DigiGear AR Platform & Mobile Application

DigiGEAR- Introducing Augmented Reality in the VET sector with a focus on the Automotive Engineering sector

2023-1-IT01-KA220-VET-000159898

CUP: G81B23000950006

Erasmus+ KA220-VET- Cooperation partnerships in vocational education and training

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Project title	DigiGEAR - Introducing Augmented Reality in the VET sector with a focus on the Automotive Engineering sector
Project acronym	DigiGEAR
Funding programme	Erasmus+ KA220-VET - Cooperation partnerships in vocational education and training
Project code	2023-1-IT01-KA220-VET-000159898
Project national ID	G81B23000950006
National Agency	IT01 - Agenzia Nazionale Erasmus+ - INAPP
Consortium	Partner 1 (LP): TW - The Way S.r.l. Società Benefit, Italy Partner 2: AKMI - Institute of Vocational Training, Greece Partner 3: EVBB - European Association of Institutes for Vocational Training, Germany Partner 4: NG - Newport Group, Slovakia Partner 5: BKC - BK Consult GmbH, Germany Partner 6: ISQ - Welding and Quality Institute, Portugal Partner 7: GTC - Gothenburg Technical College, Sweden Partner 8: MG - Maggioli SpA, Italy
Project duration	36 months
Project start date	01/12/2023
Project end date	30/11/2026
Project budget	400.000 EUR.
Erasmus+ priorities	VET: Contributing to innovation in vocational education and training VET: Increasing attractiveness of VET

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	HORIZONTAL: Addressing digital transformation through development of digital readiness, resilience and capacity
Objective	Train the new generation of automotive engineers by introducing Augmented Reality in the VET sector
WP	WP4: Development phase of the DigiGEAR Training Package
Target groups	VET trainers and providers VET learners Industry experts and stakeholders Other organizations i.e. corporate sector, government agencies, academic institutions, NGOs, the media, chambers of commerce, regional cooperatives.

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Executive Summary

This report presents the Augmented Reality (AR) scenarios of the DigiGEAR application. It begins with an **Introduction** that outlines the purpose, context, and objectives of the AR application as a whole. It proceeds to describe each of the **seven activities** with their included AR scenarios. Each activity corresponds to a specific module of the DigiGEAR Training Package. **Activities 1 and 2 are introductory** and focus on the infrastructure required to support electric vehicles, and are therefore delivered with 2D interactive graphics, while **Activities 3 - 7 hold the core learning activities** and contain multiple instructional AR scenarios.

This document first presents the section “Home Menu” which describes the structure of the home menu to give overview and access to the activities. Then, two short introductory activities are described. **Activity 1** focuses on the production of **electric energy**, which corresponds to Module 10 – Green Energy and Sustainability, and **Activity 2** focuses on the technology and infrastructure for **charging electric vehicles**, which corresponds to Module 3 – **Charger**. Afterwards, the core activities focusing on the electric vehicle itself are described. These are: **Activity 3** which is the most important activity corresponding to Module 2 – Complete Overview of the **Electric Car**, and four more activities: one for each individual component, i.e. **Activity 4** for Module 4 – **On-Board Charging**, **Activity 5** for Module 5 – **Inverter**, **Activity 6** for Module 6 – **Battery**, as well as **Activity 7** for Module 8 – **Electrical Motors**.

Each section in this document describes the activity content in detail, and outlines the value of the AR activity in terms of learning outcomes and their relationship to the corresponding MOODLE module's content and learning outcomes.

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Introduction

The AR application contains activities that accompany the DigiGEAR learning modules on a 1-1 basis to help users consolidate learning outcomes. It is recommended that users **engage first with the e-learning modules** and **afterwards with the interactive activities**, since the activities rely on using pre-existing knowledge and aim at reinforcement. This reduces the need for long on-screen text and allows activities to rely more on a hands-on approach, which is the main benefit for an AR-based learning approach.

Narrative design

The content of the AR application is structured as a narrative on the flow of energy: starting with energy generation, moving to energy distribution, leading to charging stations, and then visiting all the intermediate steps inside the car until electric energy finally transforms into kinetic energy when driving.

The content is separated in two main categories: introductory activities, which target all required infrastructure and components outside the car (e.g. charging stations and energy production factories), and the core activities, which target the electric car itself and all the required internal components with their connections.

For the introductory content, the application provides a 2D representation, since most of the relevant objects are in city- or building- scale and thus not recommended for representation in AR. For the core content, the application opts for a 3D representation in AR, since it is important for users to acquire a thorough understanding of the visual appearance and structure of the physical components, as well as their relative scale to each other and the user's actual physical environment.

Figure 1 shows a graphical representation of this narrative flow, with a list of the activities, their logical structure and their recommended sequence of engagement, while Table 1 presents a structured overview of the application's activities, their correspondence to the learning modules, and the delivery format for each activity.

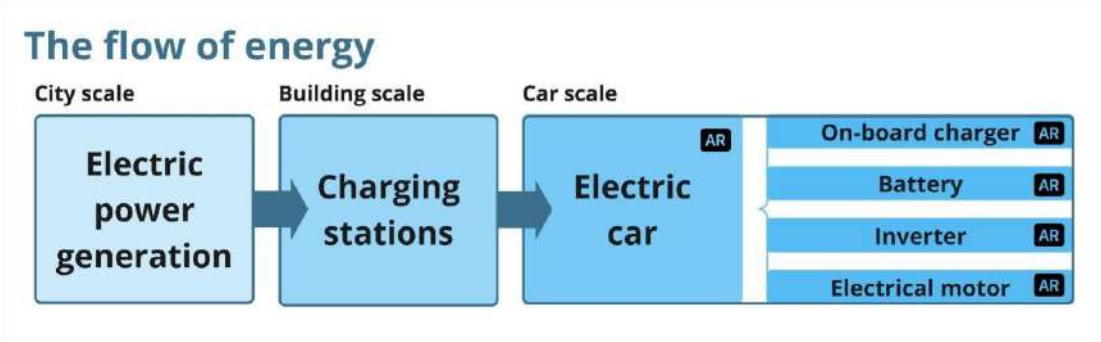

Figure 1 Structure of the mobile application content

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Table 1 Application contents, relationship to E-Learning and delivery format

#	Activity Name	Corresponding E-learning Module	Delivery format
1	Electric Power Generation	Module 10 - Green Energy and Sustainability	2D
2	Charging stations	Module 3 - Charger	2D
3	The Electric Car	Module 2 - Complete overview of electric car	3D in AR
4	The components: On-board Charger (OBC)	Module 4 - Onboard charging	3D in AR
5	The components: Battery	Module 5 - Battery	3D in AR
6	The components: Inverter	Module 6 - Inverter	3D in AR
7	The components: Motor	Module 8 - Electrical Motors	3D in AR

In terms of engagement priorities, the DigiGEAR consortium ranked the proposed as follows using the MoSCoW method[1]:

Figure 2 Hierarchy of engagement with content

AR scenarios

Each of the activities delivered with 3D in AR contains one or more interactive AR scenarios. Each scenario is designed around well-established interactive learning actions, using verbs that draw from Bloom's taxonomy of learning, such as "identify", "connect", and "select". The supported **AR scenario templates** are the following:

1. Explore
2. Identify
3. Place
4. Connect
5. Find

The most important activity, **Activity 3 - Electric car**, includes four different AR scenarios, i.e. Explore, Identify, Place and Connect, while the components adopt the same AR scenario, i.e. Find. The AR scenario templates for each activity are presented in Table 2 alongside descriptions how the AR scenario template is used in its context.

[1] https://en.wikipedia.org/wiki/MoSCoW_method

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Table 2 AR scenarios per activity with descriptions

#	Activity Name	AR scenario	Use
1	The Electric Car	Explore	Learn about the components of a car in free-style exploration using an interactive 3D model.
2	The Electric Car	Identify	Identify the presented components one by one based on their physical appearance and size.
3	The Electric Car	Place	Place the components one by one in the right position in the frame of an electric car.
4	The Electric Car	Connect	Connect the components in the right sequence to enable the flow of electric energy.
5	The components: On-board Charger (OBC)	Find	Find important subparts of the component on a 3D model.
6	The components: Battery	Find	Find important subparts of the component on a 3D model.
7	The components: Inverter	Find	Find important subparts of the component on a 3D model.
8	The components: Motor	Find	Find important subparts of the component on a 3D model.

In addition, in order to engage with the AR scenarios, the user should be able to perform the following human-computer interactions (HCI) with 3D content, as listed below:

Interaction with AR 3D content

1. Select
2. Move
3. Scale
4. Rotate

To perform the aforementioned interactions with AR 3d content, the user interacts with the touchscreen of the mobile device with common gestural input, such as tap, drag and pinch, as listed below:

User input

1. Tap
2. Drag
3. Twist
4. Pinch

The relationship between activities, AR scenarios, interactions and user input methods is depicted in Figure 3. More information about the content and interactions in each scenario, as well as detailed mock-ups can be found in the section of the respective activity.

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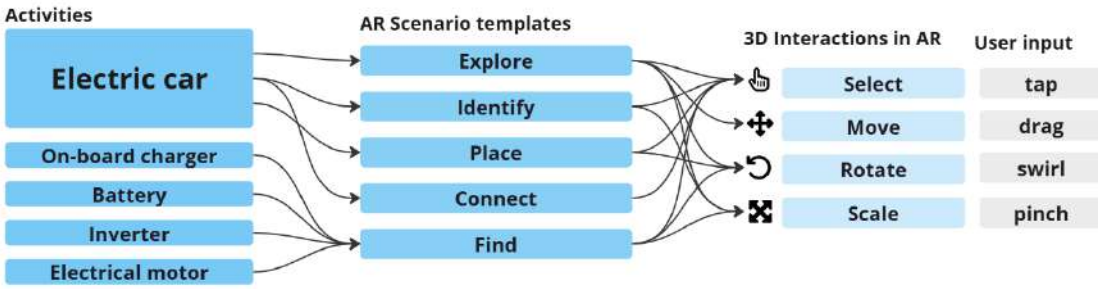

Figure 3 Relationship between activities, AR scenarios, interactions and user input methods

Learning Outcomes and learning activities

The learning outcomes for each activity are derived in close connection to other deliverables, most notably A4.1 Development of the training material. The general overview is depicted in Table 3, while a detailed list of learning outcomes is presented at the beginning of each activity chapter.

Table 3 Learning outcomes for each activity

#	Activity Name	LO type	Educational activity	Feedback	Assessment
1	Electric Power Generation	Knowledge	Match, Choose, Text Input	Y	N
2	Charging stations	Knowledge	Match, Choose, Text Input	Y	N
3	The Electric Car	Knowledge	Explore	Y	N
3	The Electric Car	Skill	Identify	Y	Y
3	The Electric Car	Skill	Place	Y	Y
3	The Electric Car	Skill	Connect	Y	Y
4	The components: On-board Charger (OBC)	Skill	Find	Y	Y
5	The components: Inverter	Skill	Find	Y	Y
6	The components: Battery	Skill	Find	Y	Y
7	The components: Motor	Skill	Find	Y	Y

User requirements

Lastly, the AR scenarios and the suggested interactions should take the system and user requirements into account, as documented in previous deliverables, specifically *A3.6*

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Defining the technical specifications for the AR platform based on the identified needs of the Automotive Engineering sector. As a reminder, the relevant URs are presented in Table 4.

Table 4 Application user & system requirements

Requirement ID	Description	Priority
US-FR-001	The user should be able to use the device's camera to preview their environment and scan nearby surfaces	High
US-FR-002	The user should be provided with content automatically upon detection without further user action	High
US-FR-003	The user should be provided with interactable virtual content and/or with a graphical user interface.	High
US-FR-004	The user should be provided with gesture-based input to perform complex interactions and with touch input for GUI elements.	High
US-FR-005	The user should be provided with voice input for a predetermined set of commands.	Low
US-FR-006	The user should be given direct feedback after concluding an interaction loop using audio and visual elements (evaluation).	Medium
US-FR-007	The user should be given guidance using audio and visual elements if requested and/or if the system detects progress difficulty (based on timers or amount of mistakes).	Medium
US-FR-008	The user should be able to adjust the volume of any audio elements and the brightness of any visual elements.	Low
US-FR-009	The user should be able to start, pause, resume or restart the experience at any point.	High
US-NFR-001	The AR application must be performant on a wider range of devices, including low-end devices.	**High**
US-NFR-002	The AR application should be user-friendly for an audience with low familiarity with AR technology.	**High**
US-NFR-003	The AR application installation process should be streamlined and familiar for users with average technological familiarity.	**Medium**
US-NFR-004	The AR application should follow standard accessibility guidelines.	**High**
US-NFR-005	The AR application should properly manage any persistent data files that it generates, and remove all traces on uninstallation.	**High**
US-NFR-006	The AR application should clearly ask the user for permission for any device features it requires access to,	**High**

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	according to industry guidelines.	

Home Menu

The application starts with a home scene that allows the user to log in, preview, and access all available activities in a structured way. The following user requirements should be implemented for the home menu:

Table 5 Home menu user requirements

#	Requirement	Format
1	The user can use the GUI to change language.	Dropdown
2	The user can use the GUI to preview all lessons.	Buttons
3	Before starting the lesson, users should be given a preview of each lesson. Each lesson should have a header with the title, an image preview, a short text description of the lesson, and a button to start the activity.	GUI Layout
4	Users should be able to choose any lesson they want, but should also be provided with recommendations on the proposed order of engagement. Therefore, all lessons will be unlocked, but lesson buttons should have three states: completed, highlighted (recommended as next), upcoming.	Button appearance
5	Users should be able to quickly access the corresponding MOODLE module to revisit the learning content before or after the activity.	GUI button with hyperlink to module
6	Users should be able to keep track of their progress in the application (e.g. which lessons have been completed), and should be able to reset their progress to start anew.	UI notification icon

Welcome and sign-in

Upon starting the app, the user is welcomed by a screen to choose their user account management preference. A new user can sign up with a user account to make use of the cloud save feature. The cloud save feature means that the user can retrieve from a cloud service their progress if they uninstall and reinstall the application, or if they change devices. A user with an existing account can directly sign in. The application will remember the sign-in of a user across sessions, until a user actively chooses to log out using the Settings menu (see Settings). Lastly, a user can go ahead and enter without an account to directly try out the application. All mentioned options are shown in the sequence of screenshots in Figure 4.

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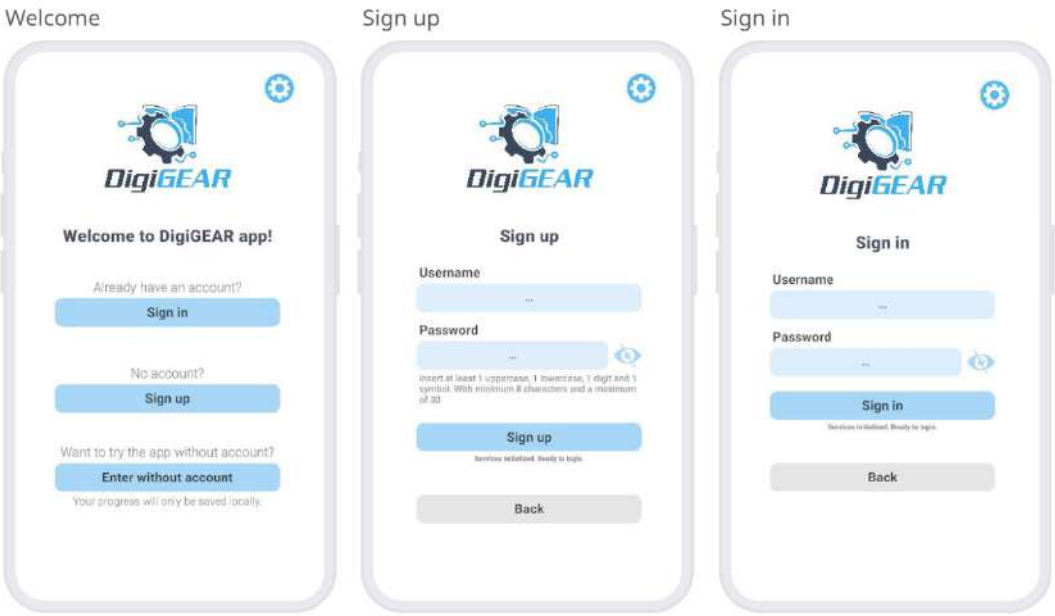

Figure 4 Welcome and user account management options

Home menu layout

Figure 1 below illustrates the implementation of these requirements. The mockup on the top-left, labeled Home menu, shows the landing screen of the application. The button labeled “Electric Power Generation” is displayed in highlighted state (e.g. bright blue) and leads to the first recommended activity (UR4). Clicking the button opens the submenu of “Electric Power Generation” (top-right mockup), where the user can read a short introduction for the learning content and use a button to start the activity (UR3). The user can also click on a shortcut button (e.g. topright) to open the corresponding module on the web browser of their device for quick access (UR5). After the user has completed this activity, the respective button changes to the completed state, and the button of the next recommended activity becomes highlighted. For all completed activities, a small icon displayed next to the respective button (e.g. a star) visualizes the user’s performance in that activity (UR6). In addition, the Gear button on the top right allows the user to open the settings panel to choose language and manage the saved user progress (UR1, UR2). In Figure 1, the bottom-right mockup illustrates the submenu of the second activity, “Charging Stations”.

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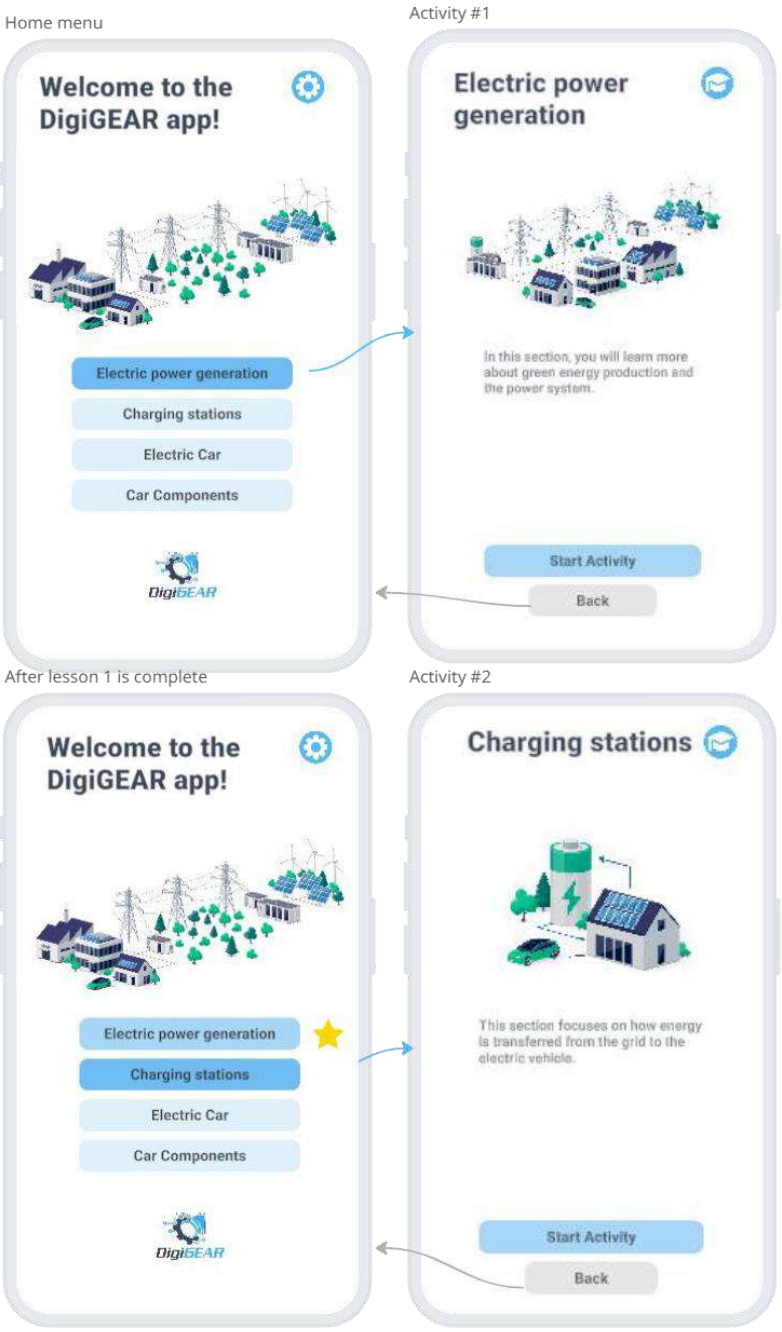

Figure 5 Home scene and introduction to 2D activities

Both of these introductory activities are delivered with 2D content, but the rest of the activities under “Electric Car” and “Car components” are delivered in 3D with AR. For that reason, a Tutorial to understand AR interactions is mandatory. After the tutorial has been completed, the AR activities are unlocked, as shown in Figure 5.

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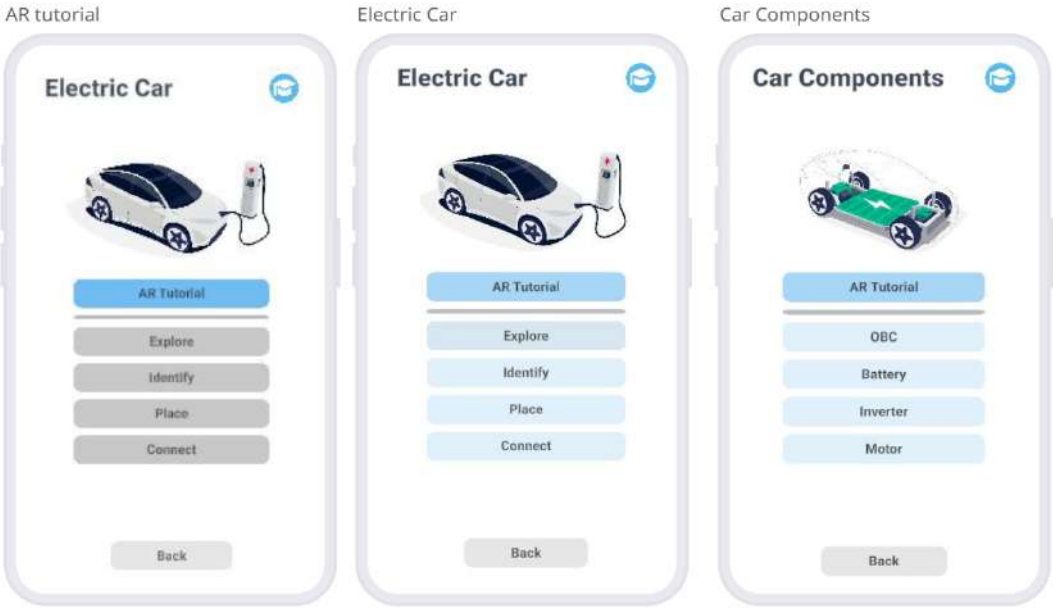

Figure 6 Electric car scene when AR tutorial is not completed (left), when completed (middle) and Car components scene with AR tutorial completed

From the Electric Car scene, the user can enter the four (4) AR activities, while from the Car components scene the user can open an intermediate screen with some information about the component before entering the activity. As with previous activities, each activity has its dedicated screen which displays a 3D render of the component, a short descriptive text, and buttons to start the activity, or to return to the previous screen, as shown in Figure 6.

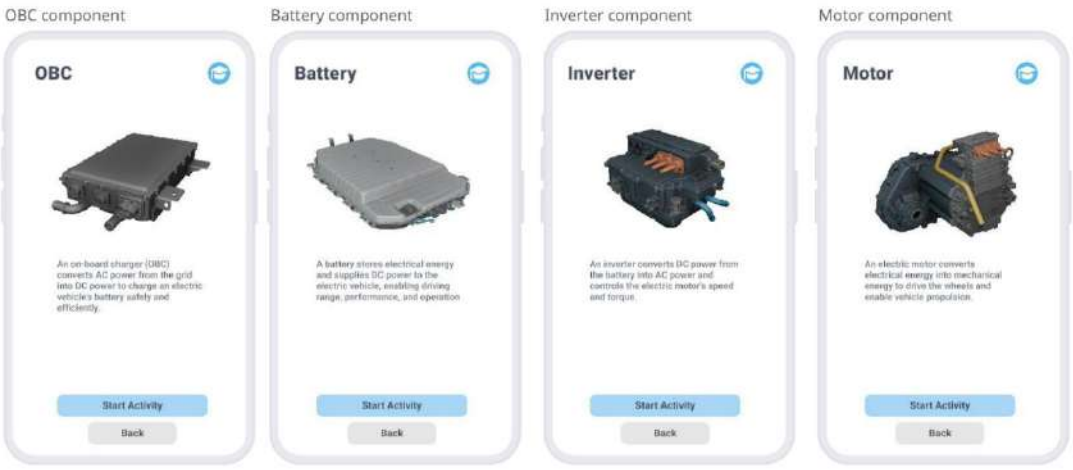

Figure 7 Car Component screens

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Completion of activities

After completing all activities, the user is met with a pop-up notification when they return to the home again (Figure 7). The pop-up prompts the user to use the Settings panel to reset their progress and start again.

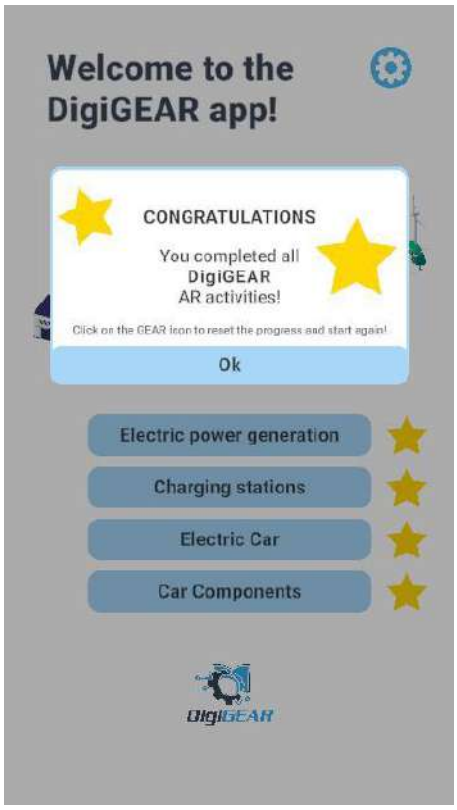

Figure 8 Home menu - Congratulations screen

User Settings

From the Home menu, the user can select the icon on the top right to access the app's settings. The user can perform language selection, audio setting edits, reset of progress and preview/sign out of their current account, as shown in Figure 7. Specifically, the user can change language selecting from the following languages:

- English (en)
- German (de)
- Greek (el)
- Italian (it)
- Portuguese (pt)
- Slovak (sk)
- Swedish (sv)

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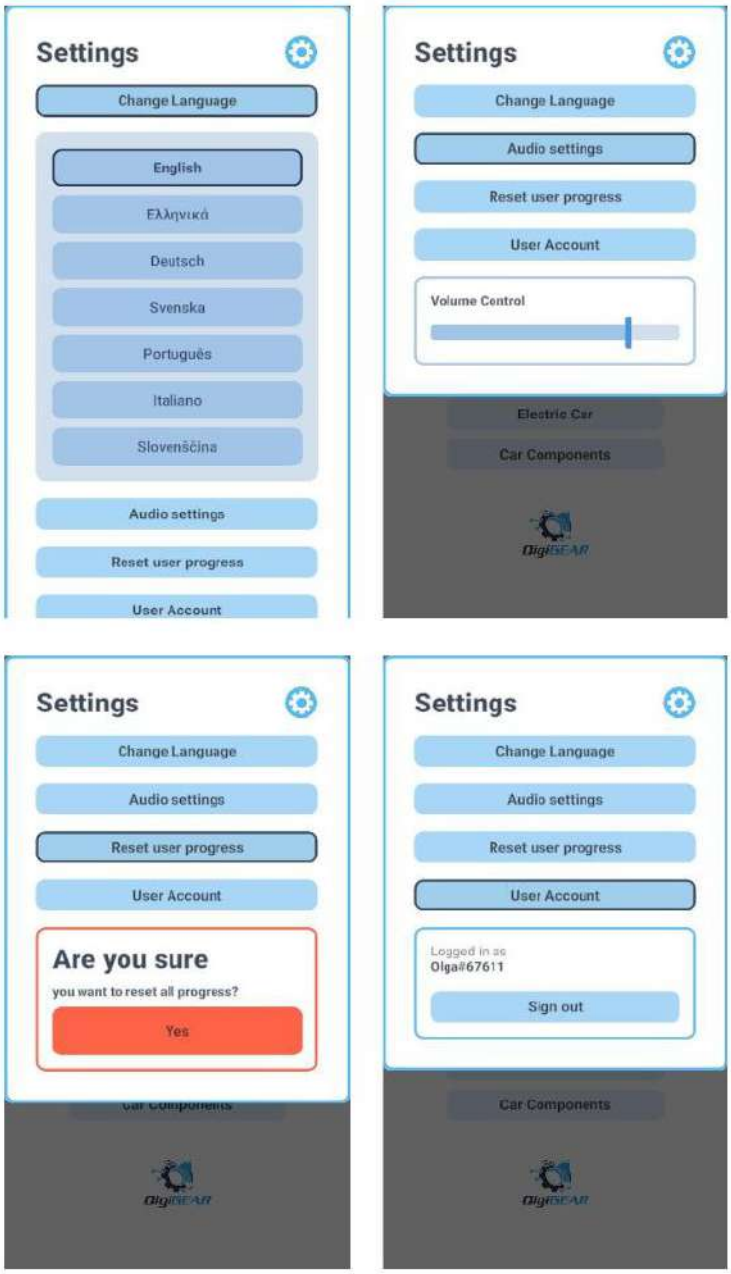

Figure 9 Application settings

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Activity 1 - Electric Power Generation

Out of the learning outcomes recorded in the respective module in **4.1**, the mobile application activity targets the following outcomes:

Table 6 Activity 1 - Targeted Learning outcomes

	Knowledge	
1K	Basic knowledge of the environmental impact of road transport activities	Y
2K	Basic knowledge of the sustainable mobility concept	Y
3K	Basic knowledge of alternative energy sources in road transport	Y
4K	Basic knowledge on green energy systems	Y
	Skills	
1S	Describe the environmental impacts of the road transport sector.	Y
2S	Distinguish between types of alternative fuels and their respective benefits and limitations in the context of transport sustainability.	Y
3S	Evaluate the advantages and limitations of renewable energy integration in road transport systems.	
4S	Explain the challenges and opportunities EVs bring to green energy systems (smart charging, V2G, Storage solutions)	
	Autonomy	
1A	Reflect on personal transport habits and make informed decisions that align with sustainability mobility principles.	
2A	Demonstrate awareness of the impact of EVs in energy systems	Y

The learning outcomes are delivered with the following three learning activities:

1) a drag and drop activity for completing the power grid to allow energy to reach from production to consumption, as shown in Figure 8,
2) a selection from a dropdown activity to name the five most common renewable energy sources, as shown in Figure 9,
3) a slider activity to reflect on the production of greenhouse gas emissions from a selection of transportation categories, as shown in Figure 10.

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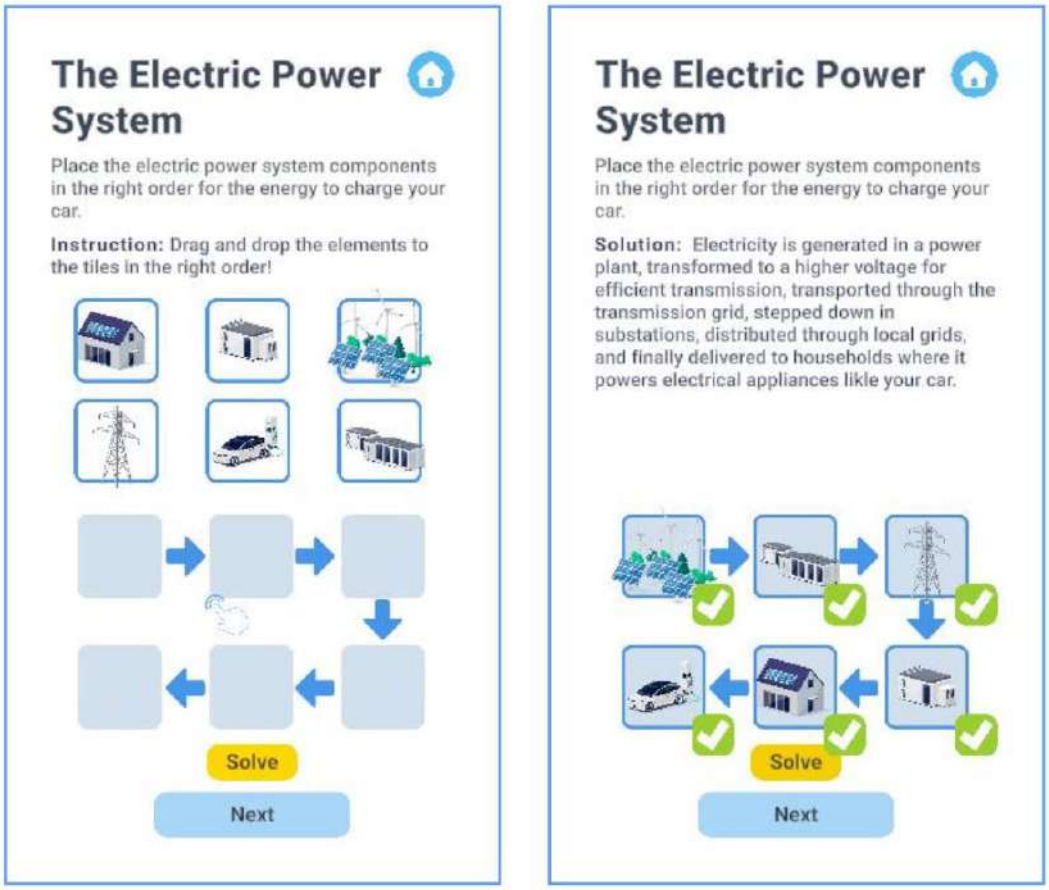

Figure 10 Activity 1 - Drag and Drop activity

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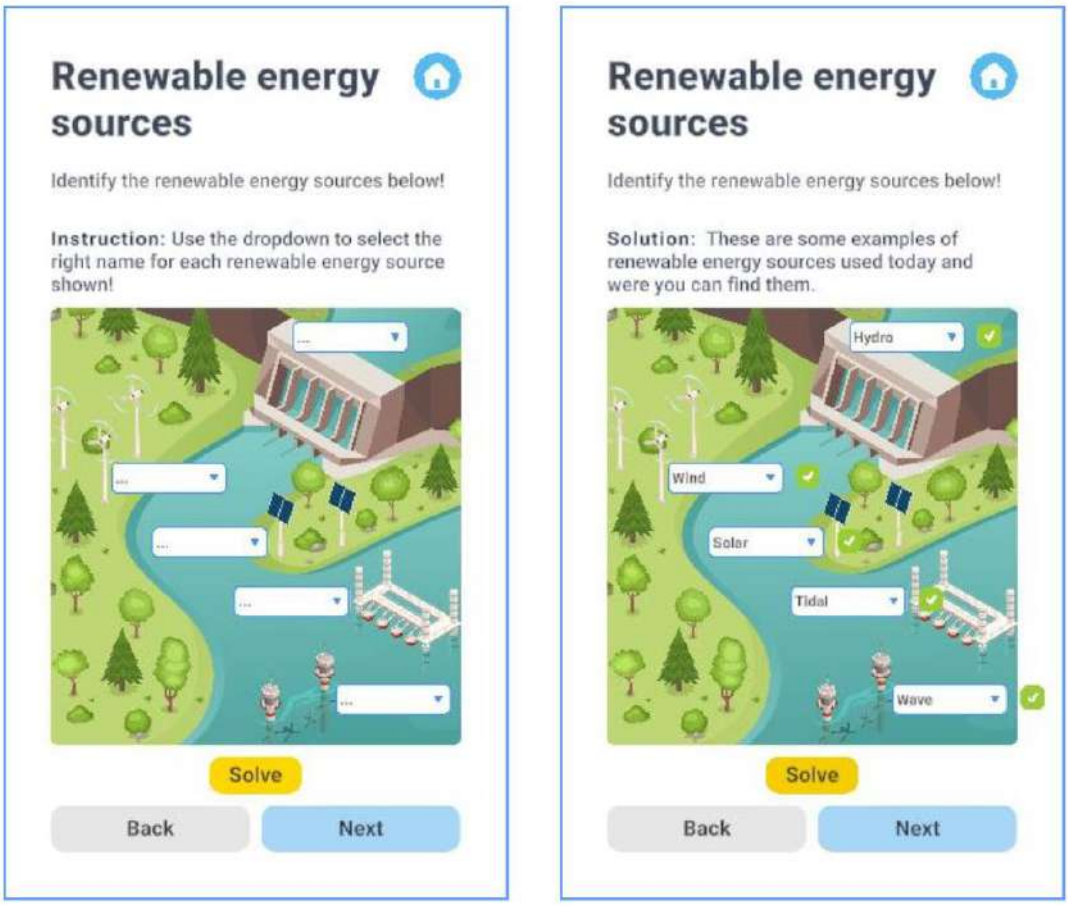

Figure 11 Activity 1 - Dropdown activity

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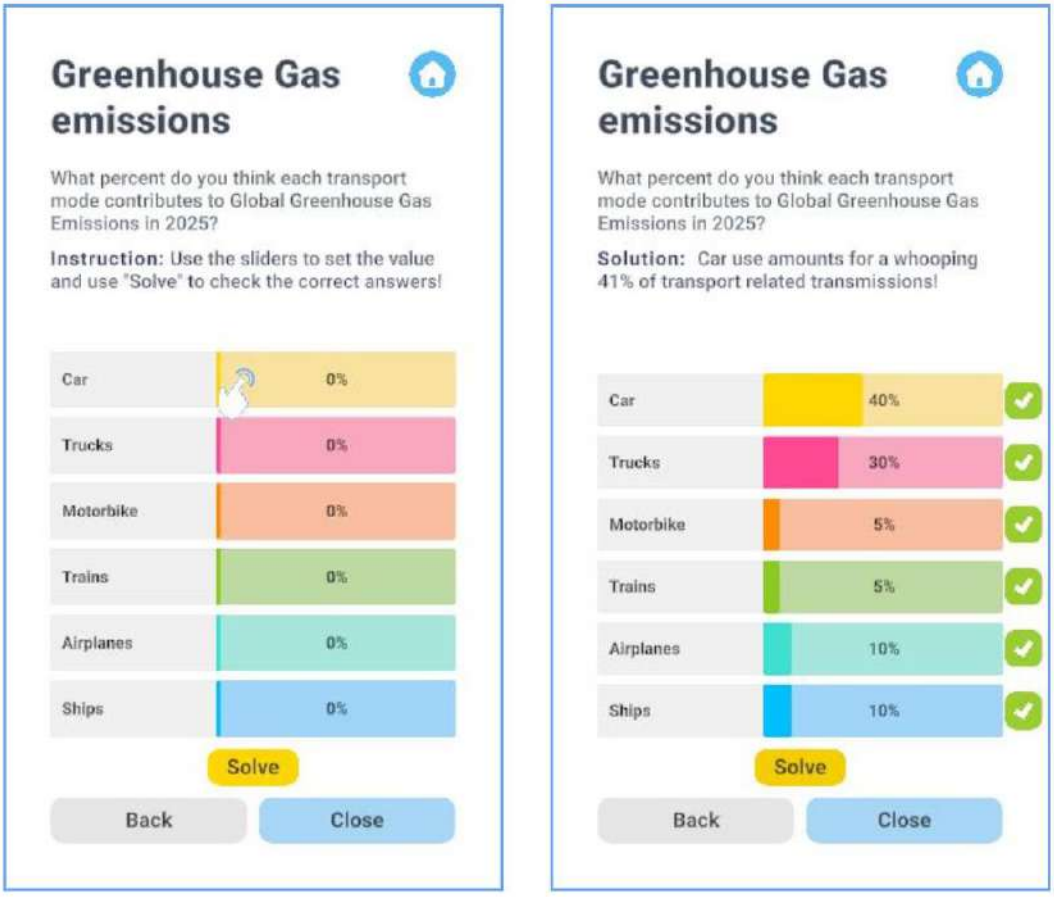

Figure 12 Activity 1 - Slider activity

Table 6 shows how the Learning activities map to the Learning outcomes.

Table 7 Activity 1 - Learning Activities-Outcomes mapping

#	Learning Activity	Learning Outcomes
1	Recreate the energy grid for energy distribution by placing elements in the right sequence	3K, 4K, 2S
2	Name renewable energy sources	3K, 4K, 2S
3	Estimate the percentage of road transport sector to greenhouse gas emissions	1K, 2K, 1S, 2A

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Activity 2 - Charging stations

Out of the learning outcomes recorded in the respective module in **4.1**, the mobile application activity targets the following outcomes:

Table 8 Activity 2 Targeted Learning Outcomes

	Knowledge	
1K	Identify the main types of EV chargers and their purposes	Y
2K	Understand how EV chargers support electric mobility	
3K	Recognize key components and safety features	Y
	Skills	
1S	Distinguish between charging options and select suitable use cases	Y
2S	Analyse and compare different charger types and technologies	Y
	Autonomy	
1A	Apply acquired knowledge in further learning or job-related discussions	
2A	Understand and engage in sustainability-related decision-making	

These are delivered with the following three activities:

1) a drag and drop activity to connect the category of chargers (fast or slow) with their electrical current type (AC or DC) and the locations where they are supported (domestic or public infrastructure), as shown in Figure 11,
2) a dropdown activity to identify the type of chargers (AC or DC) based on their visual appearance, alongside a typing input field to indicate the full name of the AC and DC acronyms, as shown in Figure 12,
3) an input field activity to fill in the appropriate Voltage value or value range for each type, as shown in Figure 13.

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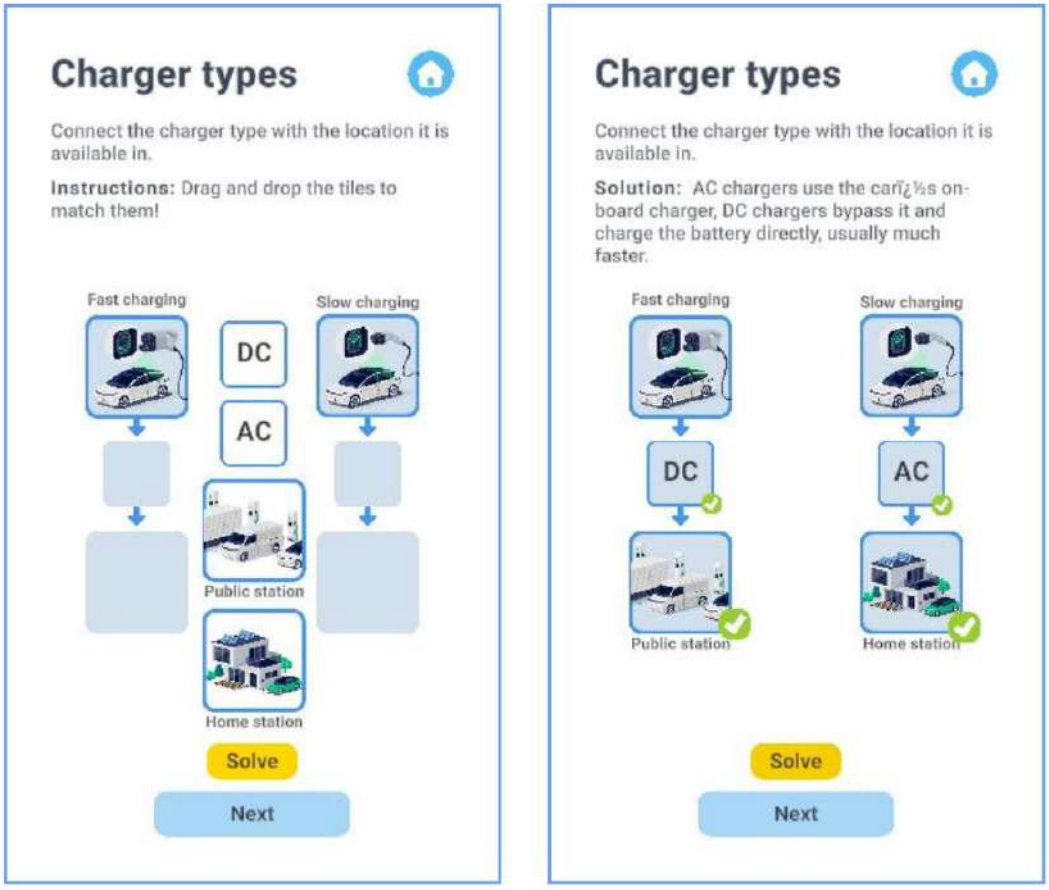

Figure 13 Activity 2 - Drag and Drop activity

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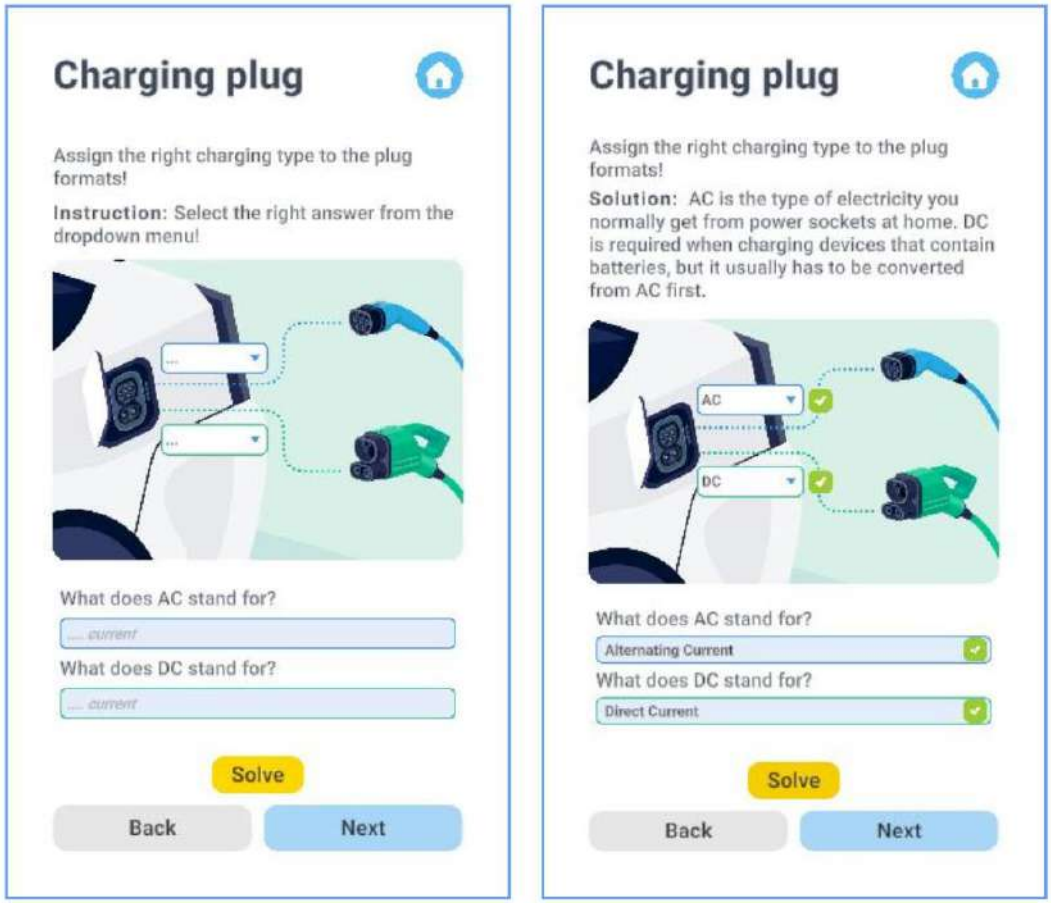

Figure 14 Activity 2 - Dropdown and input field activities

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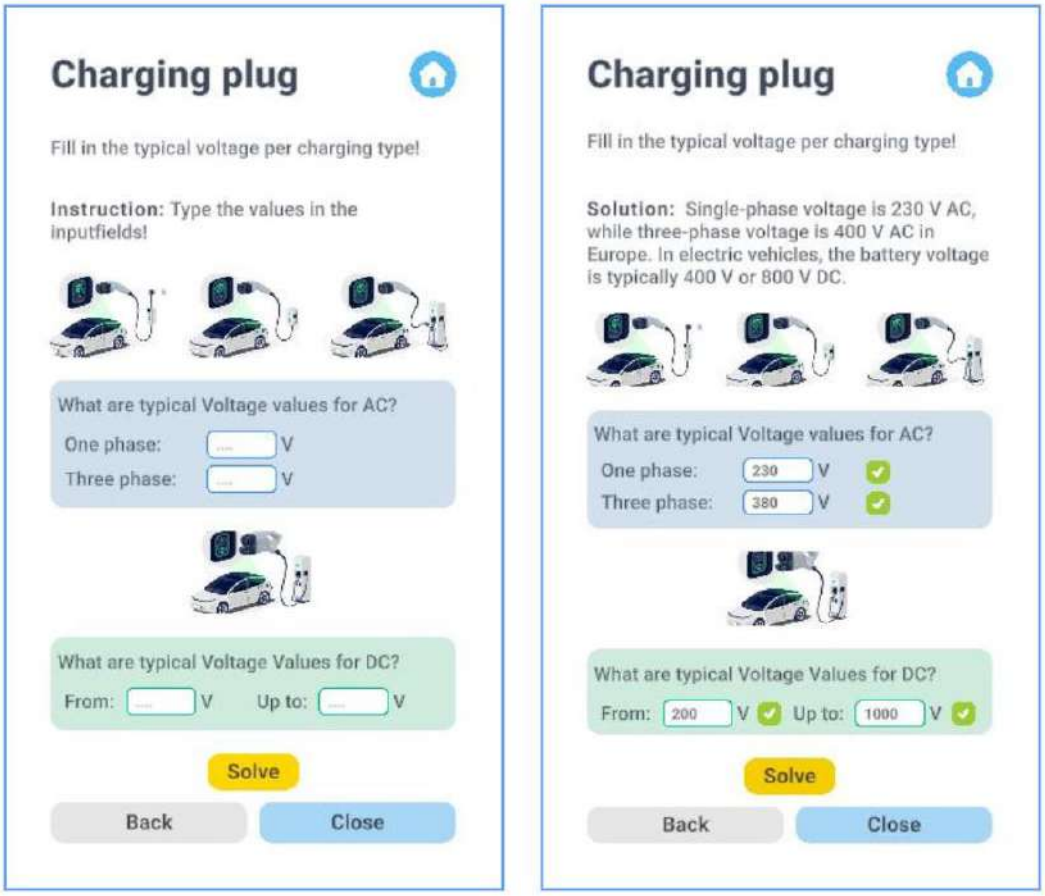

Figure 15 Activity 2 - Input field activities

Table 7 shows how the learning activities map to the Learning outcomes.

Table 9 Activity 2 - Learning Activities-Outcomes mapping

#	Learning Activity	Learning Outcomes
1	Recognize charger types and connect them to the respective locations	1K, 1A
2	Recognize charging plugs and recall their key characteristics	3K, 2S

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Activity 3 - The Electric Car

Out of the learning outcomes recorded in the respective module in **4.1**, the mobile application activity targets the following outcomes:

Table 10 Activity 3 Targeted

	Knowledge	
1K	Learners will understand the structure and function of an EV drivetrain.	Y
	Skills	
1S	Learners will be able to identify drivetrain components and describe how they work together.	Y
	Autonomy	
1A	Learners will be able to explain basic drivetrain operations and compare them with traditional systems.	

The user will be prompted to complete the following activities in the order they are presented, as shown in Table 11, with specific mention how they relate to the above-stated learning outcomes.

Table 11 Activity 3 - Learning Activities-Outcomes mapping

#	AR Scenario	Learning Activity	Learning Outcomes
#0	AR Tutorial	Technical requirement, not a learning activity.	-
#1	Explore	Examine the electric car and its component, where they are placed, how they are connected and what their main function is.	1K, 1S
#2	Identify	Identify components based on their visual appearance	1K, 1S
#3	Place	Place the components in their right configuration on an empty electrical car wireframe	1K, 1S
#4	Connect	Connect the components in the right order to enable the flow of electrical energy to the wheels	1K, 1S

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Since this is the first activity in AR, it is pertinent to reference the user requirements from A3.6. Contextualizing the overall user requirements for this activity yields the following table of user requirements. The user will familiarize themselves with all these requirements during the AR tutorial.

Table 12 User and system requirements for all AR activities

#	User requirements	Format
1	The user can use the touchscreen with gestures to place, scale and rotate the car.	Touch screen gestures
2	The user can switch between the solid view and the wireframe view to see the inside of the car.	GUI button
3	The user can click on the available car components to learn more information about them.	3D model as button
4	The user can request hints or support if in difficulty.	GUI button
5	The user can click on any activity button to start the activity or the Back button to exit this lesson.	GUI layout

AR Tutorial

The user should first initialize the AR content in their environment. The user is prompted to help the application locate flat horizontal surfaces in their environment, and then target one flat surface to place the car model, as shown in Figure 15 (UR#1). The car model will appear in a reduced scale suitable for indoor use, but the user will be able to scale, move and rotate the model to better adapt to the user's environment, as shown in Figure 16 (UR#1). Followingly, the user can use the app's interface to switch from full car view to car component view (UR#2) and click on components to learn more about them (UR#3), as shown in Figure 17. Lastly, the user learns how to ask for hints (UR#4) and navigate back to the home menu (UR#5) using the respective UI elements, as shown in Figure 17.

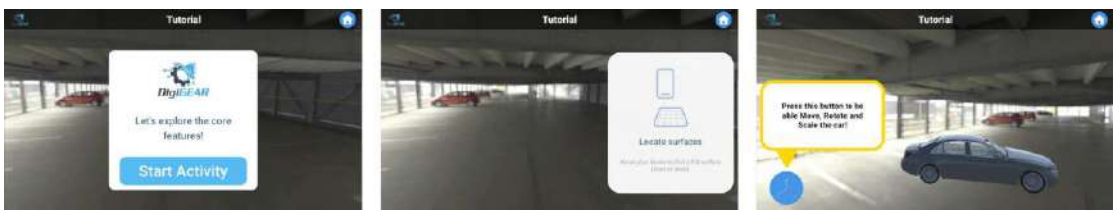

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Figure 16 AR Tutorial - screenshot sequence 1

Figure 17 AR Tutorial – screenshot sequence 2

Figure 18 AR Tutorial – screenshot sequence 3

Explore challenge

After successfully completing the AR tutorial, the user is prompted to engage with the exploration challenge. In this challenge, the user is prompted to place the car again in their local space, switch to component view, and select the four most important components. The components are listed with hidden entries in proposed order of interaction. It is expected from the user to move around the car, zoom in and out and think what to click on. Upon clicking an interactive component, there is a popup with informative text about the discovered component. A visual highlight tracks which components have been already explored (e.g. turn from grey to green), as shown in the sequence of screenshots in Figure 18. The user is awarded a point for each component they find. If in difficulty, the hint feature can be used. If the user uses the hint feature to locate a component, they are not awarded a point. At the end, the user is provided with a score indication for their engagement, as shown in the sequence of screenshots in Figure 19.

Figure 19 Explore challenge - screenshot sequence 1

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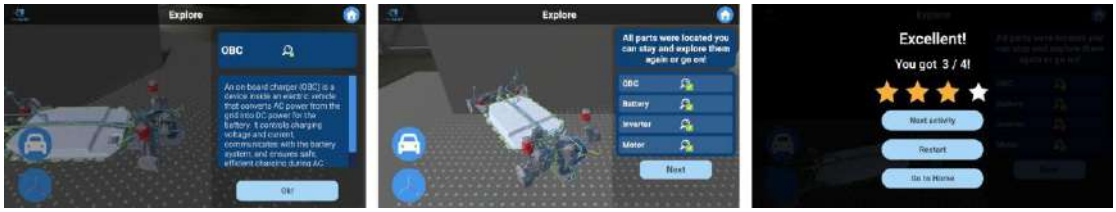

Figure 20 Explore challenge - screenshot sequence 2

Identify challenge

The Identify challenge displays the same 3D model of each component as they encountered in the Explore challenge, but this time isolated one by one. The challenge asks the user to correctly identify which component is being displayed each time, judging from their visual appearance. The user received instant feedback on right or wrong answers. In case of a wrong answer, the user can try again as many times as they need until they get it right. At the end of the activity, the user receives a quantitative assessment of their performance based on how many answers they got right on their first attempt (in other words, additional errors after the first one do not count in each turn). Figure 21 and Figure 22 show the flow of the activity.

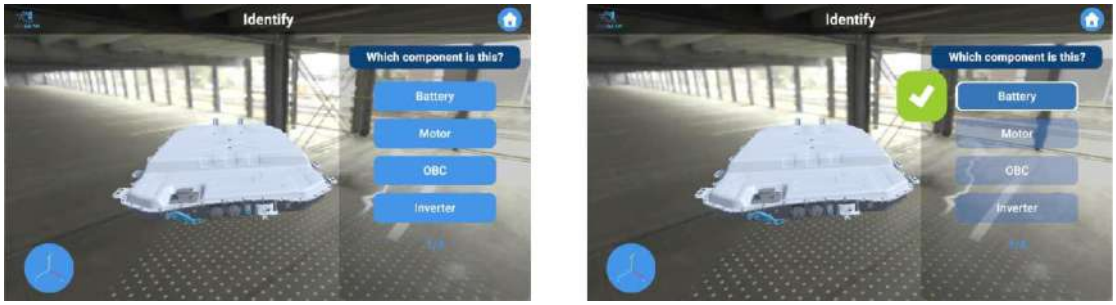

Figure 21 Identify challenge - screenshot sequence 1

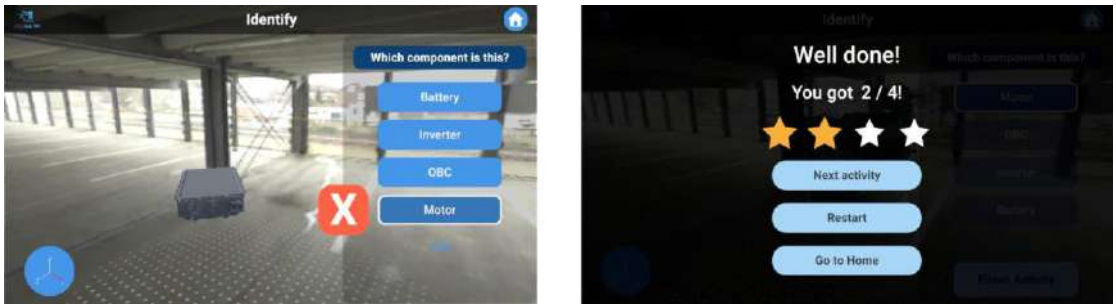

Figure 22 Identify challenge – screenshot sequence 2

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Place challenge

The Place challenge requires the user to first place a car and switch to component mode. All component visuals are hidden and replaced by bounding boxes of relevantly equal size. The user is prompted to appropriately place one component at a time, in random order, on the car schematic. The instructional approach is the same as in the Identify challenge, meaning that the user always receives instant feedback, they are free to retry as many times as they need, and the final assessment only counts correct answers on the first attempt. Figure 23 and Figure 24 show the flow of the activity.

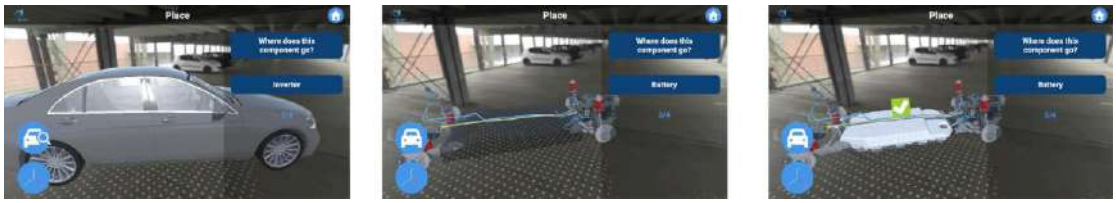

Figure 23 Place challenge – screenshot sequence 1

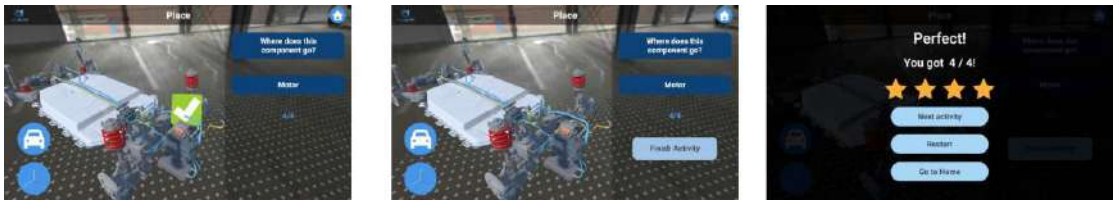

Figure 24 Place challenge – screenshot sequence 2

Connect challenge

The Connect challenge builds on the previous activity and asks the user to connect the placed components of the car schematic in the right order based on the flow of electrical energy. The instructional approach is the same as in the Identify and Place challenges (instant feedback, unlimited number of retries, final assessment based on first attempt). The user is prompted to select the right component and receives feedback, as shown in Figure 25.

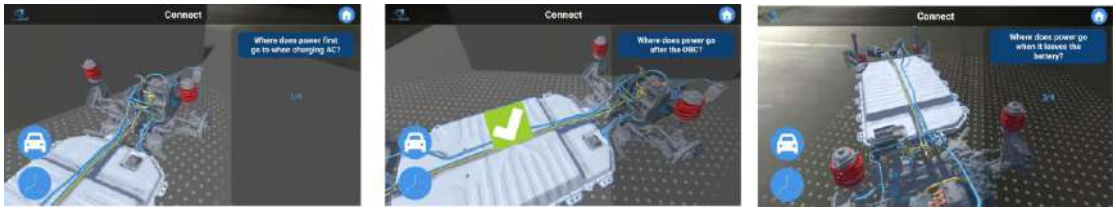

Figure 25 Connect challenge - screenshot sequence

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After the user has completed all four AR scenarios for the electric car, i.e. the freeform exploration activity, and the three structured sequential challenges, the user can engage with the AR scenarios for the individual components and delve into more technical details.

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Activity 4/5/6/7 – Common Template

The AR learning activity for all components (i.e. OBC, Inverter, Battery, Motor) uses the same AR scenario template "Find" – i.e. to find key parts on each component. The Find AR scenario is similar to the Explore AR scenario for the whole Electric car.

After each Find challenge, there is a Reflection activity planned. This section will present the Find challenge and the Reflection activity in detail, and the next sections will only present the relevant information for each component in their respective sections.

Table 13 Learning Outcomes

#	AR Scenario	Learning Activity
#1	Find	Find key parts in the 3D model of the component and learn more about them.

Find challenge

The Find challenge prompts a user to investigate the visual appearance of the 3D model of the component for identifiable key subparts. A user should click on the area of the 3D which they consider relevant. Clicking on not relevant areas produces no significant response. Clicking on relevant areas provides the user with visual feedback and more technical information about the subpart they correctly discovered. Since this challenge has less instructional support than the previous ones, a hint system is implemented to show users the right answer in case they are stuck, like in the Explore challenge. Figure 26 shows a sequence of screenshots with the flow of the activity.

Figure 26 Find challenge - example sequence screenshot

Reflection activity

After each Find challenge is completed, a reflection post-activity is proposed. The user is prompted to think if and where the presented component exists in other daily-used household and personal items. The items are:

1) smartphone,
2) laptop,

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3) smart TV,
4) washing machine.

The user can provide their answer by clicking on none, one, more or all of the provided options, as shown in Figure 26. After providing their answer, the user can check the correctness of their answer and receive feedback and further information, as shown in Figure 27. Feedback for all possible cases is presented with screenshots: specifically, Figure 28 shows an example of a correctly selected option, Figure 29 shows an example of an incorrectly selected option, while Figure 30 shows an example of option that had to be selected and was not. Lastly, Figure 31 shows that there is no visual marking for options that should not have been selected and were appropriately not selected by the user. As a sidenote, this list of household items was chosen to enable a variety of combinations for each component showcasing the diversity of the technology involved in electric cars.

Figure 27 Visual layout of Reflection Activity

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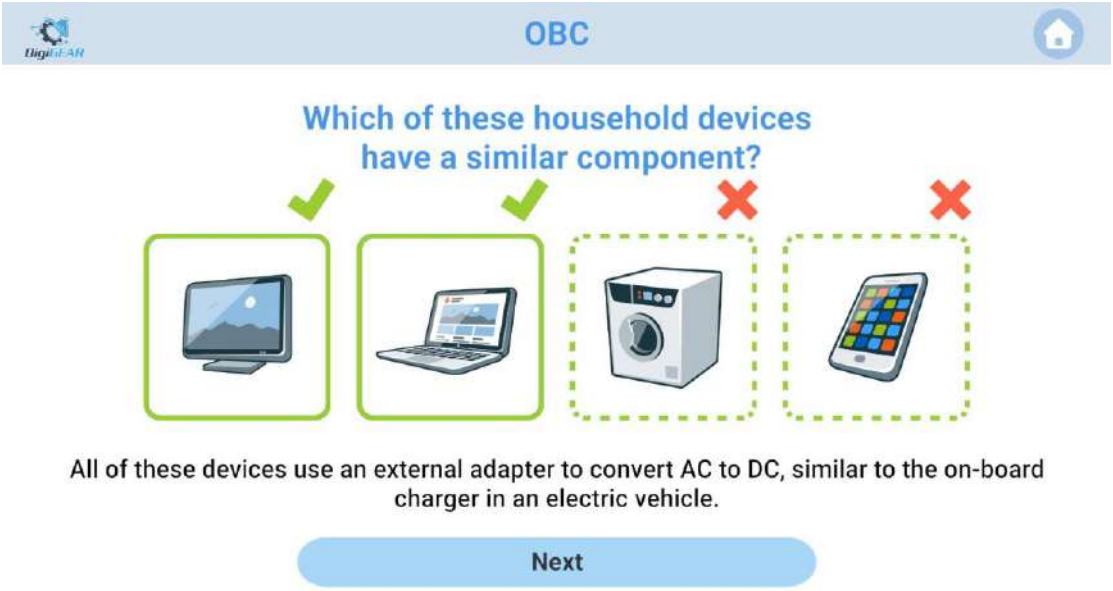

Figure 28 Example of user input and answer checking

Figure 29 Example of correctly selected option

Figure 30 Example of incorrectly selected option

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Figure 31 Example of option that had to be selected (and was not)

Figure 32 Example of option that did not have to be selected (and was not)

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Activity 4 – OBC

For the OBC, the user should find the following three key parts:

Table 15 OBC parts

#	Part
1	Data Pins
2	AC Input
3	DC Output

The screenshot below (Figure 26) presents the visual appearance of the component with all parts discovered.

Figure 33 OBC "Find parts" challenge screenshot

The correct answers to the reflection activity of the OBC are the following:

Table 16 OBC Reflection Activity answers

	Smartphone	Laptop	Smart TV	Washing Machine
OBC	Yes	Yes	Yes	Yes

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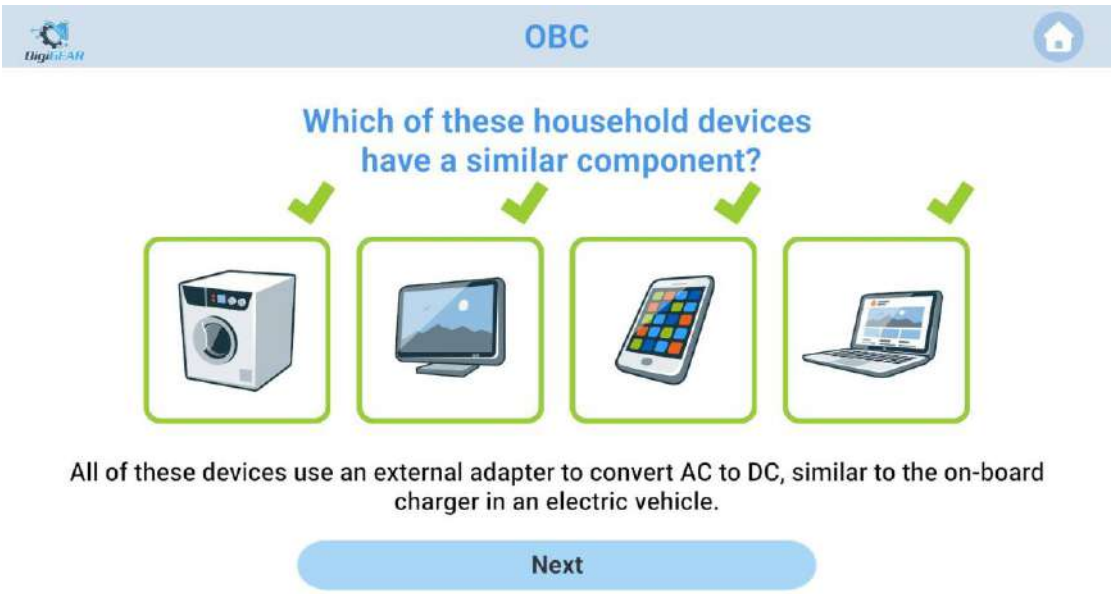

Figure 34 OBC "Reflection" activity screenshot

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Activity 5 – Battery

For the Battery, the user should find the following three key parts:

Table 17 Battery parts

#	Part
1	Cooling
2	Input
3	Data pins
4	Output

The screenshot below (Figure 28) presents the visual appearance of the component with all parts discovered.

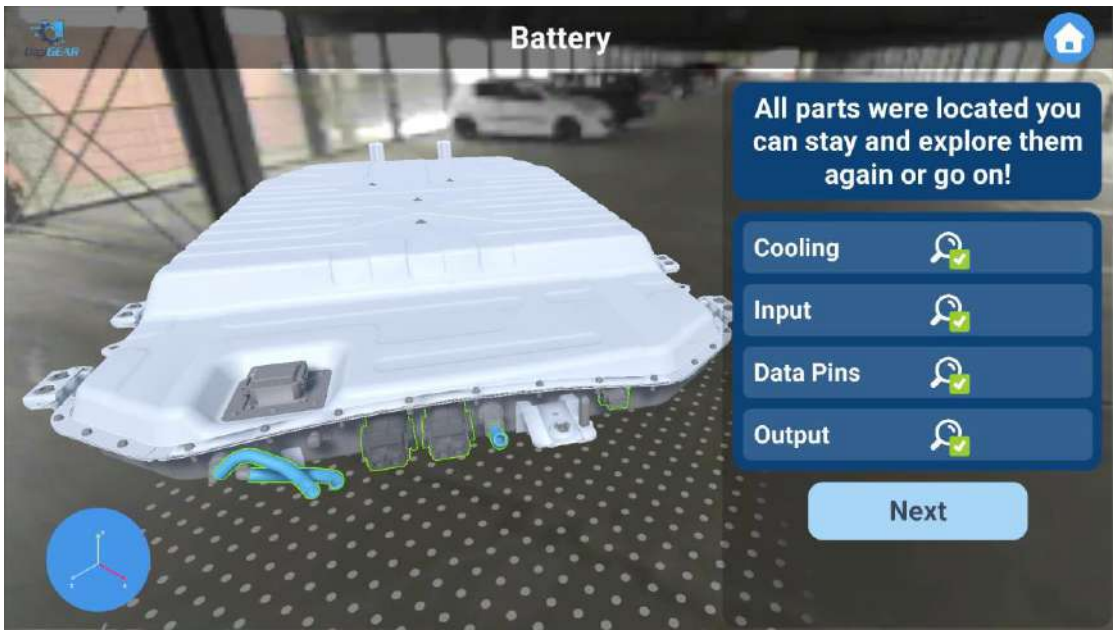

Figure 35 Battery "Find parts" challenge screenshot

The correct answers to the reflection activity are the following:

Table 18 Battery Reflection Activity answers

	Smartphone	Laptop	Smart TV	Washing Machine
Battery	Yes	Yes	No	No

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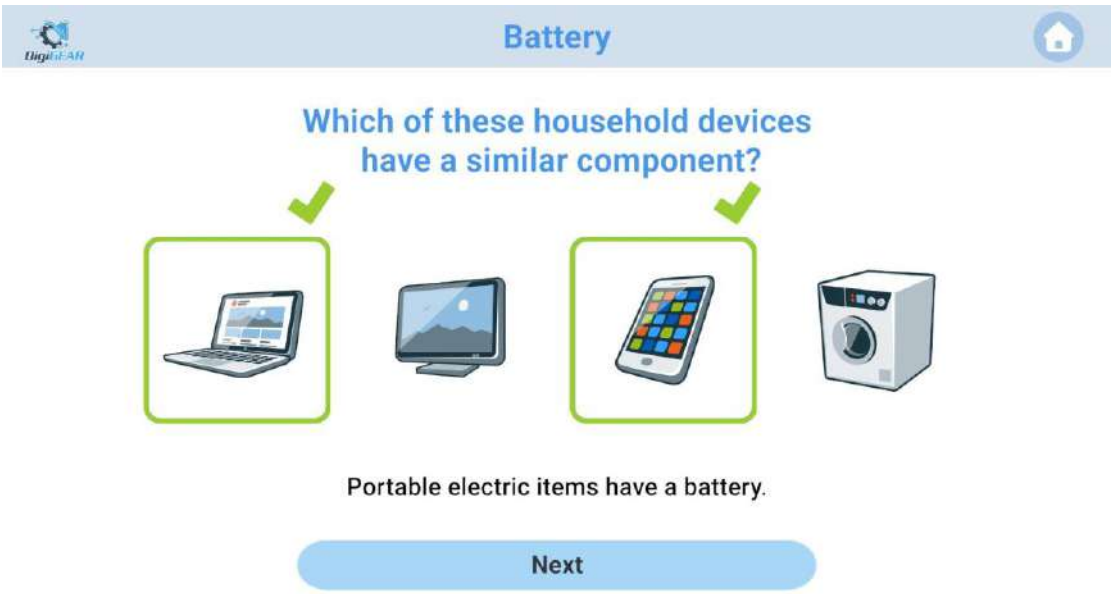

Figure 36 Battery "Reflection" activity screenshot

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Activity 6 - Inverter

For the inverter, the user should find the following three key parts:

Table 19 Inverter parts

#	Part
1	Data Pins
2	Cooling
3	AC output
4	DC Input

The screenshot below (Figure 26) presents the visual appearance of the component with all parts discovered.

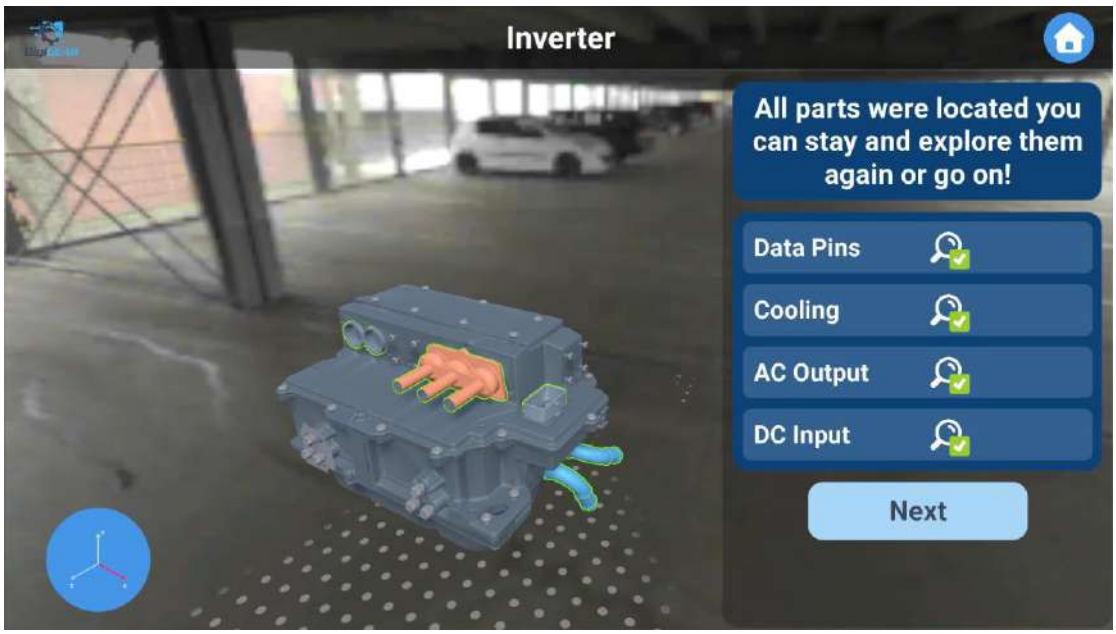

Figure 37 Inverter "Find parts" challenge screenshot

The correct answers to the reflection activity for the Inverter are the following:

Table 20 Inverter Reflection Activity answers

	Smartphone	Laptop	Smart TV	Washing Machine
Inverter	No	No	No	No

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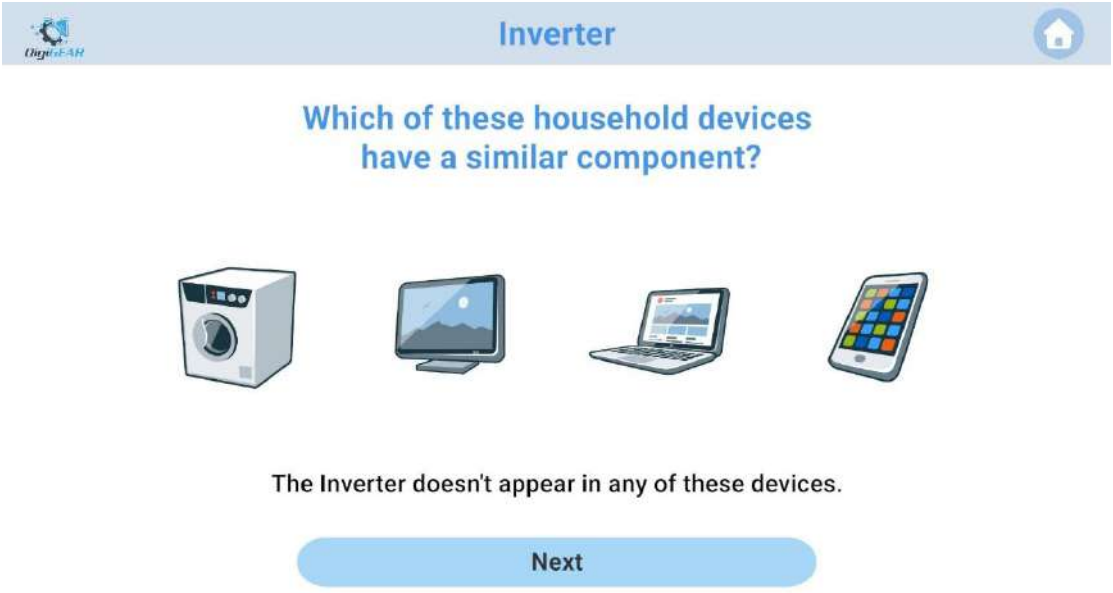

Figure 38 Inverter "Reflection" activity screenshot

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Activity 7 - Motor

Lastly, for the Motor, the user should find the following three key parts:

Table 21 Motor parts

#	Part
1	AC Input
2	Cooling Loop

The screenshot below (Figure 26) presents the visual appearance of the component with all parts discovered.

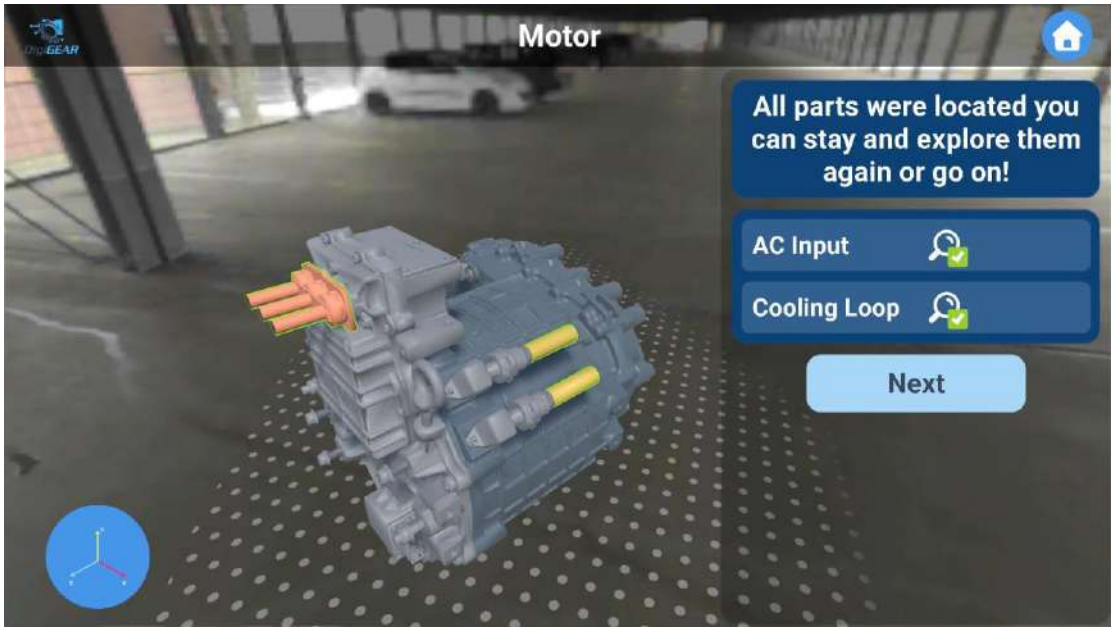

Figure 39 Motor "Find parts" challenge screenshot

The correct answers to the reflection activity are the following:

Table 22 Motor Reflection Activity answers

	Smartphone	Laptop	Smart TV	Washing Machine
Motor	No	No	No	Yes

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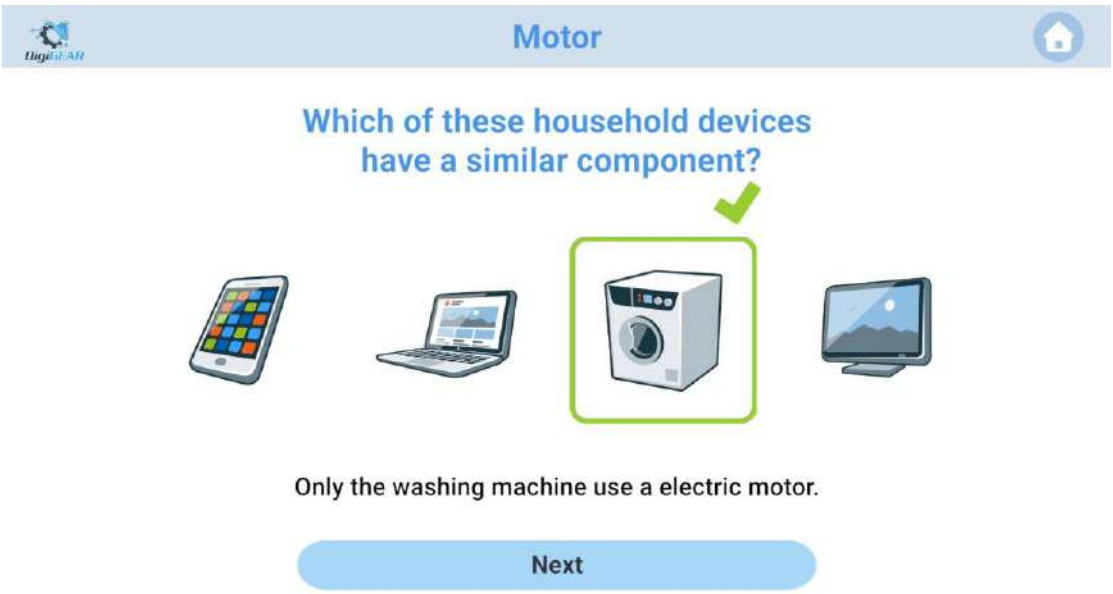

Figure 40 Motor "Reflection" activity screenshot

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Conclusions

This document acts as a comprehensive presentation of the DigiGEAR AR platform, its activities, and how they relate to the e-Learning material. It includes both high-level information, such as design decisions on matters of instructional design, application design and interaction design, and low-level information, such as step-by-step mock-ups illustrating the user story. This document also acted as a user-friendly medium to communicate the AR application design and use to faculty and students.

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