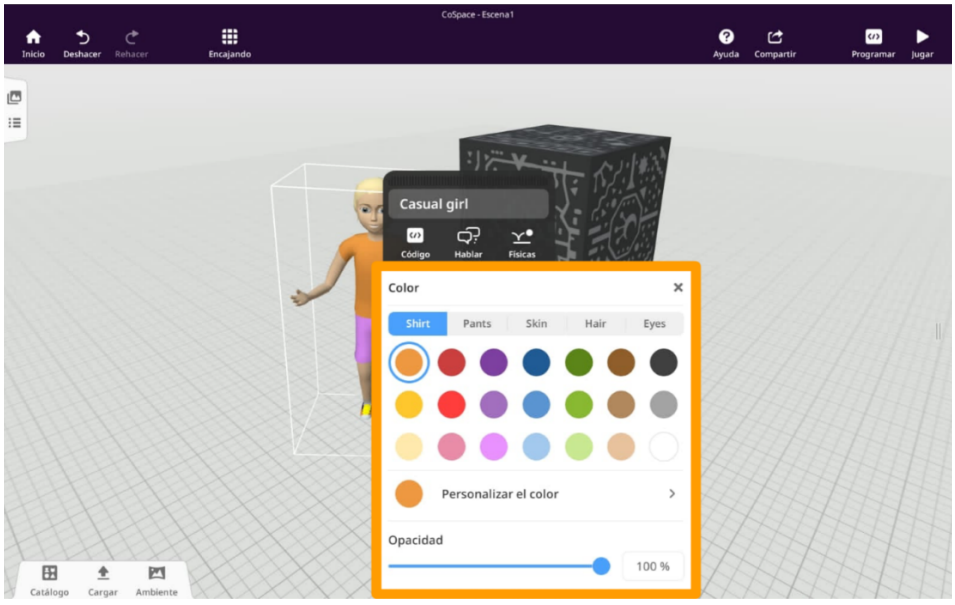


MODIFY THE COLOUR AND TEXTURE OF THE ELEMENTS

1. If you click twice in succession on the element, a menu with the options for that element is displayed. Then click on the **Material** button.

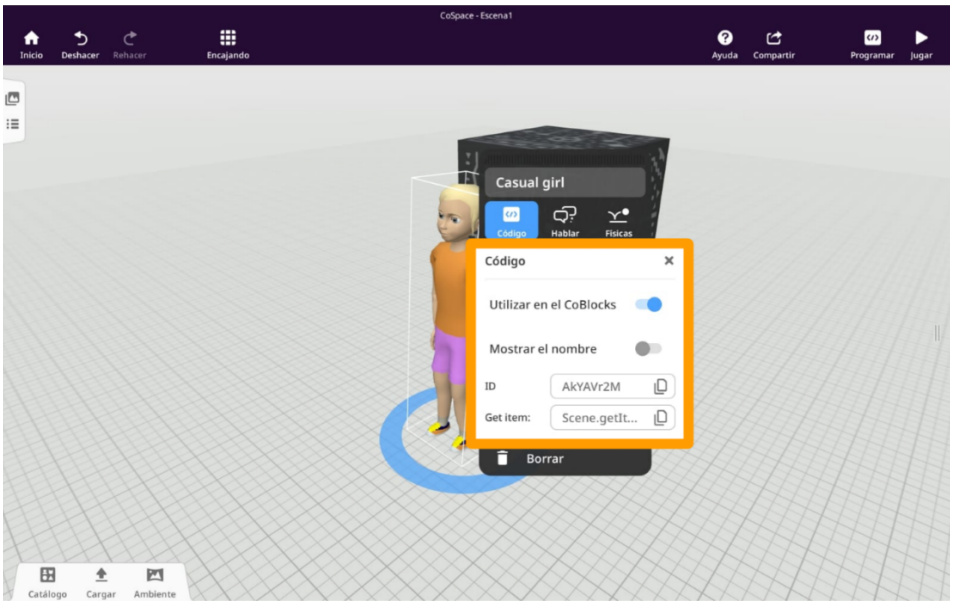


2. A new pop-up menu will open from which you can modify the colour, texture and opacity of the multiple elements that the application offers in its library.

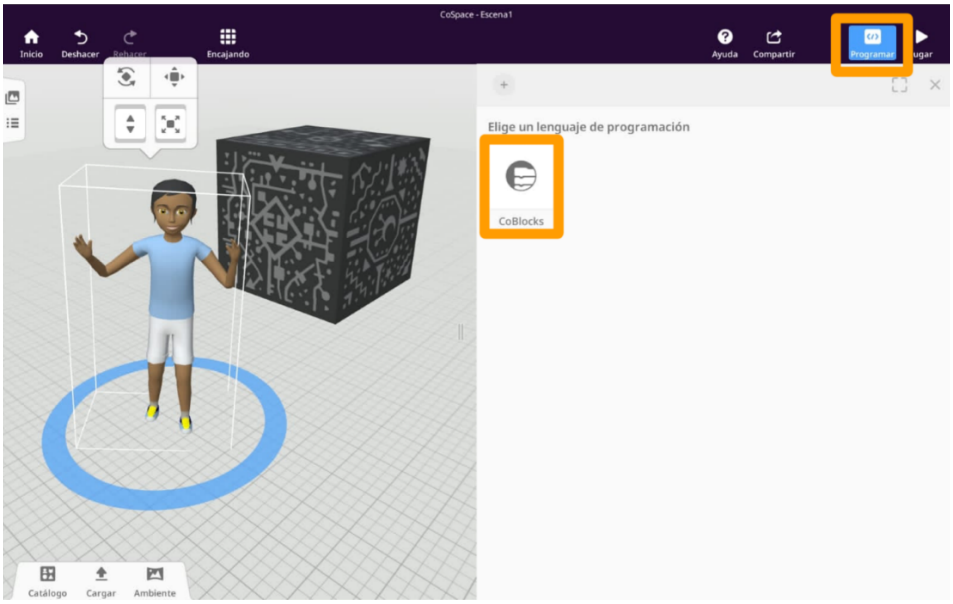


STAGE PROGRAMMING

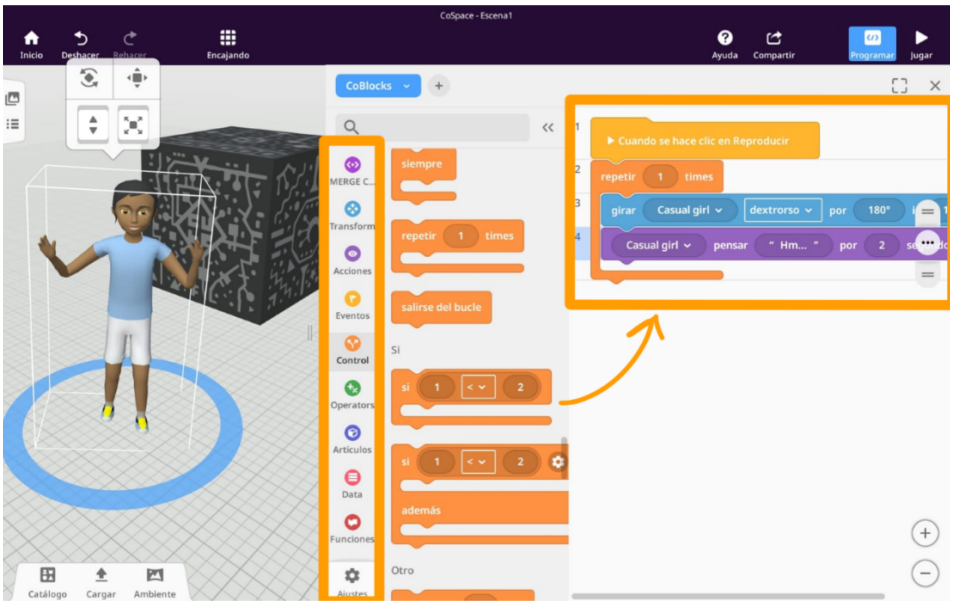
1. If you click twice in succession on the element, a menu with the options for that element will be displayed, among them click on the **Code** button. A new menu will open as shown in the image; click on **Use in CoBlocks** (the tab turns blue). In this way, you will be able to associate a programming to the element.



2. Click on the **Program** button in the upper right corner as shown in the image. Then choose the programming language **CoBlocks** by clicking on the icon in the image.

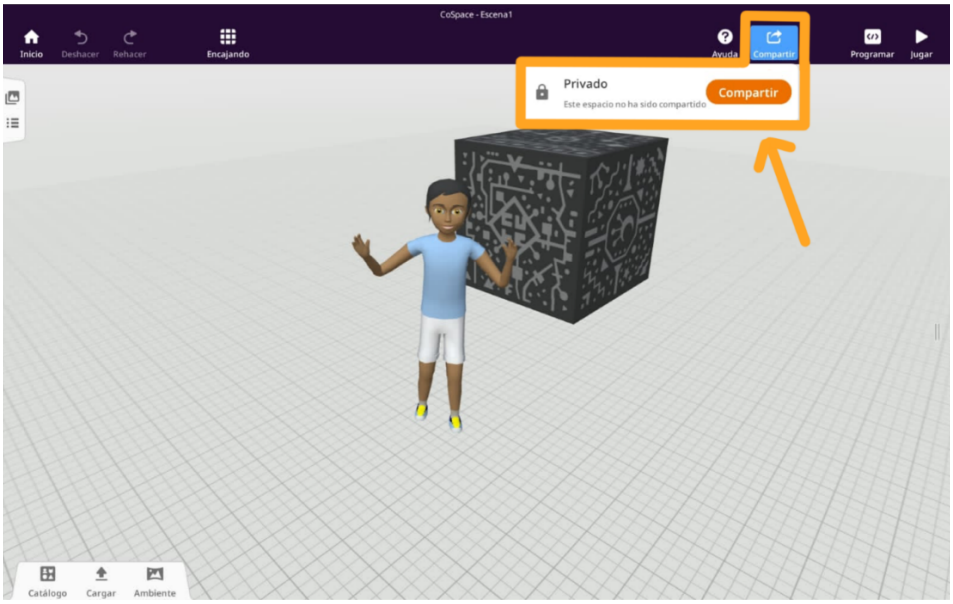


3. You will be able to choose from a long list of commands that have appeared in a new programming window. These commands are classified in the categories shown in the image. To use them, simply click and drag them to the right-hand column, placing them in a Scratch programming block-like arrangement. Edit their operation.

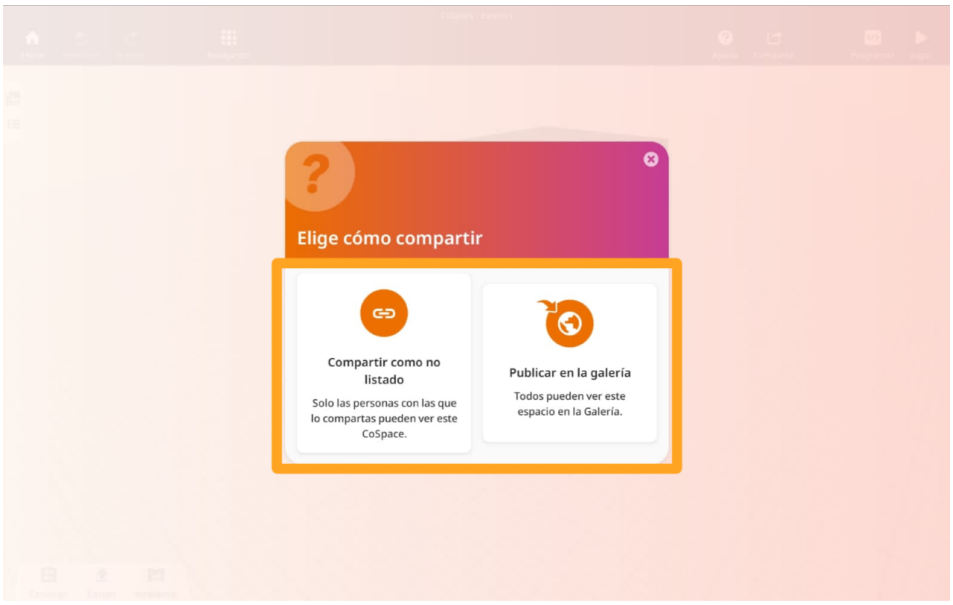


SHARING THE STAGE

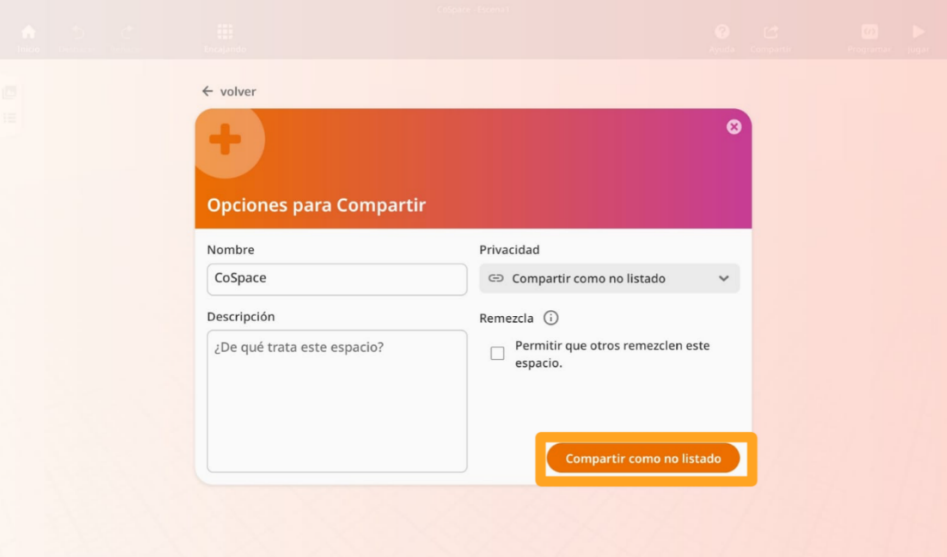
1. To share a space, click on the **Share** button located at the top right of the editing screen as shown in the image. You will see that your space is private, click again on the orange **Share** button.



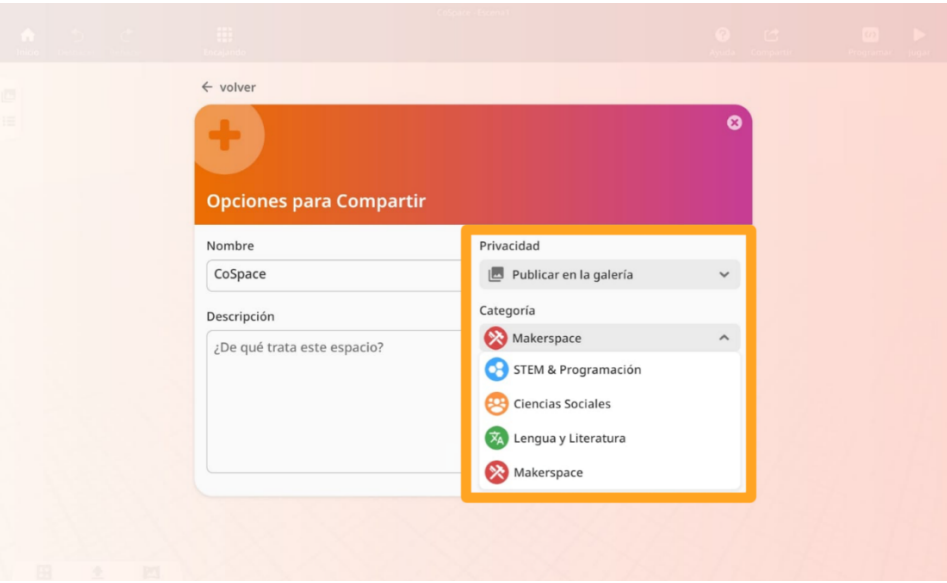
2. A pop-up window will open as shown in the image presenting the two ways to share the created scenario: **Share as unlisted** (left), and **Publish to gallery** (right).



3. If you have clicked on the **Login code** button, a pop-up window will appear as shown in the image. Here you can edit the name of the space and add a description. If you click on the **Share as unlisted** button, only the people with whom you share the code will be able to see the scenario.



4. If, on the other hand, you have clicked on the **Publish to gallery** button, a pop-up window like the one shown in the image will appear. Here you can edit the name of the space, add a description, and assign it to a category: **STEM & Programming**, **Social Sciences**, **Language and Literature**, and **Makerspace**. If you click on the **Publish now** button, the space can be viewed in the gallery by anyone who searches for it, or searches for your username.



Guidance for teachers

In order to guide the teacher in the correct application of the didactic-pedagogical material designed in Augmented Reality, and to facilitate the opening to a wide horizon of educational possibilities, a series of factors and methodological guidelines to be taken into account by the teacher are presented below.

Starting from the idea that Augmented Reality is a useful didactic resource valid for any subject at any educational stage, we will try to stay away from the design of an activity for a specific subject, as it depends on the selection of curricular content made by the teacher.

Teachers tend to show greater resistance to the incorporation of a technology such as Augmented Reality than students. In order to reduce this initial resistance, we must make complete proposals for teachers, and these must include all the steps to be followed in detail, the preparation of the technological equipment, and a clear guide for the educational management of the activity.

For all these reasons, the following is a specific description of the favourable aspects, based on methodological principles, that make Augmented Reality a suitable teaching resource for any subject, within the emerging technologies.

ADVANTAGES OF AUGMENTED REALITY IN EDUCATION

The inclusion of Augmented Reality in educational and training contexts stands out for the following positive aspects:

- Activities become faster and more interactive.
- The real world is enriched by the addition of virtual information, thus fostering the contextualisation of information.
- It favours the adaptation of activities to the real needs of the pupils..
- It promotes learning based on a more emotional and immersive experience, which generates greater student interest.
- Provides the opportunity to use learning scenarios other than the traditional classroom.
- Encourages the creation of an active learning environment. Learning to learn.
- It improves the classroom atmosphere and climate and fosters positive attitudes and student involvement in the teaching-learning process, leading to increased student motivation.
- **Encourages participation** through interactivity.
- It allows students to exploit the subjects and their immediate reality from a different perspective through **different game-based dynamics**.

- Develops autonomous work, creativity and collaboration among students.
- Preparing students for the digital age.

Just as Augmented Reality has some advantages, it also brings with it a number of disadvantages. When we incorporate ICT in the classroom, a series of changes are produced which are often reflected in the role of the teacher and the student, in the physical teaching spaces, in didactics, in assessment, in resources, etc., and in this process a series of problems can arise which should be taken into account, as reflected below:

- Students can fall into a more passive learning process. That is why it is essential to know how to orient it towards the educational sphere, not to consider it only as a recreational element.
- The very novel nature of technology, which can be a challenge for teachers, who must adapt and train in new methods of emerging pedagogy.
- **Technological and economic problems** that can result from their use.
- Possible **lack of institutional support**.
- Characteristics of an educational curriculum such as that of Secondary Education, closed and limited in time, which sometimes leaves no margin for introducing innovations in it.

METHODOLOGICAL GUIDELINES

When designing Augmented Reality materials and their application to education, we will base ourselves on constructivist pedagogical theories. These propose learning based on the students' construction of their own learning and linking it to their personal experience, to their everyday life. The constructivist approach is a teaching method that allows cooperative work in group projects to create together or through the sum of individual work on the same topic.

Within this pedagogical current, we can frame the following active methodologies as the ones that best respond to this paradigm led by Augmented Reality, both included in the AGREEMENT 29/2017, of 15 June, of the Junta de Castilla y León, which approves the II Plan of Attention to Diversity in Education in Castilla y León 2017-2022:

- **Problem-based learning:** proposes experience as a method for learning.
- **Gamification:** refers to the process of problem solving and engaging learners through play. The use of fun learning increases interest, motivation, participation and evaluation in learning; in this way we are transforming interaction into a form of knowledge.

Augmented Reality is a technology that enables a learning-teaching methodology based on these **principles**: it is an active learning methodology, it favours student understanding, and it is based on the use of multimedia elements characteristic of the digital era.

Augmented Reality is a didactic resource that proposes an active dynamic and full student activity while learning. It allows students to understand and deepen their understanding of the most difficult content, interacting with it **according to their own learning needs**.

This technology allows the student to actively learn with a virtual 3D object that is within their reality and their physical environment, an object that they can transform by moving and rotating the Merge Cube. In this way, the student will not be watching a video, but will be inside a scene that he himself is transforming, that is to say, an interactive learning scenario.

It is important to bear in mind that depending on the teacher's digital skills and competences, the design and implementation of teaching material will vary and can be better adjusted to the diversity of learners and the corresponding curricular content.

Superimposing virtual information on the real world favours the assimilation of content, as it helps students to understand what they are seeing by relating it to other content. For this reason, **the activities carried out with Augmented Reality are basically practical** and help students to assimilate learning procedures quickly. As mentioned above, the most natural way to learn something is by doing it instead of reading it, listening to it or even watching it; and all of this is enhanced by the freedom to create rich learning scenarios.

ROLE OF THE TEACHER AND THE STUDENT

TEACHER

The teacher has a fundamental role as a **creator** and designer of materials, and must therefore adopt a practical curricular approach that allows him/her to adapt the activities to the content and the students in the classroom. He/she also maintains a **mediating** role, whose function is to supervise and facilitate student learning.

Related to the work of creating content, it is also interesting that these creations are then shared on social networks and educational platforms so that they can be made available to other teachers.

STUDENT

In the activities carried out with Augmented Reality, the student is the centre of the process, maintaining an eminently **active** role, even when it is used to transmit information to the student by visual means, the student is required to interact in an active way by activating the content, moving it, exploring it, etc. Students develop autonomy in their own learning, becoming more self-directed.

We are at a point where the teacher is no longer the traditional knowledge holder, as students become empowered when they **learn to learn**.

RESOURCE GUIDELINES

When planning a didactic experience with Augmented Reality it is necessary to consider a series of questions such as:

- The **number of technological devices** available to teachers and students during the teaching-learning process.
- The **time available** for the realisation and design of the activities.
- The **cost of the necessary software** and the type of software licence. In this case CoSpaces has a free version with limited multimedia resources, however, if we want to go further and have access to all the possibilities of the application, we must pay one of the licenses offered by the application, depending on the one that best suits our case.

Generally, students have worked with computers, as these are the most common devices in educational centres. When it comes to reproducing and visualising Augmented Reality content, mobile devices also stand out, especially tablets.

It is noteworthy that in the activities developed using this type of hardware, students tend to work in groups, as the ratio of devices is low compared to the size of the class.

GUIDANCE ON USE AND HANDLING

Once we have designed and created the material in CoSpaces, we will go on to project and play it on the MergeCube. We will be able to visualise it, explore it, and interact with it in several ways, among them:

- Holding the device in our hands and moving around the Merge Cube, resting on a fixed surface, we visualise each of its faces.
- Holding the Merge Cube in our hands and rotating it with a free 360° angle in order to view all its faces. The device is fixed in one position.

We must not forget a fundamental factor when it comes to making optimal use of the Merge Cube in the visualisation of materials in Augmented Reality: light. It is essential to use the Merge Cube in a place with **suitable lighting conditions** to be able to visualise the design of the 3D material in Augmented Reality. Otherwise, poor lighting conditions do not help the device's camera to recognise and read the drawings of the cube's faces properly.

GUIDANCE ON EVALUATION

As teachers, we evaluate the final material with the intention of showing whether the information is appropriate to the profile of the learners, to improve technical aspects of it, or to check whether it is appropriate to change something. We can carry out this evaluation of ICT materials from different approaches:

Producer self-evaluation: we carry it out consciously or unconsciously in the course of the design and production of the didactic material, so it does not need to be planned. The advantages of this type of evaluation are that the team can feel more open to criticism, and that the information is used more quickly. Among the disadvantages that may arise is the lack of objectivity.

Expert assessment: this type of assessment has a number of advantages such as the quality of the response and the level of depth. It should be borne in mind that there are different experts, some of whom may be content experts, others technical and technological experts, etc. It is one of the most commonly used evaluation methods.

Evaluation by and from users: this is the most reliable type of evaluation, as its advantages include the direct participation of the recipients, the learners, and it is usually carried out in the real context of application of the material. On the other hand, its disadvantages include the high degree of laboriousness, since this type of evaluation requires time and an extra cost that the others do not, and the fact that the data collected are not automatically incorporated into the material, so it requires a revision of the material in order to be able to launch a final version. It can be carried out in various ways, for example: one-to-one, in small groups, in large groups, or field study.

On the other hand, among the long list of evaluation instruments that we can find, and that we can use to carry out the evaluation of technological material in augmented reality, in any of the three ways described above, are: observation, individual or group interviews, questionnaires, information collection sheets, debates, exams, notebooks, assignments, etc.

An instrument consisting of a questionnaire for evaluating the material created is attached in **Annex III**. The different criteria, items or dimensions from which we collect information when evaluating the technological material designed using augmented reality are the following: degree of development of specific cognitive strategies (**attention**, **perception** and **memory**), degree of **motivation** and **interest** generated in the teacher and students, degree of usability of the material by the teacher and students, degree of **accessibility** to the contents through the use of the material by the teacher and students, etc.

ACCESIBILITY GUIDELINES

It is essential not to forget the basic characteristics that all educational technology must have, which are non-intrusive, accessible, usable, and adaptable to any person and any context.

The essence of all this lies in adaptability and universality. The aim is to achieve a fully personalised environment, which learns and moulds itself according to the needs of each person.

Learning and participating in education plans and a standardised curriculum is a right for everyone. However, the learning process can become a complex task for people with some kind of diversity, and it is at this point where the appropriate incorporation of non-invasive technologies can help us to solve this problem, as well as to work under the principles of inclusion and normalisation.

Teachers responsible for pupils with special educational needs must know and handle these assistive technologies properly, as this will have a direct impact on the achievement of curricular and stage objectives.

According to the Instruction of 24 August 2017, which establishes the procedure for the collection and processing of data relating to Pupils with Specific Educational Support Needs (ACENAE) enrolled in schools in Castilla y León, pupils with special educational needs are those who require, for a period of time during their schooling, or throughout their schooling, certain support and specific educational attention derived from disability.

In this case, we will focus on pupils who have a physical motor disability in the upper limbs and with preserved intelligence. These pupils are characterised by a significant decrease or lack of coordination in the movement of one or more parts of the body. This may be caused by a malfunctioning of the central nervous system, the muscular system, the skeletal system, or an interrelation between the three, which generates postural, movement and coordination limitations in movements.

Two important benefits of ICT for students with special educational needs:

- They have a pedagogical and rehabilitative purpose, i.e. thanks to their use we can achieve optimal levels that modify their initial state of disability.
- They are a point of support for pupils in the development of their abilities, thus achieving equal opportunities. They also provide support for teachers in achieving their maximum professional development, and in improving the teaching-learning process in the different areas of the curriculum for those pupils who need it.

The frequent use of ICT by students with disabilities and the knowledge of existing adapted resources has positive effects on their learning, making them independent.

Along these lines, four alternatives to the Merge Cube control are presented below to support the learning of students with upper limb disabilities and retained intelligence:

Remote-controlled turntable:

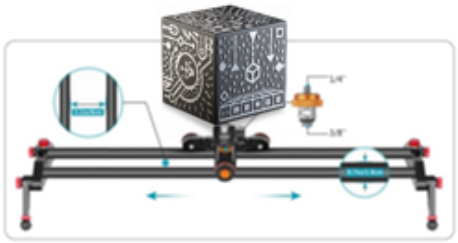
- It consists of a universal two-way swivel bracket.
- It can reach up to three speeds and supports a maximum load of 4 kilograms.
- The freedom of rotation is 360 degrees on the horizontal axis.
- It allows the display of 5 sides of the Merge Cube.
- The control is done from a remote control, without cables.

Tripod with remote control:

- It consists of a tripod that is operated by motorised remote control from a remote control, without cables.
- The freedom of rotation is 360 degrees on the horizontal axis and 360 degrees on the vertical axis.
- It supports a maximum load of 500 grams.
- Allows the display of 5 sides of the Merge Cube.

Remote-controlled rails and turntable:

- It consists of a support consisting of a rail and a turntable that is operated by motorised remote control from a remote control, without cables.
- The rails allow the Merge Cube to be moved along the horizontal axis, while the platform allows the cube to be rotated with 360 degrees of freedom.
- It allows the display of 5 sides of the Merge Cube.



Annexes

ANNEX I

VIDEO OF THE DEFENCE OF THE TFG ON AUGMENTED REALITY

Option 1: To view the TFG defence video about the material designed in Augmented Reality, access the YouTube platform and type “Rubén Sáenz del Amo” in the search engine, then click on the corresponding video. You can also access directly by clicking on the link, or on the image, both located below.

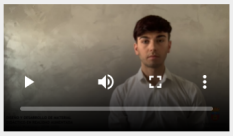
https://www.youtube.com/results?sp=mAEB&search_query=ruben+saenz+del+amo

Option 2: To download the TFG defence video about the material designed in Augmented Reality, access the Institutional Repository of the University of Burgos (RIUBU) and in the search engine type "Rubén Sáenz del Amo", then click on the corresponding link. You can also access directly by clicking on the link, or on the image, both located below.

Título	Diseño y desarrollo de material didáctico en realidad aumentada: vídeo de presentación
Autor	Sáenz del Amo, Rubén
Fecha de publicación	2020
URI	http://hdl.handle.net/10259/5350
Aparece en las colecciones	Ponencias/Comunicaciones de congresos DINPER

Ficheros en este ítem

Nombre: Sáenz_del_Amo-video_defensa_tfg.mp4
Tamaño: 177.0Mb
Formato: MPEG-4

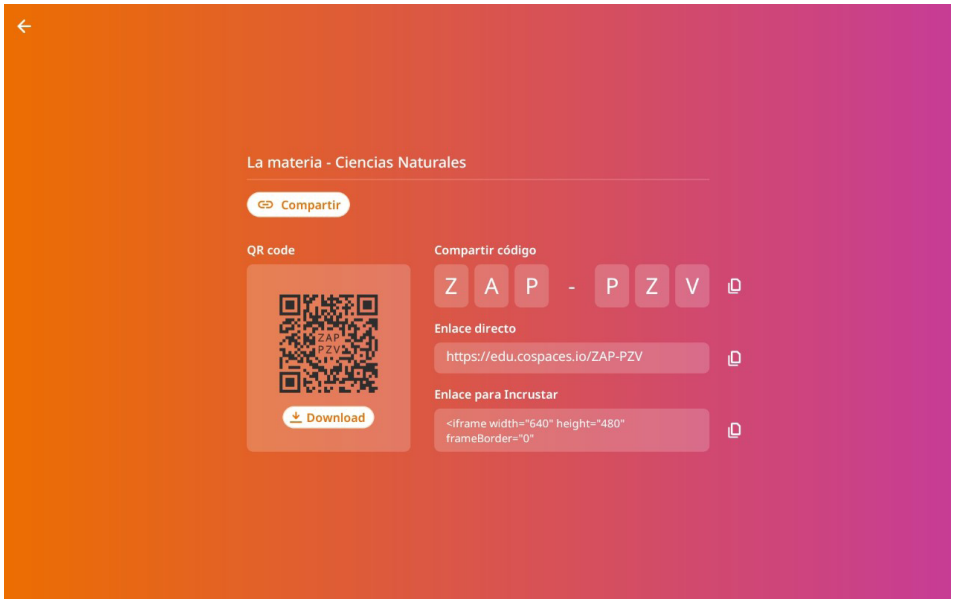


Visualizar/Abrir

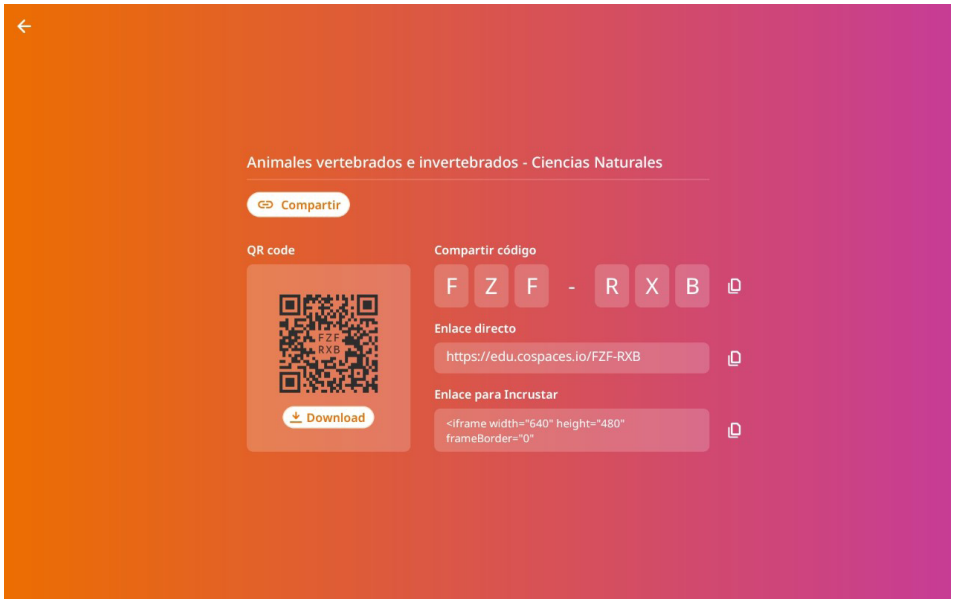
http://hdl.handle.net/10259/5350

ANNEX II

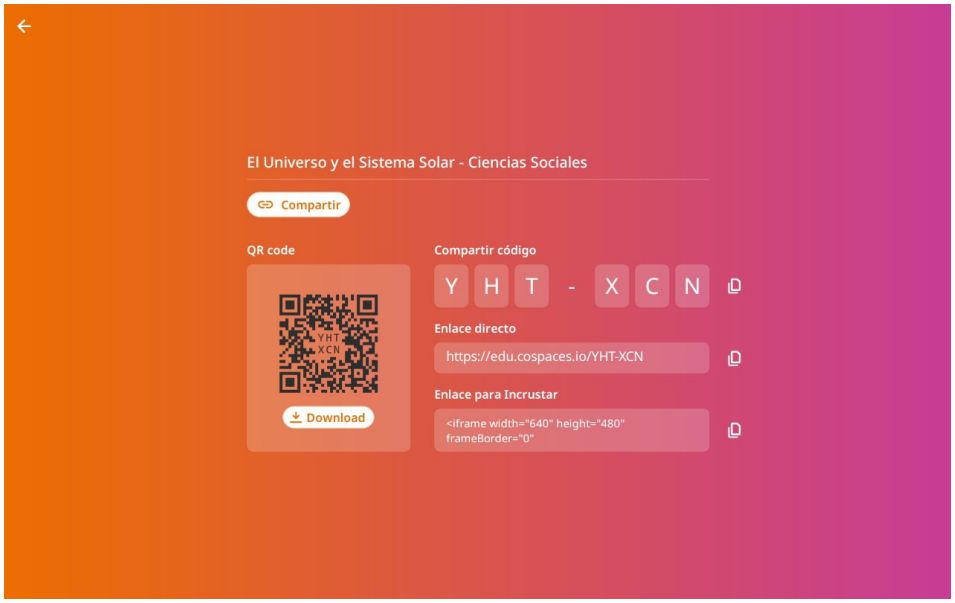
LINKS TO THE DESIGNED TEACHING UNITS



Matter - Natural Sciences



Vertebrate and invertebrate animals - Natural Sciences



The Universe and the Solar System - Social Sciences

ANNEX III

EVALUATION RUBRIC FOR TEACHERS

Project funded by the Junta de Castilla y León (BU031G19).

The use of Augmented Reality (AR) in the school environment and its impact on the teaching-learning process of students with special educational needs.

Assessment rubric for teachers

1.-Strongly disagree. **2.**- Disagree. **3.**- Agree. **4.**- Strongly agree.

CONCERNING THE MATERIAL SUPPLIED	1	2	3	4
The delivered kit (backpack with: Tablet, camera, tripod, etc.) is properly prepared to be used in the design and use of AR.				
The material provided is suitable for use in the classroom.				
I consider the material to be technically sound.				
The use of AR requires additional training for me.				
Students have become familiar with the material provided.				
The use of Tablets by the students involved is complex.				
Infrastructure problems have arisen (internet connection, spaces, etc.).				
On a general level, it is a useful material for students.				
The material provided is for sporadic use.				
The material has met my expectations.				

REGARDING THE TEACHING-LEARNING PROCESS	1	2	3	4
The contents presented in AR make it easier for students to understand.				
The use of AR in the classroom is an important change in methodology.				
AR is easily integrated into the dynamics of the classroom itself.				
AR is an essential resource in the classroom with students with special educational needs.				
AR makes sense if it is complemented by other methodological strategies.				
AR facilitates cooperative work among students.				
AR increases students' attention.				
AR facilitates student motivation towards learning.				
The students' attitude towards the contents presented in AR was satisfactory.				
Students have become familiar with the material provided.				
The use of AR should be generalised to all levels of education.				
There is a need to have more materials designed in AR.				
Overall, I am satisfied with the materials designed in AR.				

Observations and areas for improvement:

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