ARETE – DELIVERABLE (D7.3)

WP7 - D7.3: Showcase Mobile App

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1.0	25/06/2021	TOU, UCD: Final corrections and submission

[1] Nature:
R = Report, P = Prototype, D = Demonstrator, O = Other
Dissemination level
PU = Public
PP = Restricted to other programme participants (including the Commission Services)
RE = Restricted to a group specified by the consortium (including the Commission Services)
CO = Confidential, only for members of the consortium (including the Commission Services)
Restraint UE = Classified with the classification level "Restraint UE" according to Commission Decision 2001/844 and amendments
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The final version of the deliverable will be published as soon as approved by EC.

Disclaimer

Table of Contents

Executive Summary

This deliverable describes and documents the ARETE showcase app, MirageXR. The deliverable is written in tutorial style, guiding the reader step by step through the key functionality of the application.

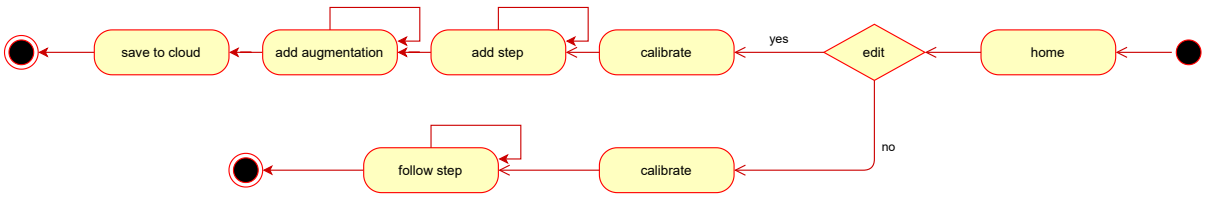


Figure 1. MirageXR user workflow (UML activity diagram)

Figure 1 outlines the user flow (from right to left), which is reflected in the organisation of this document. Users start on 'home' (see Section 2), entering either 'learning mode' (Sections 3-6) or 'authoring mode' (Section 8-11). Additional relevant server functionality of the learning management system is described in Sections 7 and 12 (not depicted). An outlook and some remarks conclude this report.

The app is available in version v1.5 (June 9, 2021) for iOS, Android, and Windows Holographic, running on a wide range of hardware devices[2] that shipped since 2014, 2016, and 2016, respectively. For 2020, ARtillery assesses the global reach with 1.8 billion ARkit/ARcore compatible devices[3], as opposed to 598 million active AR-users on these devices.

The back-end repository, the ARETE Moodle ARLEM repository, is running on an instance of Moodle (running 3.10.1) installed at https://arete.ucd.ie/ with release 1.0.1 (June 7, 2021) of the plugin.

[2] *Android:* the lower-level library ARcore (first release March 2018) was originally designed to run on Android Nougat (7.0), thus available on devices shipping from typically after August 2016, with superior performance on later generation premium devices, of course. *iOS*: the lower-level ARkit library (first release June 2017) is backwards compatible with devices as old as 2014, with superior performance in particular on latest-generation lidar-enabled devices (since 2020: iPhone Pro 11/12, iPad Pro). *Windows holographic*: the lower-level library MRTk is compatible with devices that shipped since March 2016 (Hololens 1) and November 2019 (Hololens 2).

[3] https://arinsider.co/2020/09/03/artillery-briefs-episode-41-mobile-ar-revenue-outlook/

1. Introduction

The MirageXR app is an IEEE P1589-2020 compatible Augmented Reality education and training application, which is available cross-platform for Android, iOS, and Windows Holographic. The application is available free of charge, currently in version v1.5ß, from the following source:

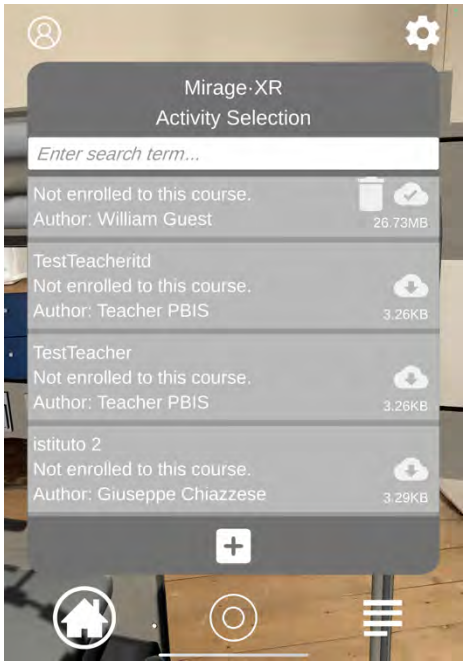
https://bit.ly/miragexr15

https://bit.ly/miragexrmoodle

The app requires a sign up for the back-end repository service, the ARETE Moodle instance, where the webservices for storage, search, retrieval, and learner management are located.

2. Home

When starting the app, the first home screen appears, the 'activity list'. The activity list provides a scrollable list of all activities available to the user, selection depending on their role and rights in the back-end system Moodle – listing first those activities assigned to courses the user is registered for (displaying also according deadlines) and second all other public activities.



Settings

User authentication: log in to Moodle with username and password, log out

Settings: set, e.g., the URL of the Moodle instance to use

Activity List

Search for an activity by name.

Cloud checkmark: activity can be downloaded from the server to the device. Trash icon: remove from local again[4].

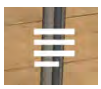
Cloud download: fetch activity from the server and store on to the device. Only downloaded activities, can be executed.

The app has an integrated authoring toolkit for in situ creation and editing of AR learning experiences. It can be reached via the "+" icon.

Navigation

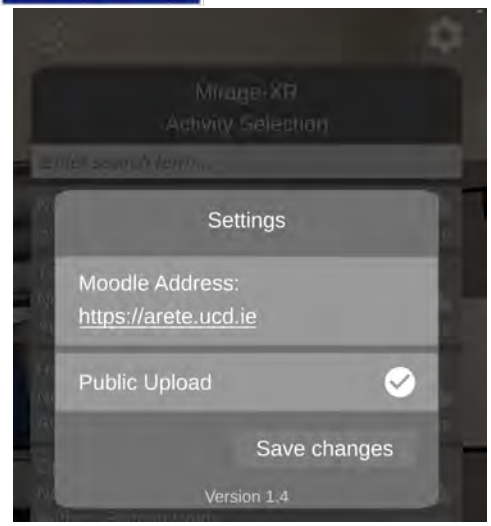
Home: brings always back to the activity selection screen

Step: displays info about current action step.



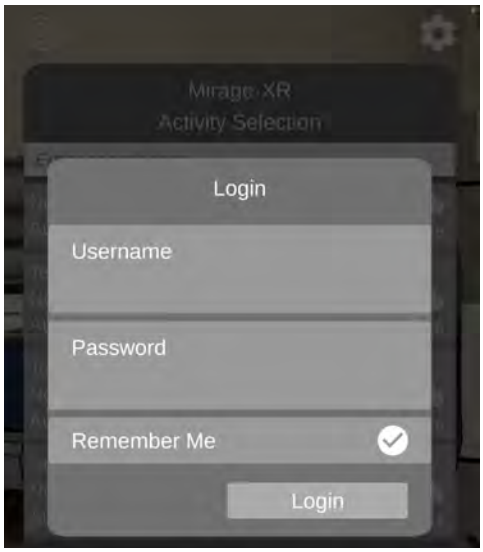
Task list: display the list of action steps in the current activity.

[4] Activities already uploaded to the server can only be deleted in the Moodle back-end, for security reasons.



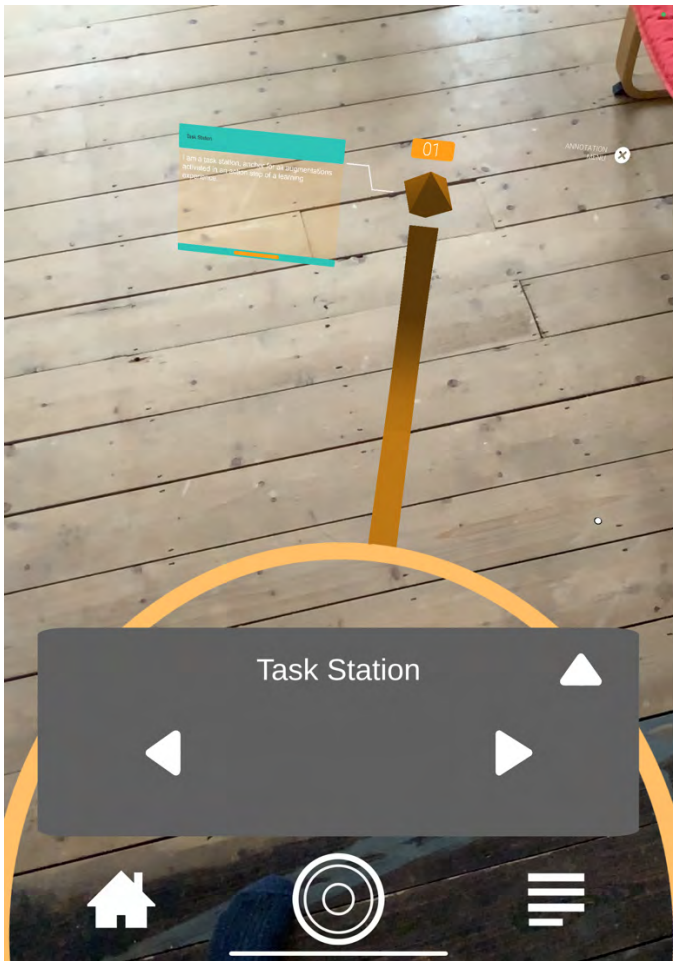
The cogwheel icon brings up the server configuration, where the URL to the Moodle repository can be changed.

The flag “public upload” decides whether all activities created on the device are per default public. This setting can be changed for each AR learning resource created in the Moodle back-end on an individual basis.



The person icon brings up the authentication settings for the user, where username and password can be entered, and a flag can be set on whether to store username and password (with encryption) on the local device, so that the user has to enter these credentials only once.

3. Aura

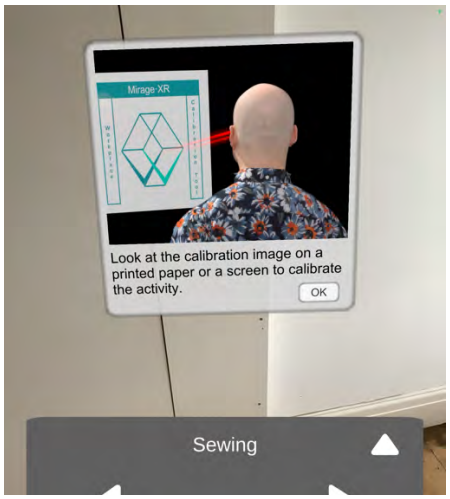


Real-world Learning activities are designed to involve several ‘task stations’ (symbolised by the orange diamond in the picture), which are placed at different locations in the physical surrounding of the learners.

To ensure users do not get lost, MirageXR introduces the concept of the ‘aura’, a glowing circle on the floor that spans around where the user stands.

When looking down at the aura, floor lines always guide to where the action happens.

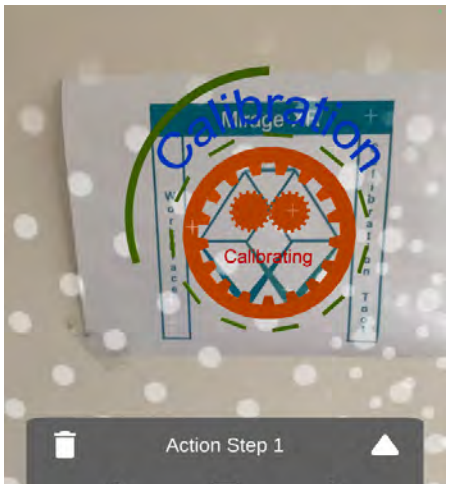
4. Calibration



Learning in the real world is most effective when the activities are responsive to points of interest and events in the real world. MirageXR uses a single calibration marker to tie the digital augmentations to points of interest in the physical environment of the user.

Where locations do not matter, the calibration marker can be hung somewhere where enough open space is provided to place the holograms.

Where locations matter, like, for example, when instructing in a maker's lab on how to handle a 3D printer, the activity will either include instruction on where to place the calibration marker directly or a hand-out will show students or teachers how to.



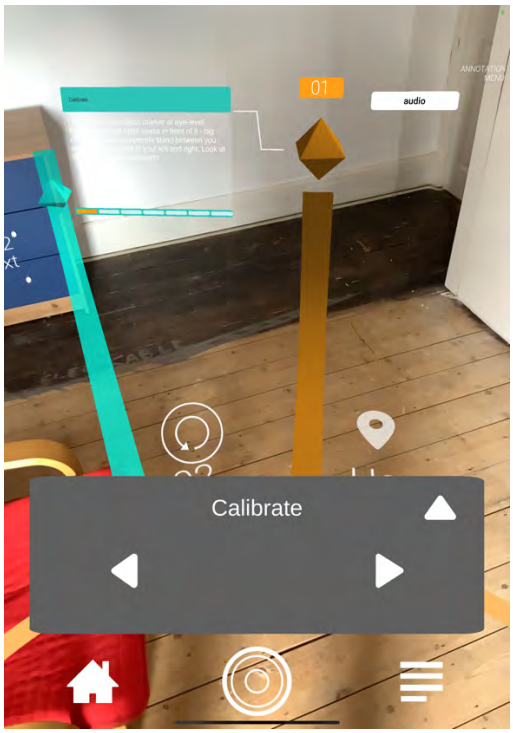
Calibration is run simply by gazing at the calibration marker. An overlay animation will appear, with a circle completing segment by segment. A 'click' sound indicates when the calibration is concluded, and the overlay disappears.

During calibration, all positions of task stations and their attached augmentations are repositioned relative to the marker centre.

Orientation of the marker is not relevant, so it does not matter whether the marker is hung on a wall or lying on a table.

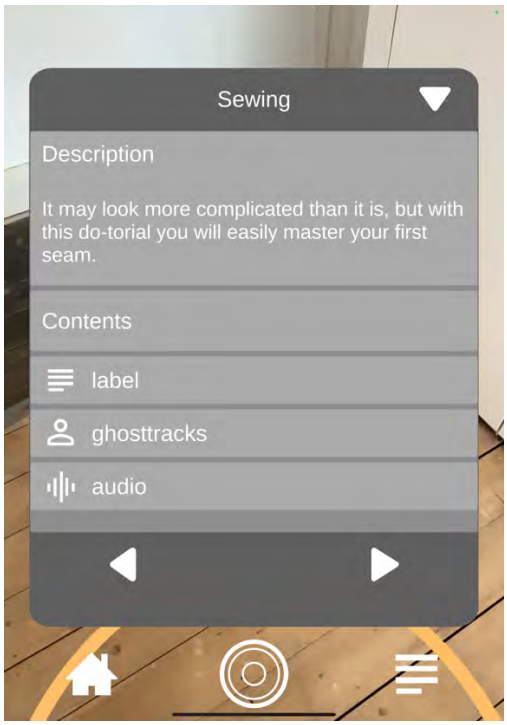
The calibration marker.

5. Task station learning



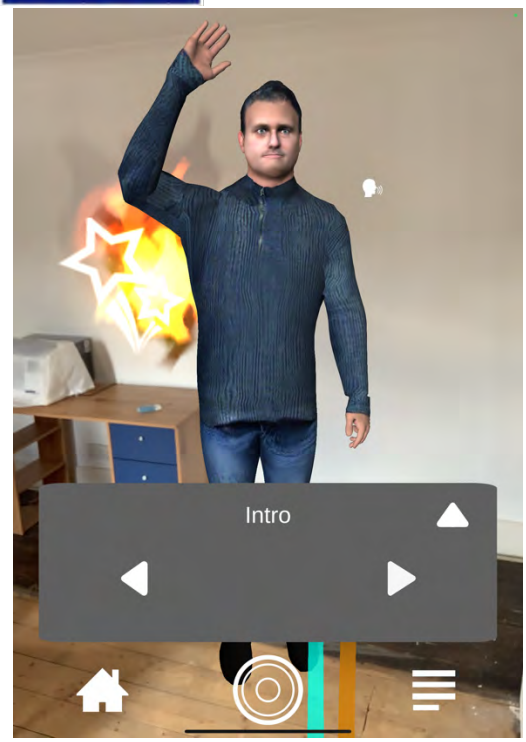
Once calibration concludes, the learning experience starts automatically. With ‘experience’, we refer to a learning activity consisting out of action steps, where each action step may have multiple so-called ‘augmentations’, digital content blended in with the real world. For example, this can be some audio instruction, delivered from a specific location in 3D space, or a 3D animation superimposed on a physical object.

Each step in the learning activity is anchored to a ‘task station’, represented by an orange diamond placed at a specific location in the room. Any augmentation, where the location in 3D space matters (spatial audio, holographic 3D characters, action glyphs, etc.) will be tied to this task station diamond.



A grey ‘task card’ floats in the foreground providing instruction on what the learner is expected to do in this step. The task card is per default folded away, but a tap on the up arrow (▲) folds out the full description. This task card features additionally a list of the contents provided, so that the user can check, what to expect.

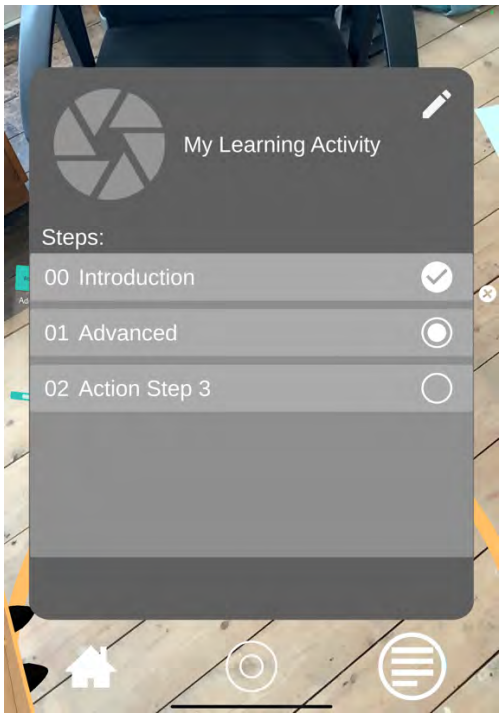
The down arrow (▼) hides the task card content away again to display only the action step title.



Instructional design is a creative job, so the way AR learning experiences are constructed varies widely. There is no one size fits all and there is always an alternative way of how the learning content could be translated to the system of augmentations MirageXR supports.

The right (▶️) and left (◀️) buttons navigate to the next and previous action step.

6. Action List



The icon on the right always brings up the full list of all action steps, so that the users can quickly see, where in the sequence they are.

The completed action steps are marked with a checkmark (✓), the current one with a circled bullet (◉), and next steps with an empty circle (◯).

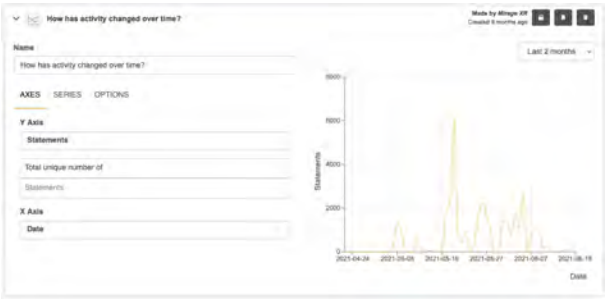
The pencil icon (✎) switches to edit mode, allowing the user to modify own or cloned activities of others.

The application remembers states, resuming the activity where the user last stopped.

This is what the data for a statement record looks like, which MirageXR sends to the so-called Learning Record Store that is configured in the app.

Behind the scenes, if the user is logged in, the system collects behavioural traces of learning, to provide Learning Analytics back to the user.

For example, when an activity is initialized and when actually started (after calibration), and when ended, gives insight into engagement.



To make another example: Popularity rankings can be a useful tool to discover new activities.

7. Learning Management System

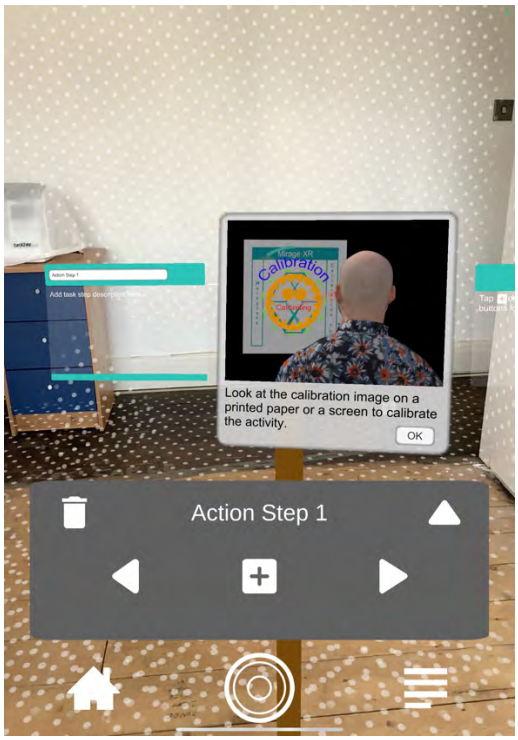
Behind the scenes, MirageXR links up with Moodle as Learning Management System (LMS). This can be configured in the app via the settings (⚙) icon.

Through the ARETE repository plugin, Moodle gets a new activity type 'Augmented Reality', which can be added to course topics or weeks to schedule delivery to the students registered for the course.

If opened on a browser on the mobile device or on the smart glasses, the launch button (▶) 'deep links' into the app, directly downloading and opening the learning experience.

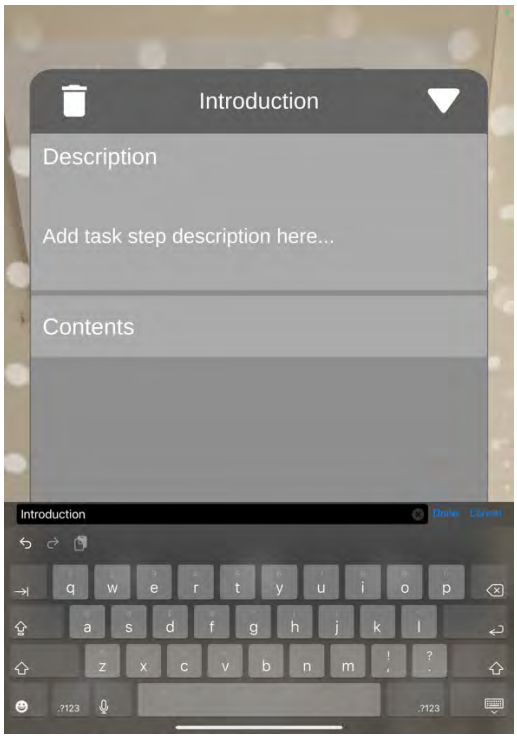
To simplify classroom sharing, and also allow teachers to bypass the course and booking system of Moodle, the deep links and QR codes can alternatively be used to launch the activity on the students' devices.

8. Editing



Same as when running learning activities, when creating a new activity (+ icon on the home screen, see Section 2) or when editing an existing one (✎ icon on the action list, see Section 6), the first thing to do is to calibrate the activity using the calibration marker.

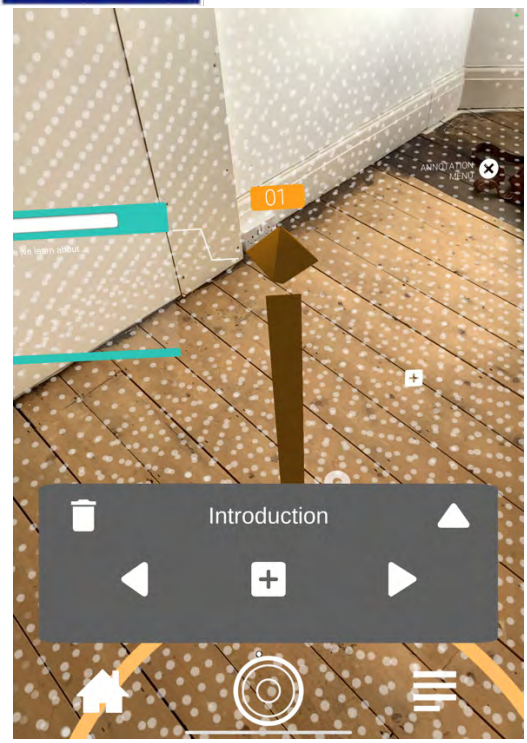
Choose the location wisely, as it cannot be changed later easily[5]!



Fold up the task card (see Section 5) to edit the title and the description of the action step.

Titles should be short, but meaningful and distinct.

[5] (Technically, calibration can also be executed last, but tends to be forgotten, then creating unintended side-effects that require re-editing and subsequent rearrangement of all task stations.)

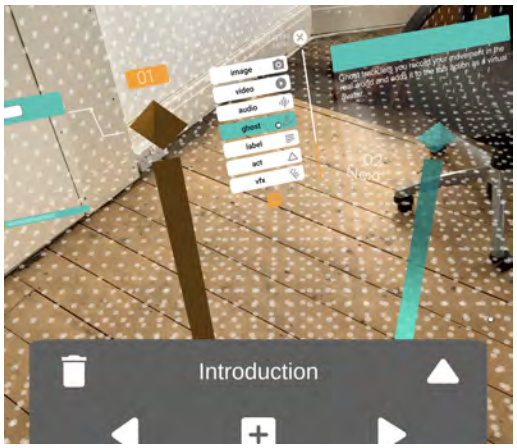


The task station can be moved by tapping and holding the diamond, and then slowly moving the device around to place it on its target location.

Drag & drop also works here, but is sometimes tricky to handle, as the screen space is only 2D, but the placement is in 3D space.

The + icon on the grey task bar adds new diamonds (= action steps with their task station location).

The back (◀️) and forth (▶️) buttons help navigate between action steps.



The second **+** button placed in space near the task station diamond brings up a context menu, which helps add new augmentations from a list of different augmentation types offered.

Note: This context menu is about to move onto the folded-out task card, so in future versions, this menu will be integrated into the flat menus on the screen.

The list has a scroll bar, which can be used to pan the list up and down to access items not visible. Tap-holding on an entry will bring up a short description of what this augmentation type is about.

9. Augmentation Types

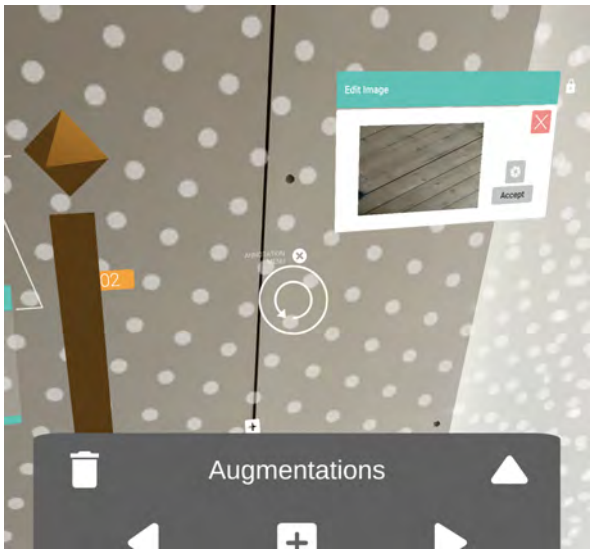
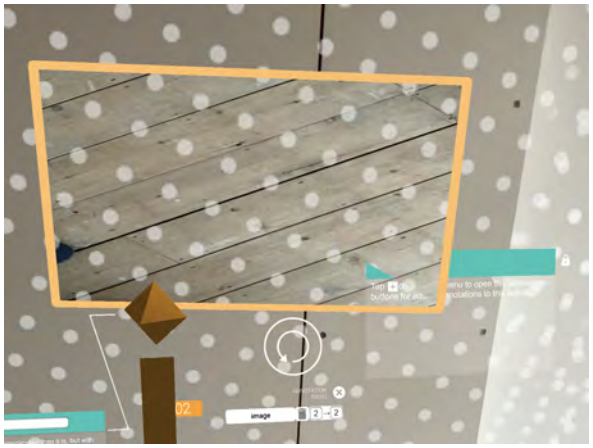


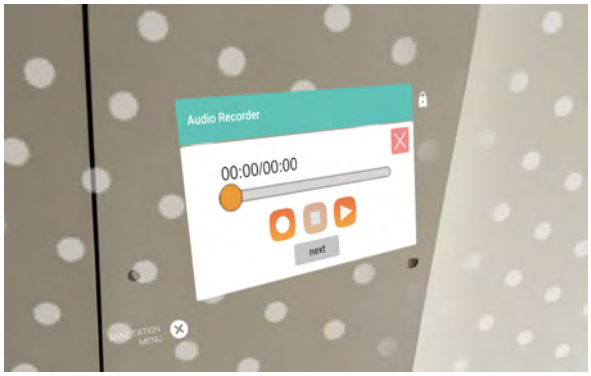
Image and Video

Image and videos can be recorded using the shutter (depicted on the left) or record/stop icons (not visible).

Once the video is recorded, it has to be accepted to show up above the task station.



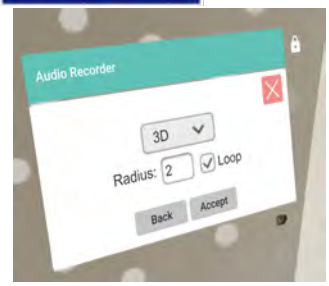
From there, the image or video can be moved and resized, as needed. Please note that both image and videos are bill-boarded, so that they always automatically face the user.



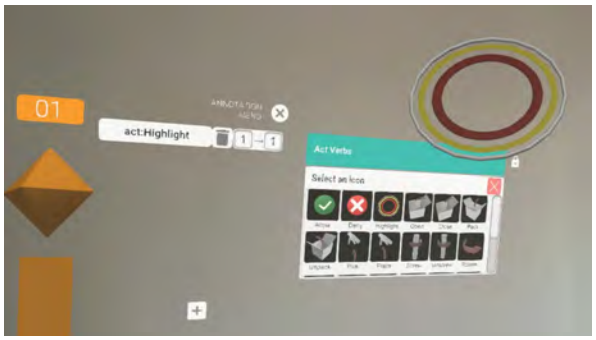
Audio

Audio recordings are a useful tool to deliver timed instruction with a personal note.

Please note that several other augmentations (ghost, character) will create separate audio augmentations so that the audio can easily be re-recorded or modified, if needed.



Audio can be placed as 2D, i.e., plays with the same volume from any location in the room, or as spatial audio in 3D, playing from a specific location in the room with volume decreasing with the radial distance (provided in meters).



Act: Actions Glyphs

A built-in visual language for instructing the user on how to move or handle real world objects. This inventory of glyphs provides a rich set of action instructions that come handy in many situations and that have prepared, aesthetic 3D icons.

In the picture: the 'highlight' glyph, used to direct the user's attention to a specific location in 3D space.

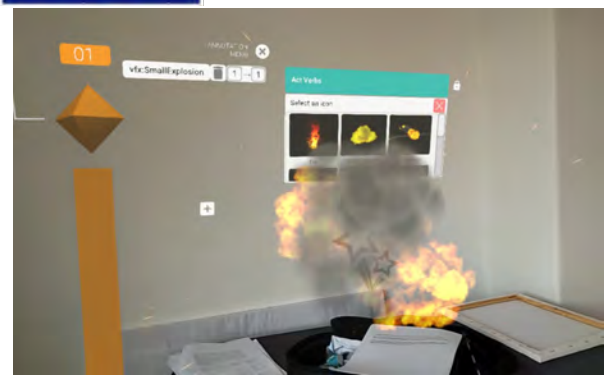
Ghost: GhostTrack

The GhostTrack uses the built-in sensors of the device to record where the teacher moves. On mobile devices, the hands position is fixed. On smart glasses, the hands position is recorded using the built-in sensors (or additional wearable gear).

The GhostTrack additionally records audio, allowing the teacher to deliver explanations, instruction, or other following a think aloud protocol.

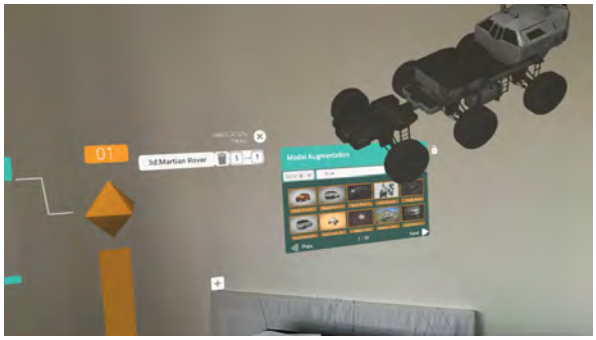
Label

This augmentation can be used to annotate virtual or real 3D objects and space surrounding the learners. Additionally, it is possible to add a detect trigger, so that the system automatically moves to the next action step, if the user gazes long enough at the label (gaze duration specified in seconds).



Vfx: Visual Effects

To direct attention, visual effects come handy – they can be used to highlight a specific point of interest with a bit of a bang.

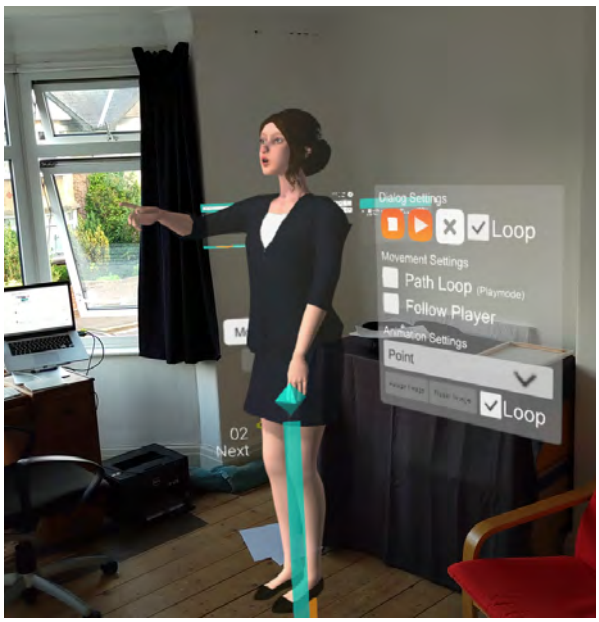


3D model

This interface for 3D models allows to search in Sketchfab's database of 3D models, offering access to more than three million models already back in 2018.

To find models, enter the search term into the search field and hit search. To place a model at the task station, first select it and confirm that you really want to download. Once the download is finished, a little green checkmark will appear in the lower right corner and with a second tap, the object can be placed.

Depending on size and complexity, it may take a while to download and to render.

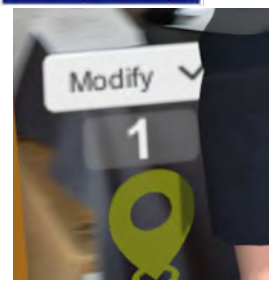


Character: 3D character models

Character models have an appearance, voice, and behaviour, including preconfigured animations.

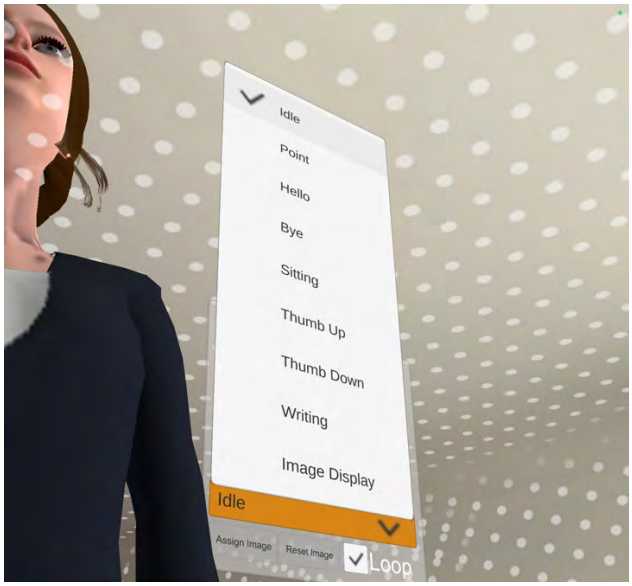
Select a character model of your choice (in the picture: Hanna), which will place her near the task station diamond (or close by where space allows).

Audio recorded will be delivered then by the character model, using lip-sync.



The location marker on the floor allows you to move and rotate the character model around. Adding location markers will create a path the character model will try to walk along if there are no obstructing objects. The characters intelligently try to find the shortest path around any obstructing objects, using the spatial map continuously scanned by the delivery device. This path can be looped, making the character model walk back and forth between the markers.

Alternatively, there is a intelligent behaviour added “follow the user”, which makes the character model try to go where the user stands, stopping just short of bumping into the user. This is the first of future intelligent behaviours we intend to add.

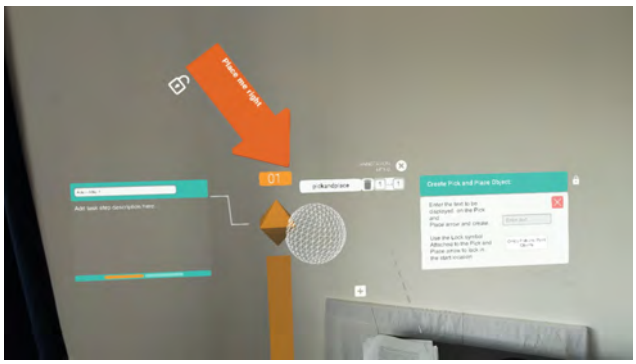


Character models can deliver animations, most of them support the full standard set depicted to the left: idle, point, waive ‘hello’, waive ‘good bye’, sit, thumb up, thumb down, write, or a magic one called ‘image display’.

Character Model: Image display

The latter requires the author to add an image augmentation to the task station, which then can be assigned (tap 'assign image', then tap the image augmentation in the list of augmentations beside the task station diamond).

Once assigned, the characters will pull a poster board from behind their back – out of thin air – presenting the image assigned.



Pick & place

This augmentation is useful to provide augmented reality quizzes – 'placing' an object onto the right location. The resizable sphere indicates the correct target location. The lock defines on whether the pointer snaps back upon release if the user did not drop the object in the correct place.

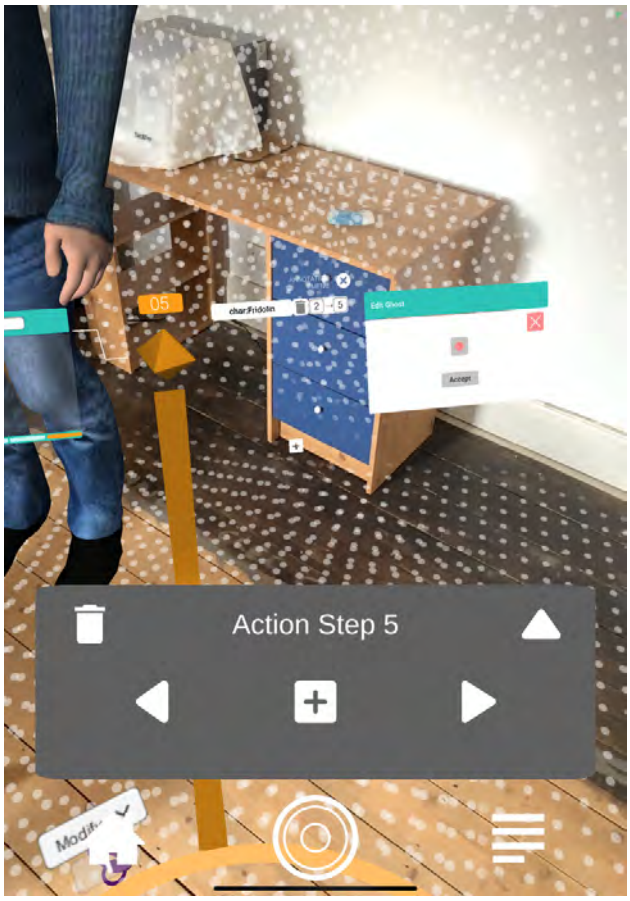
Image Marker

(editing available on Hololens only, replay across platforms)

The image marker augmentation allows to attach the location of the task station to any object that can be recognised with computer vision. To tie a task station to a image target marker, the augmentation prompts the user to take a photo first, resize and crop until the (ideally flat) surface of interest is clearly in focus. In the picture, this is a photo of the palm tree picture. When the learner encounters the picture of the palm tree, the task station will be placed relative to the palm tree.

This allows to, e.g., take picture of the front blade of a machine (if it has distinct features) and then tie instruction to specific locations on the machine.

10. Keep alive



In order to create more complex arrangements, augmentations can be made to span multiple action steps, meaning that when switching to the next step, they will remain in the current position.

This is particularly useful, when a 3D model is used to explain something bit by bit. In this case, the user creates the required number of action steps first, then moves back to the action step from which on the augmentation shall exist. Via the augmentation list besides the task station, the user can enter from which step to which step the augmentation shall be 'kept alive' (in the picture below: from step 2 to step 5).

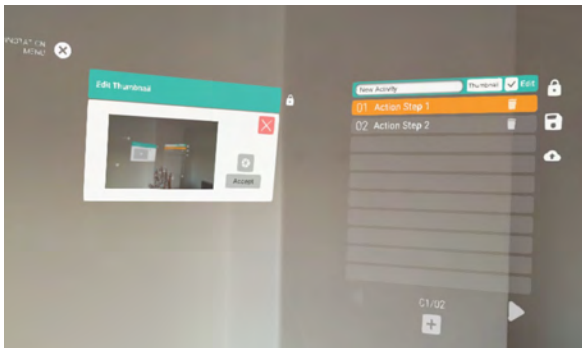
Character models allow to be reconfigured in each action step, so that it is possible to walk from location to location, provide different audio, and different end-of-path animations, as needed to guide the learner with the holographic AI through the full learning experience.

The location of other augmentation, however, will always be the position from the first action step. (When moving other augmentations, this will move them for all action steps).

11. Upload to the cloud

The task list (see Section 6) has in edit mode some additional icons in the bottom bar: save (on local device) and cloud upload.

Tap the activity title to give it a meaningful name. Then save locally and upload to the Moodle repository server. The system will notify you once the upload is completed.

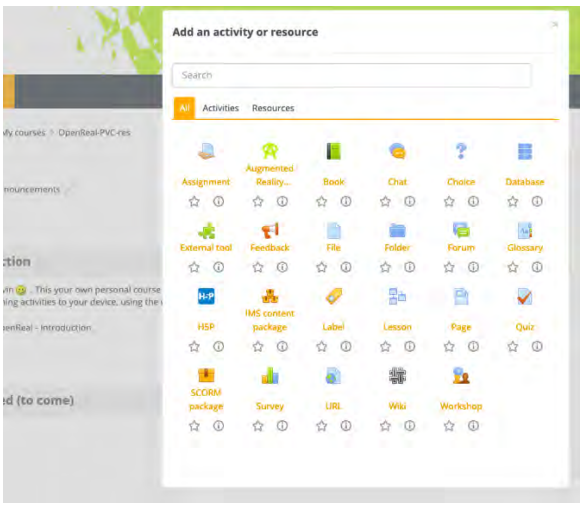


On smart glasses, you can also add a thumbnail for the activity (this functionality is scheduled to be available on mobile devices soon).

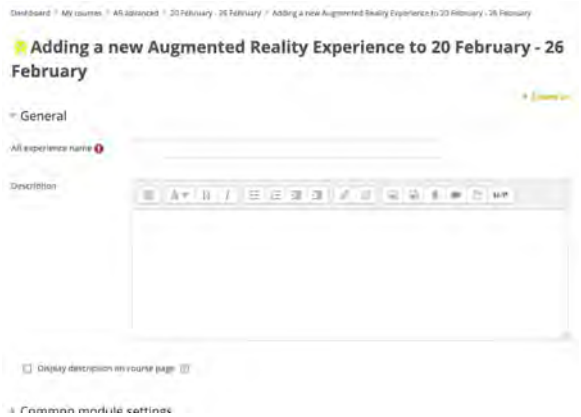
12. Learner Management in Moodle

Setting up courses in Moodle works the same way as explained in the Moodle documentation. Once the course is set up, click 'turn on editing'.

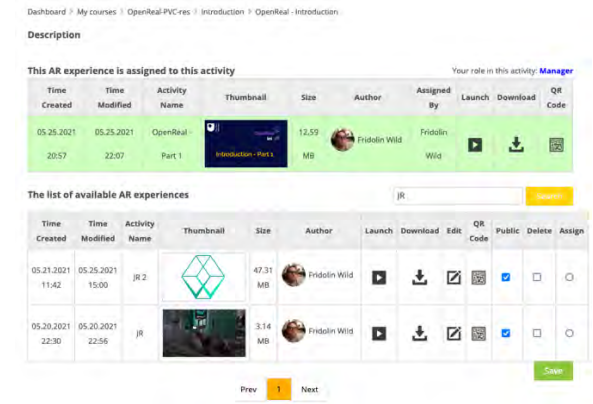
Courses follow either a topic format or a weekly format, and in each topic / week, activities and resources can be added (see picture to the left).



Select 'Augmented Reality' from the activities and resources offered.



Add the new activity container, entering a title + description, and click 'Save and display' at the bottom of the page.



Subsequently, you need to assign the uploaded AR learning experience to the course from the list below. If needed, search for the activity title, select ‘Assign’, and ‘save’ to do so.

Via this interface, activities can also be permanently deleted from the server (still remaining on local devices, if they holds a copy downloaded or created on the device).

Export via ‘Download’ is also possible.

Edit ARLEM file

Click ‘Edit’ to access the zip archive of the learning experience.

This allows to download and upload/replace any of the media files contained in the unit. For example, by uploading a new thumbnail.jpg (1168 x 657 pixel), the preview thumbnail visible in the picture above can be replaced.

Similarly, replacing .wav files can be used to create new audio. Other .mp4 or .jpg files (1168 x 657 pixel) can be identified to redo video or images as needed.

For example, to make a character model give a presentation, it is possible to export a powerpoint slide (with the resolution of 1168x657 pixels). Then add a character model with image display animation, assigning a dummy image that then is replaced with a new upload (the exported slide).

13. Conclusion

This report provides a comprehensive tutorial on how to use the ARETE demo app, MirageXR. At the time of writing, the app is available in stable release v1.5β, not yet released to the app store, but available for installation directly onto devices from a download link.

Since version v1.2, MirageXR supports white labelling, using configuration files and an integrated brand manager component to set colour scheme of the lead colours orange and turquoise as well as icons and splash screens. This allows to quickly configure further branded versions from the Open-Source core in case the project's dissemination or exploitation activities should require so.

This tutorial describes in its screenshots the functionality as seen from a mobile device (Android or iOS) with most of the screenshots produced from an iPad. The cross-platform demo app, however, is also available for Hololens 1 and Hololens 2, there adding additional interaction functionality, where the mobile platforms are still falling short. For example, ghost tracks recorded on a Hololens also have the possibility to record the hands position, which is rather pointless on mobile, hand-held devices.

As the project moves forward and new versions are released, this tutorial will unfortunately become dated over time. We therefore have begun to compose a Moodle course for 'Teaching with AR', which seeks to complement this hand-out with up to date and additional information.