



## DELIVERABLE No 2.4

### IT platform, gamified apps and integration prototype

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PP	Restricted to other programme participants (including the Commission Services)	
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## **IT platform, gamified apps and integration prototype**

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## 1. Introduction

This document is the **companion to the software deliverable** of type DEMONSTRATOR D2.4, IT platform, gamified apps and integration prototype, produced by POLIMI.

The purpose of this document is to describe the software artifacts that constitute the deliverable D2.4, and to **provide the reference to the public software repository** where the source code has been stored and made available for public download.

The rest of this document is organized as follows:

- Section 2 summarizes the background of the work performed in WP2, which has led to the development of the IT platform and of the gamified application and game.
- Section 3 explains the global architecture of the developed software modules and the flow of their interconnection at run-time.
- Section 4 illustrates the design concept, the architecture and the interface of the Augmented Reality gamified app, called **FunergyAR**, which implements the game conceived to be played by school children.
- Section 5 provides the specifications and the interfaces of the IT platform for content editing, which is used by the administrators of the service (typically the marketing and communication managers of an utility company) and by the end-users (typically teachers and pupils of the schools), to create and approve content for the FunergyAR game.
- Section 6 provides a reference to the public software repositories where the realized software modules can be downloaded.

## 2. Background

The PENNY project is focused on the investigation of the determinants of consumer's behavior towards sustainability.

Within this general goal, WP2, and especially Task 2.4 *Platform design and social gaming*, investigate the impact of IT and of gaming on the promotion of the behavior of consumers towards sustainability.

To this end, the task has produced an IT platform back-end and an awareness mobile app, based on a gaming design concept. The general idea of the mobile app is to embed a traditional gaming schema (notably, a trivia quiz game) within an interesting and modern technological setting, such as Augmented Reality interaction. The target of the designed game is the group of the primary and secondary school children, aged between 6 and 13. The idea is that behavioral change in households can be conveyed at best acting on the children, who could then transfer the acquired awareness to the whole family in an effective way.

To address the children in the selected age range optimally, it is important to exploit the institutional leverage and influence that the school can exercise. To this end, the social game is accompanied by a simple IT back-end platform with a Web interface, whereby schools can contribute content that will be consumed by the game. A school can register to the IT platform and provide quizzes that will be used in the game, can rank quizzes by difficulty, can write an explanation to convey the reason why a response is correct, and finally can tag the quiz with the object that is referred to in the question (e.g., a TV set, the fridge, and so on). The tag information will be exploited in the FunergyAR game, to build an innovative and engaging play mechanics, which exploits **Artificial Intelligence**, **Computer Vision**, and **Augmented Reality** to let children

explore their surrounding environment and discover how to save energy by a proper use of the objects that populate their homes.

The content provided by the school can be acknowledged in the game (e.g., the explanation can contain a reference to the school that provided the question), so that a social comparison with peers is fostered.

### 3. Architecture of the IT platform, gamified apps and integration prototype

Figure 1 shows the general architecture of the IT platform, its web interfaces, the mobile game FunergyAR, and the roles involved in their use.

The **IT back-end platform for game content management** consists of a web application that manages the content of the FunergyAR mobile game. It relies on a database, which stores the data of the quizzes (question, correct answer, wrong answer, and explanation), the data of the objects to which a quiz may refer, and the association between a quiz and the object(s) it refers to.

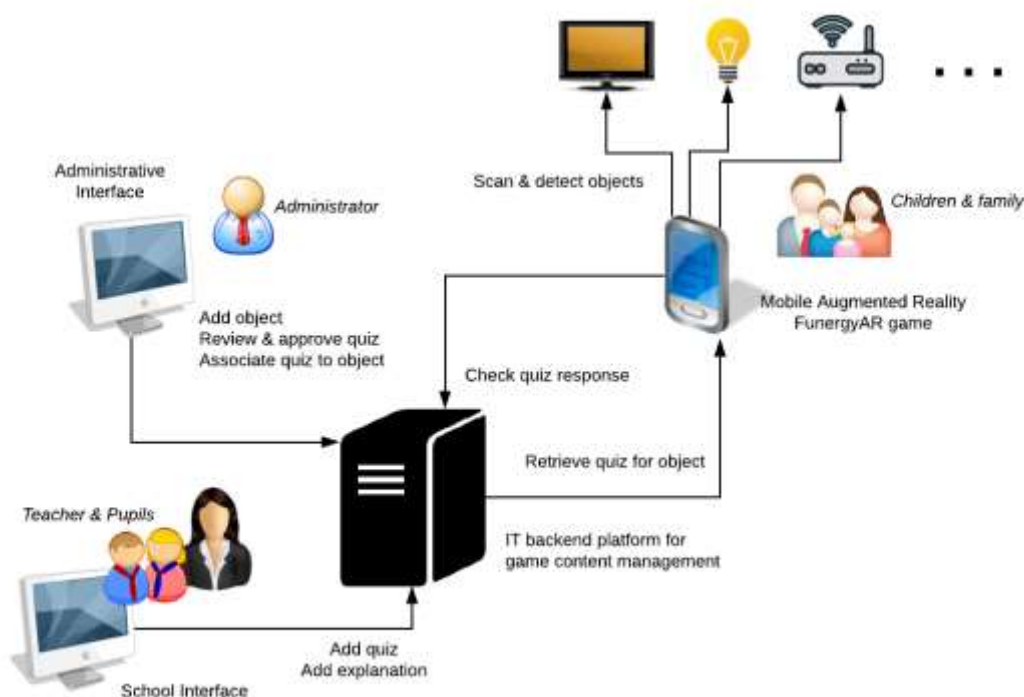


Figure 1: architecture, components and roles of the IT platform and gamified mobile app

The **Administrative interface** is a web application offered to the content administrator so that she can initialize and configure the database content of the game, and approve quiz proposals inserted by the schools.

The **School interface** is a web application whereby the school teachers, together with the pupils, can register the school to the FunergyAR community and insert into the database the proposals of quizzes to be exploited in the game.

The **Mobile Augmented Reality** game **FunergyAR** is an app for mobile devices that exploits Artificial Intelligence, Computer Vision, and Augmented Reality to let children explore their surrounding environment and discover how to save energy by a proper use of the objects that populate their homes. The player can use the telephone camera to point to an object; if the object is recognized by the Computer Vision module and there are quizzes for such object, then the gameplay starts and the user can respond to the quiz.

The envisioned roles of the IT architecture are as follows:

The **administrator** configures the back-end database of the gamified application, inserting the object tags, creating quizzes, approving quizzes inserted by schools, and associating quizzes to the objects mentioned in them.

The **school teachers and pupils** can propose new quizzes and add a short explanation to illustrate the correct answer.

The **children and their family** can play the FunergyAR mobile game, by detecting objects in their home and responding to the quizzes associated to them.

## 4. Architecture and interface of the FunergyAR Augmented Reality gamified app

The Augmented Reality gamified app **FunergyAR** is a mobile game that exploits Artificial Intelligence, Computer Vision, and Augmented Reality to let children explore their surrounding environment and discover how to save energy by a proper use of the objects that populate their homes. The player can use the telephone camera to point to an object; if the object is recognized by the Computer Vision module and there are quizzes for such object, then the gameplay starts and the user can respond to the quiz.

An example of quiz associated to objects is the following:

**Question:** Using a screen saver always saves energy

**Correct answer:** False

**Wrong answer:** True

**Explanation:** Screen savers were useful at the time of cathode ray tube monitors, to avoid consumption of screen pixels. With modern monitors they are no longer needed, on the contrary they can prevent the PC from entering the energy saving mode. To learn more, you can read an in-depth article (in English): <https://www.howtogeek.com/128644/htg-explains-why-screen-savers-are-no-longer-necessary/>

**Associated objects:** Desktop Computer, Laptop, computer keyboard, screen

Another example is:

**Question:** EU energy labels use letters to describe an appliance's energy consumption, which letter denotes the MOST energy efficient types?"

**Correct answer:** A

**Wrong answer:** B

**Explanation:** The energy efficiency of an appliance is rated with classes from A to G on the label, A being the most energy efficient, G the least efficient

**Associated objects:** Television, radio, refrigerator, vacuum, dishwasher, microwave

The following screenshots illustrate the graphical user interface of the Funergy AR app.



Figure 2: The home screen of the app provides access to the “take a picture” mode, the “single player” mode and the application settings

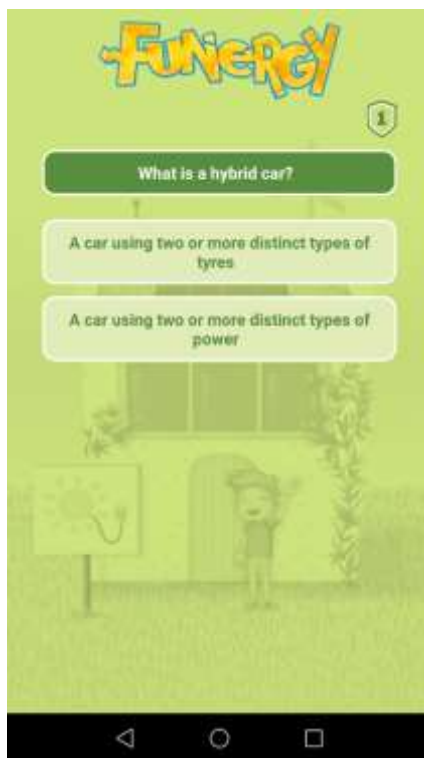


Figure 3: On the “single player” mode, the app presents the user with a series of quizzes, if the user responds correctly a determined number of times he will climb one level up and the question will become more difficult.

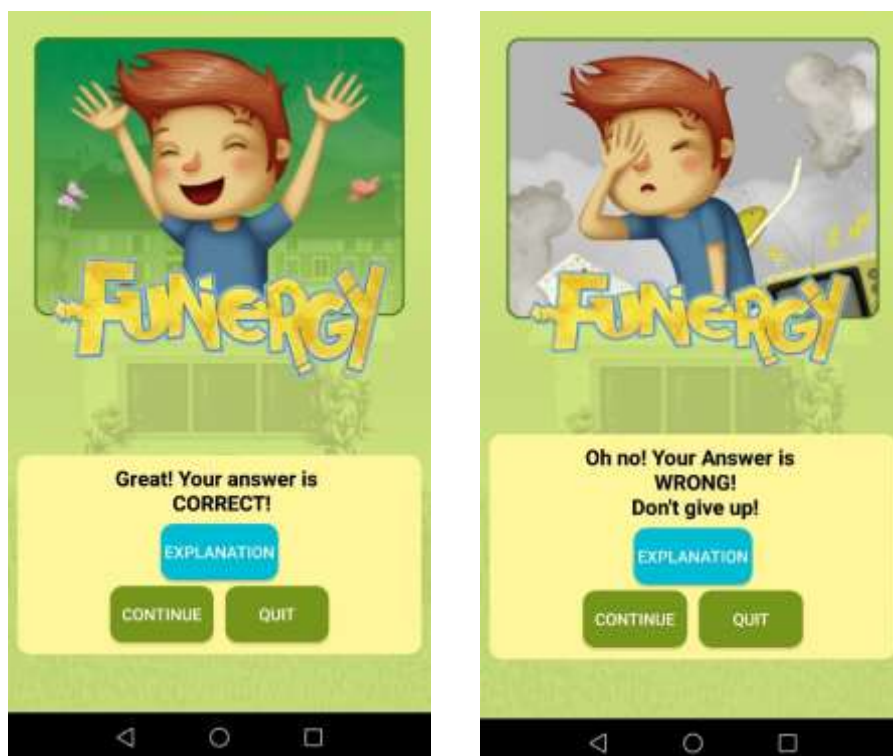


Figure 4: Depending on the user’s answer, the app provides feedback about whether he was right or wrong.





Figure 5: All the questions on the app have an explanation, to help users understand why the answer they provided was right or wrong.



Figure 6: The “Take a picture” mode exploits a Computer Vision module to identify the object the user is pointing at. The mobile phone buzzes when the object is recognized and overlays on it the tag associated to the recognized object(s)

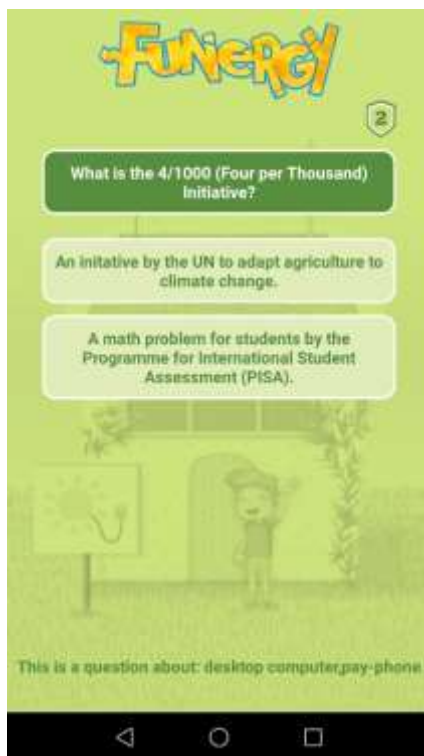


Figure 7: If the object is identified, the game starts and the app presents the user with a question related to the identified object, the game proceeds as in the “single player” mode.



Figure 8: The settings allow one to change the language; the application interface and questions are available in multiple languages.

## 5. Specifications of the IT platform for content editing

The IT platform for the game content management is a multi-lingual web application reachable at the address:

<http://funergy.ifmledit.org/funergy>

The Home Page is common to all the types of users and allows them to log in, as shown in Figure 9.

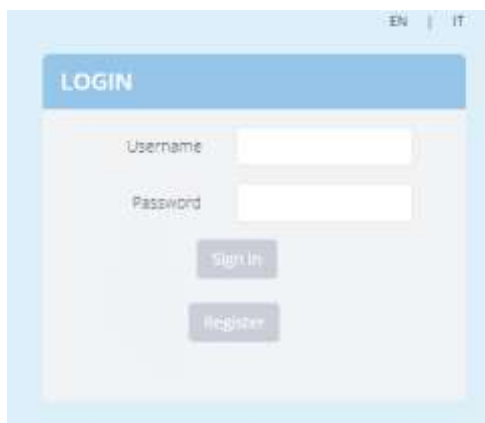
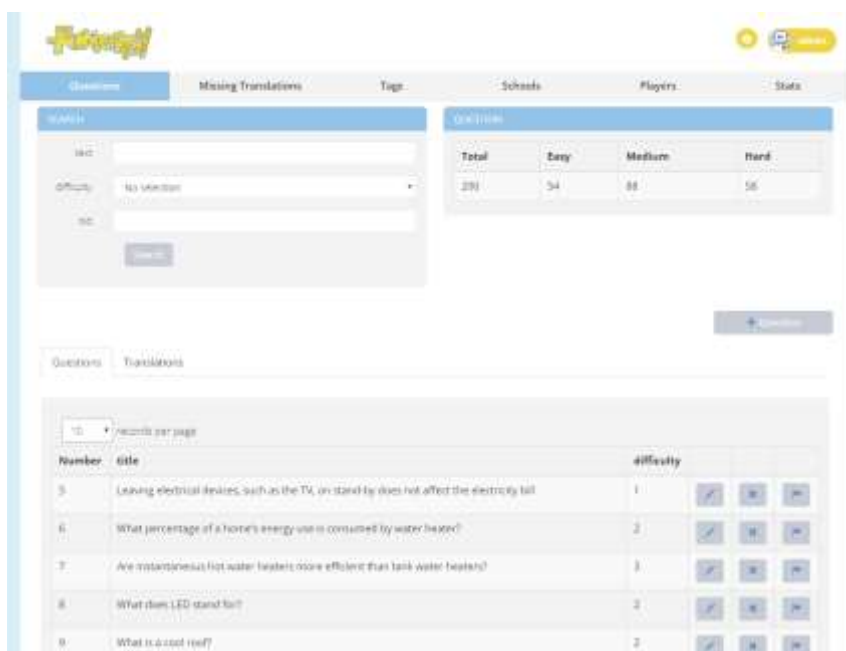


Figure 9: login form to the contest management back end platform

After the log in, each user is directed to the application pages specific for her role.

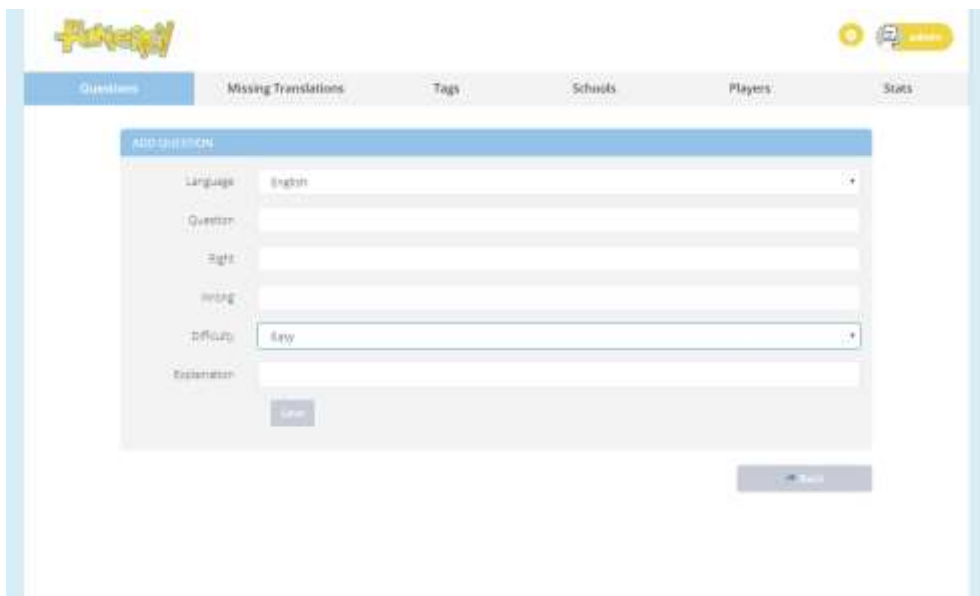
### **Specifications of the administrative interface**

The following screenshots shows the user interface for the administrator of the game content.



Number	Title	Difficulty
5	Leaving electrical devices, such as the TV, on stand by does not affect the electricity bill	1
6	What percentage of a home's energy use is consumed by water heaters?	2
7	Are instantaneous hot water heaters more efficient than tank water heaters?	3
8	What does LED stand for?	2
9	What is a cool roof?	2

Figure 10: Landing page of the administrative interface: the administrator can search the database of the questions or scroll the list of existing questions. She can inspect each question, edit it, and delete it.

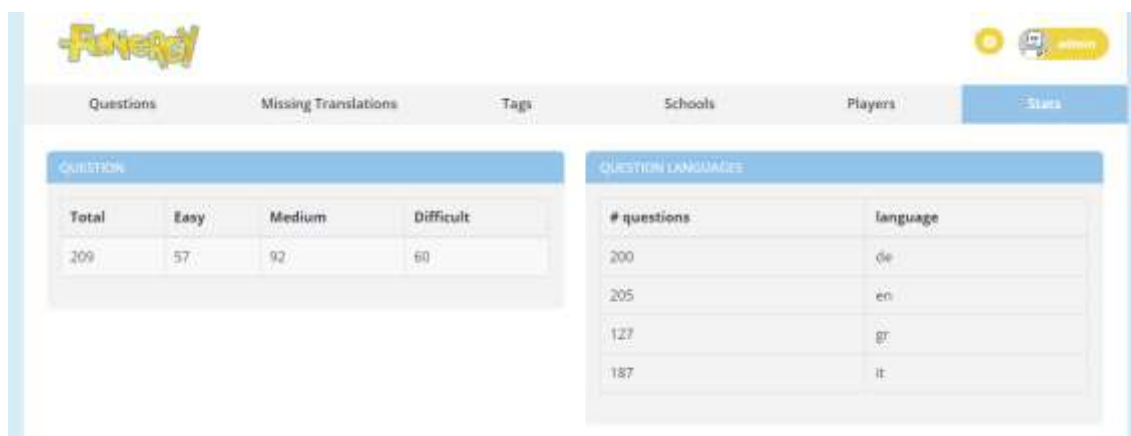


The screenshot shows the 'Add Question' form in the Penny administrative interface. The form is titled 'ADD QUESTION' and includes the following fields:

- Language: English (dropdown menu)
- Question: (text input field)
- Right: (text input field)
- Wrong: (text input field)
- Difficulty: Easy (dropdown menu)
- Explanation: (text input field)

There are two buttons at the bottom: 'Save' and 'Back'.

Figure 11: Page of the administrative interface for creating a new question.



The screenshot shows the 'Stats' page in the Penny administrative interface. It displays two tables:

**QUESTION**

Total	Easy	Medium	Difficult
209	57	92	60

**QUESTION LANGUAGES**

# questions	language
200	de
205	en
127	gr
187	it

Figure 12: Page for inspecting the statistics about questions, translation languages, and difficulty levels.

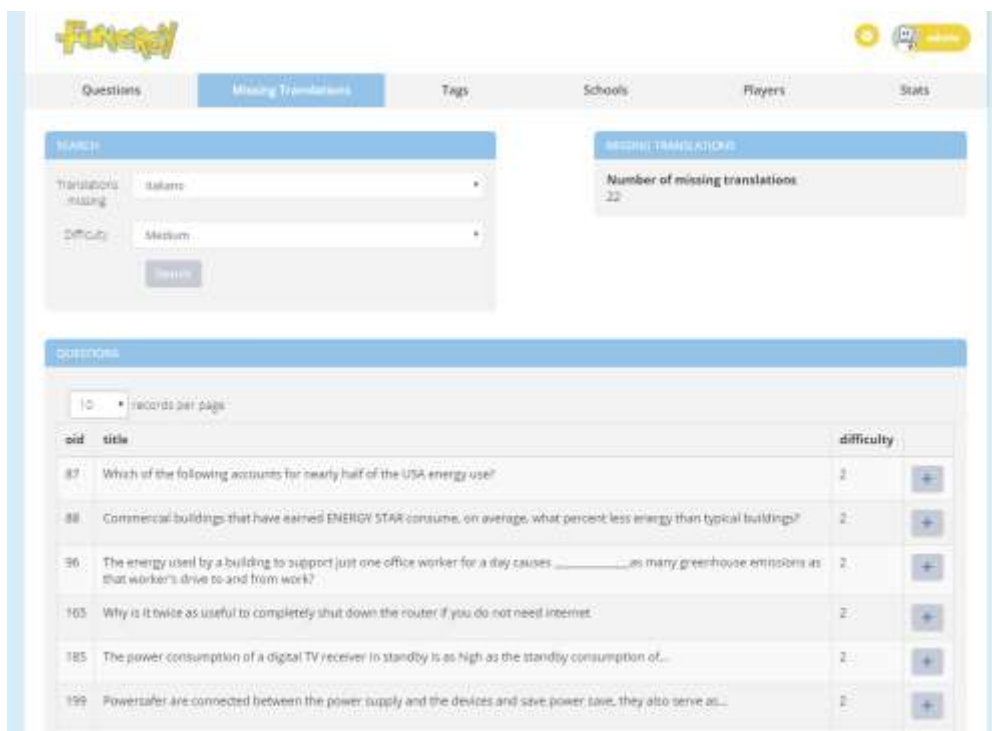


Figure 13: Page for inspecting the missing translation and add such translation to the database.

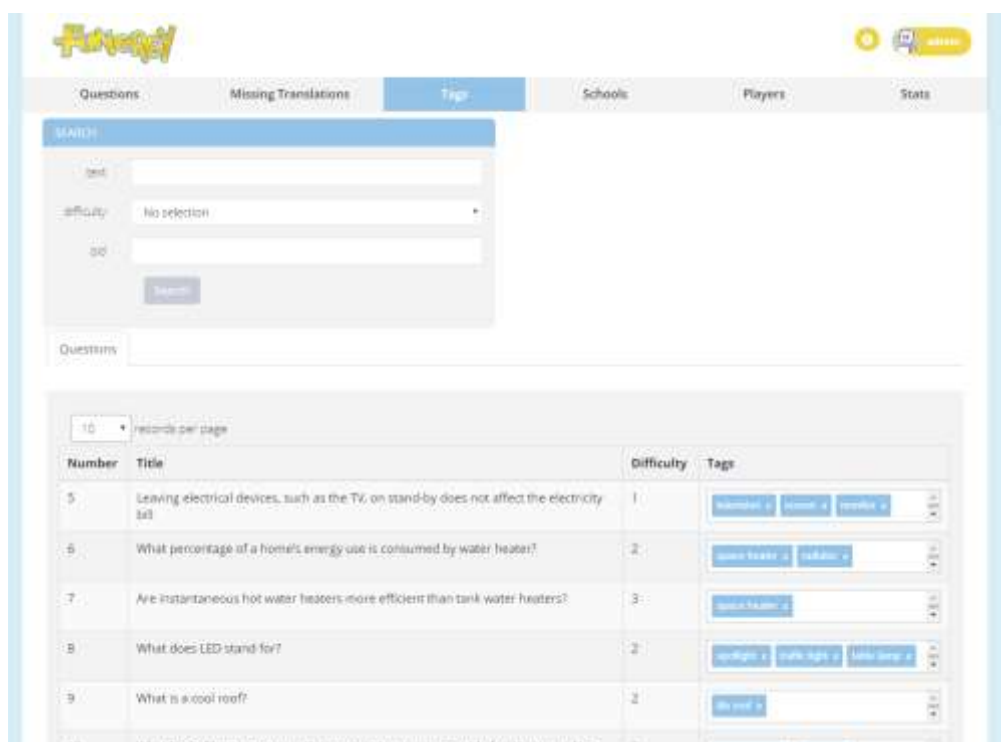
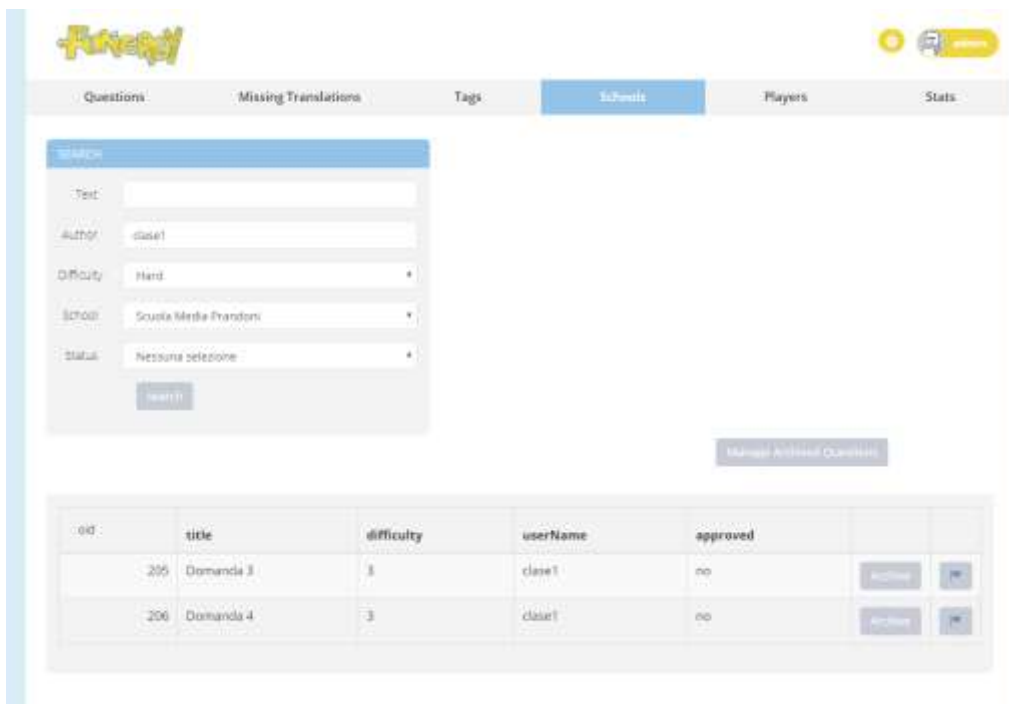


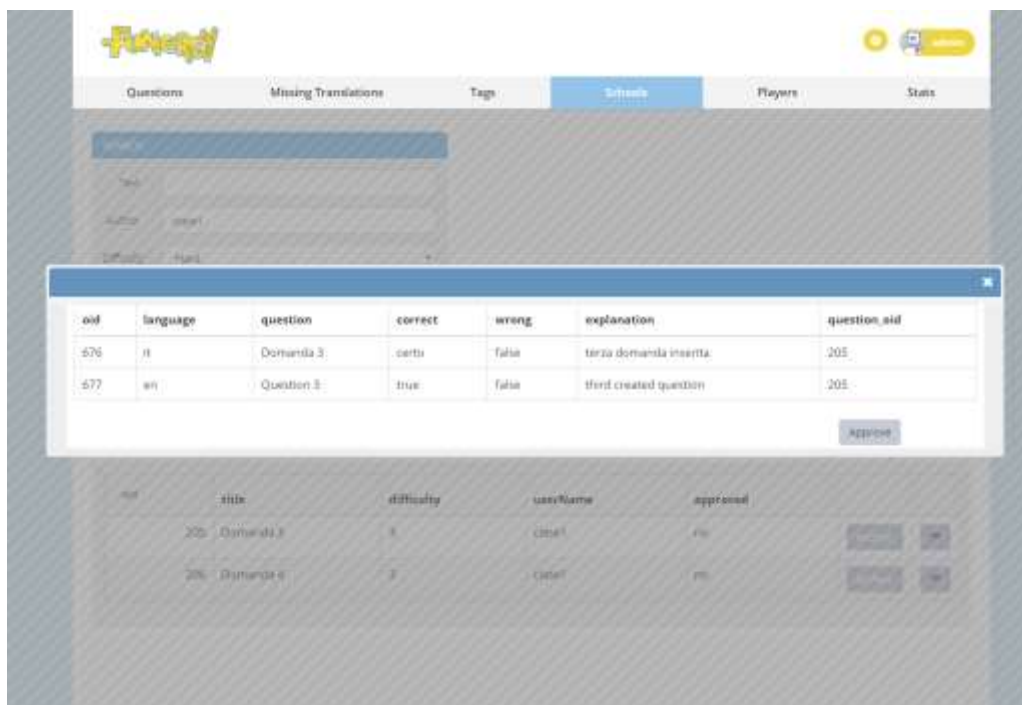
Figure 14: Page for tagging a question with the object(s) it is relevant to, so that it becomes usable by the FunergyAR game, after object detection.



The screenshot shows the 'Questions' page with a search filter on the left and a table of question proposals below. The search filter includes fields for Text, Author (class1), Difficulty (Hard), School (Scuola Media Pratom), and Status (Nessuna selezione). A 'search' button is at the bottom of the filter. Below the filter is a 'Manage Archived Questions' button. The table below has columns: id, title, difficulty, userName, approved, and buttons for 'Archive' and 'Unarchive'.

id	title	difficulty	userName	approved		
205	Domanda 3	3	class1	no	Archive	Unarchive
206	Domanda 4	3	class1	no	Archive	Unarchive

Figure 15: Page for searching and inspecting the proposals of questions submitted by a school



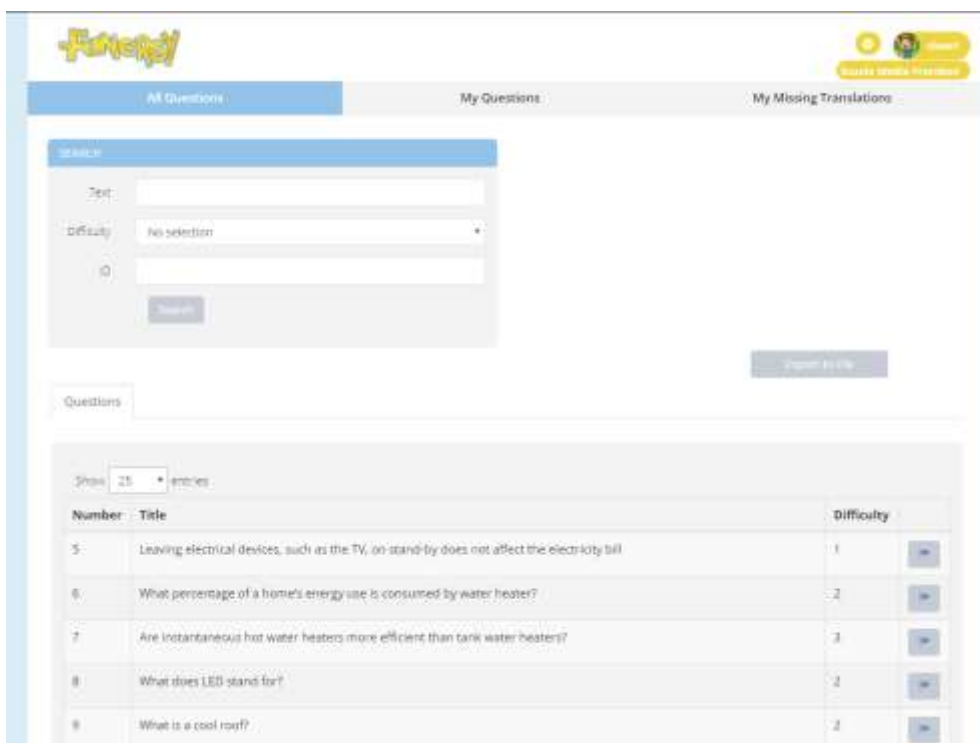
The screenshot shows the 'Questions' page with a modal window open for approving a question proposal. The modal window has a table with columns: id, language, question, correct, wrong, explanation, and question\_id. Below the table is an 'Approve' button. The background shows the same search filter and table as in Figure 15.

id	language	question	correct	wrong	explanation	question_id
576	it	Domanda 3	certa	false	terza domanda inserita	205
577	en	Question 3	true	false	third created question	205

Figure 16: page for approving a question proposal submitted by a school

## Specifications of the school interface

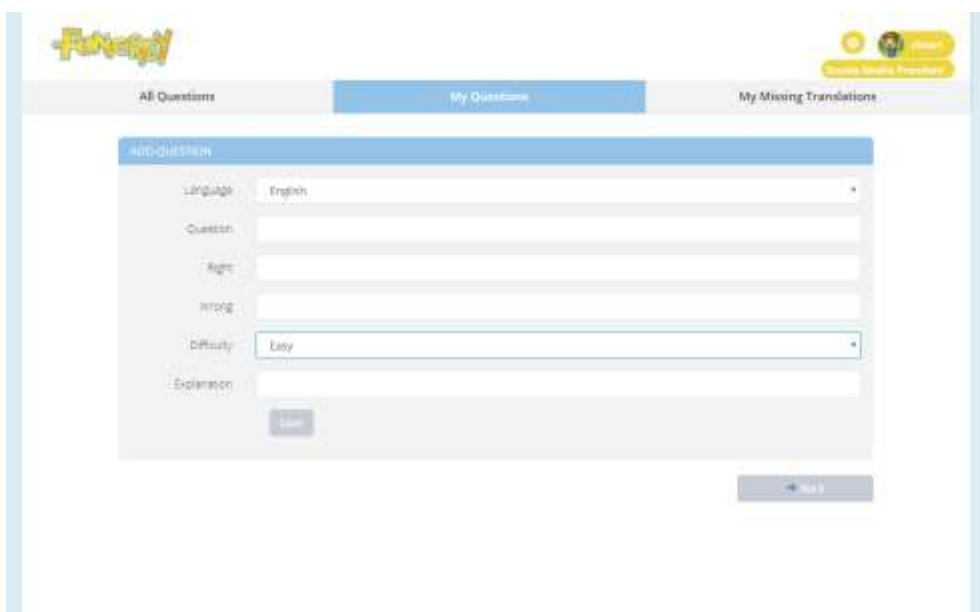
The following screenshots illustrate the graphical user interface for the school teachers and pupils.



The screenshot shows the 'All Questions' page. At the top, there are tabs for 'All Questions', 'My Questions', and 'My Missing Translations'. Below the tabs, there is a 'QUESTION' form with fields for 'Text', 'Difficulty' (set to 'No selection'), and 'ID'. A 'Submit' button is at the bottom of the form. To the right of the form is a 'Export to file' button. Below the form, there is a 'Questions' section with a 'Show 25 entries' dropdown. A table lists questions with columns for 'Number', 'Title', and 'Difficulty'. Each row has a 'More' button next to the difficulty level.

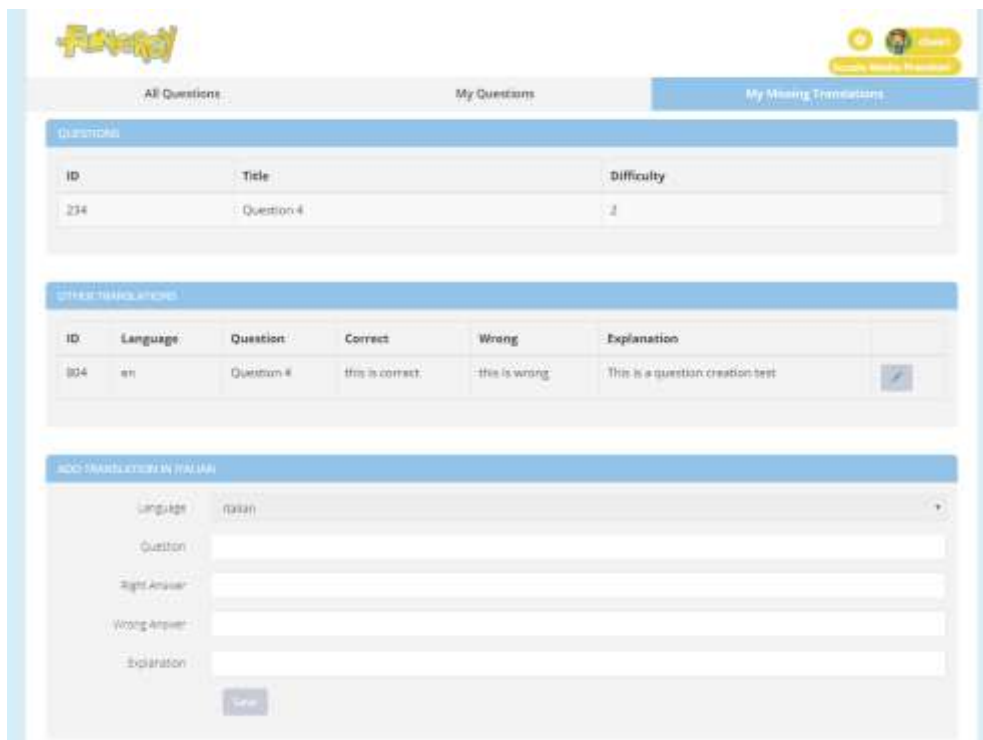
Number	Title	Difficulty
5	Leaving electrical devices, such as the TV, on stand-by does not affect the electricity bill	1
6	What percentage of a home's energy use is consumed by water heater?	2
7	Are instantaneous hot water heaters more efficient than tank water heaters?	3
8	What does LED stand for?	2
9	What is a cool roof?	2

Figure 17: page showing the list of questions inserted by the school



The screenshot shows the 'Add Question' page. At the top, there are tabs for 'All Questions', 'My Questions', and 'My Missing Translations'. Below the tabs, there is an 'ADD-QUESTION' form. The form has fields for 'Language' (set to 'English'), 'Question', 'Right', 'Wrong', 'Difficulty' (set to 'Easy'), and 'Explanation'. A 'Save' button is at the bottom of the form. To the right of the form is a 'Go to 3' button.

Figure 18: Page for the school to create a question proposal



The screenshot shows the 'My Missing Translations' tab. It contains a table of questions with missing translations and a form to add a new translation for a selected question.

ID	Title	Difficulty
234	Question 4	2

ID	Language	Question	Correct	Wrong	Explanation
804	en	Question 4	this is correct	this is wrong	This is a question creation test

**ADD TRANSLATION IN ITALIAN**

Language: Italian

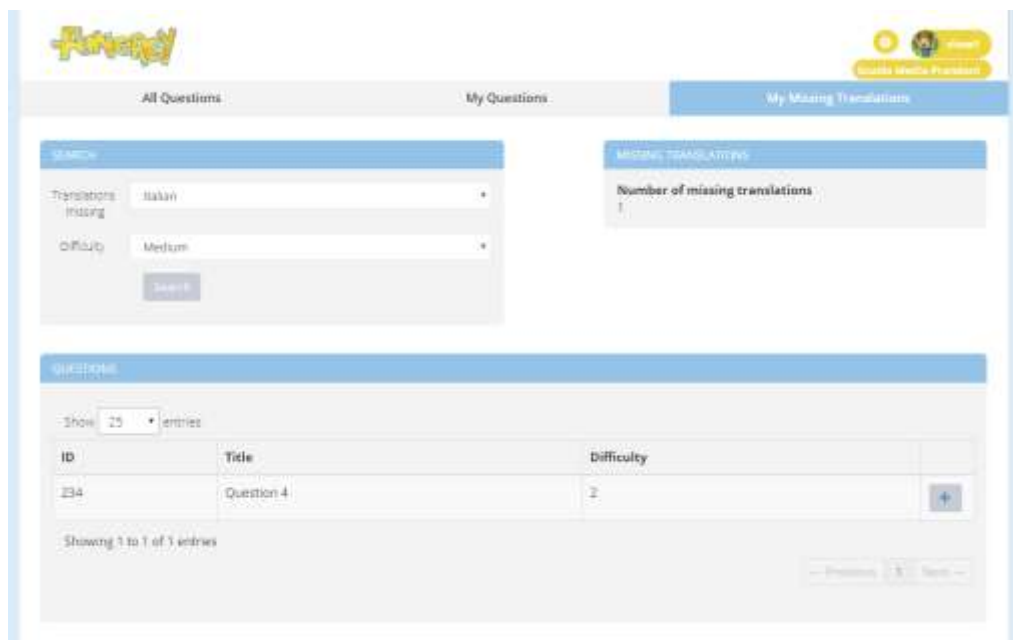
Question:

Right Answer:

Wrong Answer:

Explanation:

Figure 19: page for the school to add a translation to a candidate question



The screenshot shows the 'My Missing Translations' tab. It contains a search bar, a table of questions with missing translations, and a form to add a new translation for a selected question.

**SEARCH**

Translations: Italian

Difficulty: Medium

**MISSING TRANSLATIONS**

Number of missing translations: 1

**QUESTIONS**

Show: 25 entries

ID	Title	Difficulty
234	Question 4	2

Showing 1 to 1 of 1 entries

Figure 20: Page for the school to inspect the proposed questions without translation



## 6. Reference to the public software repositories

### 6.1 Funergy AR

Funergy AR is a proof of concept Android application; the project code is available on a Git repository.

The following instructions provide information to download the code and import it into Android Studio.

#### Requirements:

- Git v2.16 or later
- Android Studio 3.0 or later
- Java JDK 8 or later

#### Repository information:

Repository: <https://gitlab.com/wds-co/funergy-ar-app.git>

User: penny\_review

Password: sj5\$mfD&k37z1c

Step 1: Execute the following command in the Git console to create a local copy of the code:

```
> git clone penny_review@gitlab.com:wds-co/funergy-ar-app.git
```

Step 2: Open android studio, go to the menu File – Open, navigate to the location where the repository was created, and select the folder FunergyAR. The project will be automatically compiled, the app can be tested on a device with Android 6.0 or superior.

### 6.2 Content Editor and Backend services

The content editor is a web application and has been developed using Webratio, a platform for the development of web and mobile applications based on the OMG standard IFML.

The following instructions provide information to download the code and import it into Webratio.

#### Requirements:

- MySQL DBMS 5.6
- Java SDK 8 or later
- WebRatio 8
- Apache Tomcat 6.x or later

Step 1. Create a new database “funergy” and import the sql file funergy\_dump.sql from the following repository:

Repository: <https://gitlab.com/wds-co/funergy-db.git>

User: penny\_review

Password: sj5\$mfD&k37z1c

Step 2: Download the project code from the following repositories (both are required):

<https://gitlab.com/wds-co/funergy-backend.git>

<https://gitlab.com/wds-co/funergy-backend-style.git>

Step3: Open Webratio, go to the menu File – Import, and import both project as Webratio Project and Webratio Style respectively.

Step 4: For local deployment click on the “Generate and Run” option, the code will be automatically compiled and deployed to your local tomcat installation. The server will be started automatically.

Step 5: For deployment on a remote server go to the “Deployment Configurations” option, provide the details about http and https ports, on the provider tab change the data base connection details if needed, finally click the deploy button. The code will be generated inside your local tomcat installation, copy the war file to the “webapps” folder of server’s tomcat.

## 7. Appendix: IFML diagrams of the IT platform

In this appendix we provide the specifications of the user interface of the IT platform, expressed using the IFML OMG/UML standard<sup>1</sup>.

The full-size diagrams can be found in the software repository together with the executable models and source code of the applications.

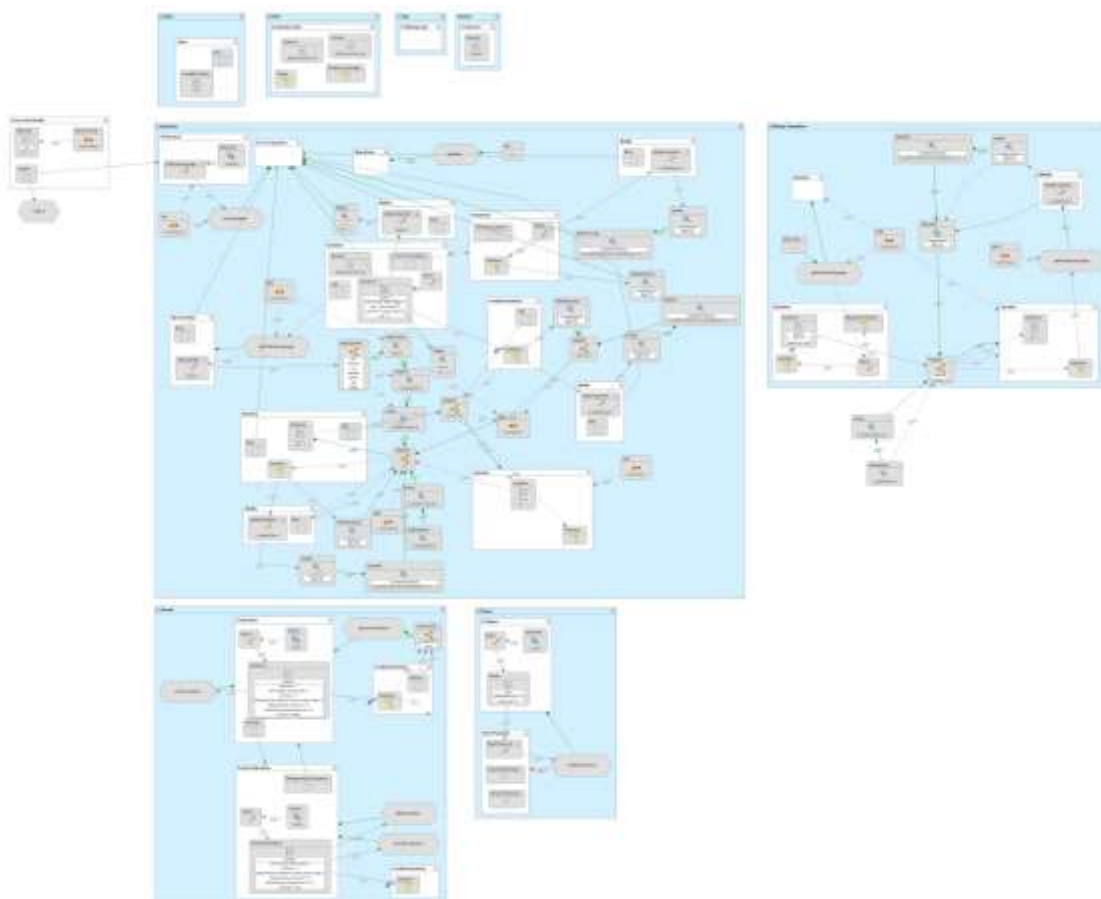


Figure 21 IFML site view of the administrative interface

<sup>1</sup> <http://ifml.org/>

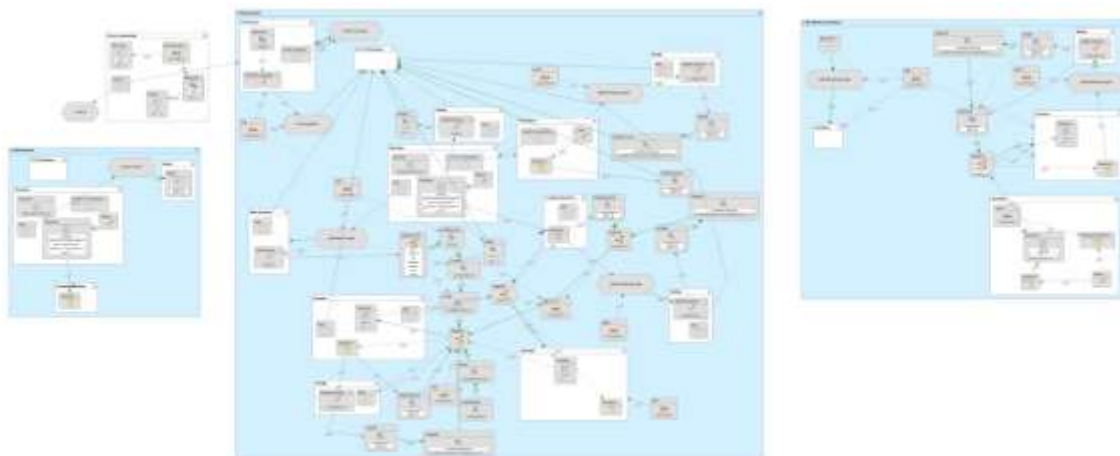


Figure 22: IFML site view of the school interface

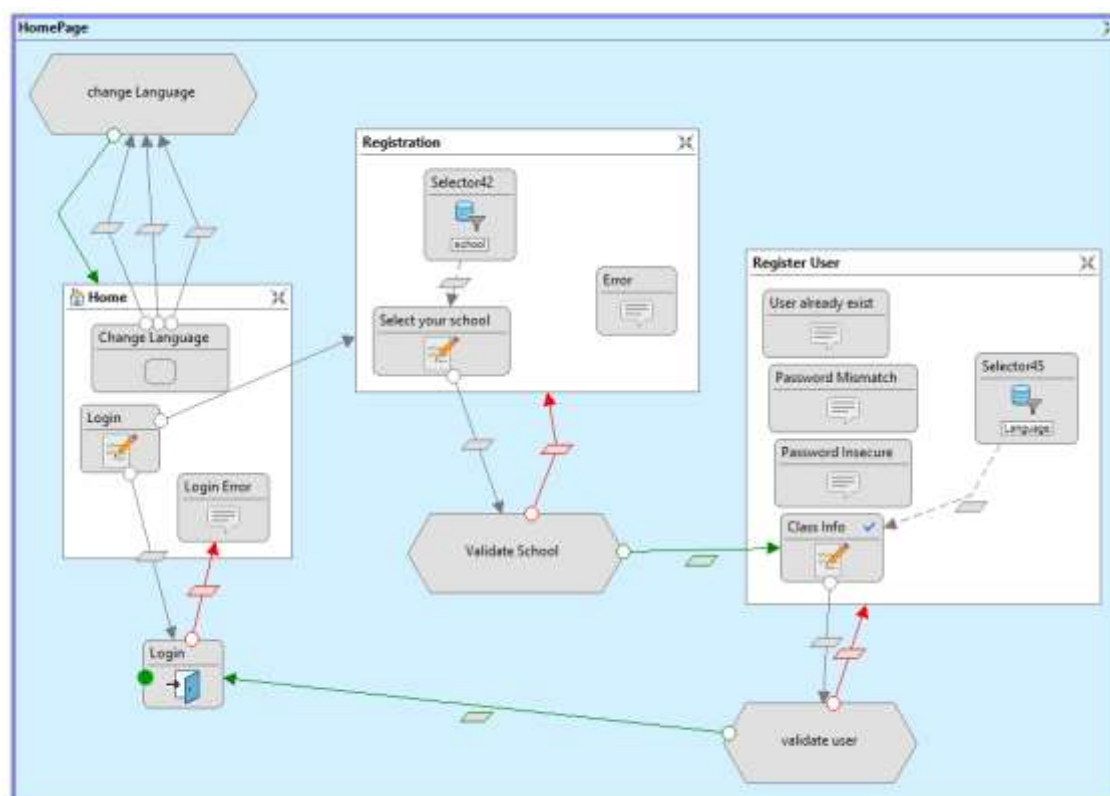


Figure 23: IFML site view for the registration process

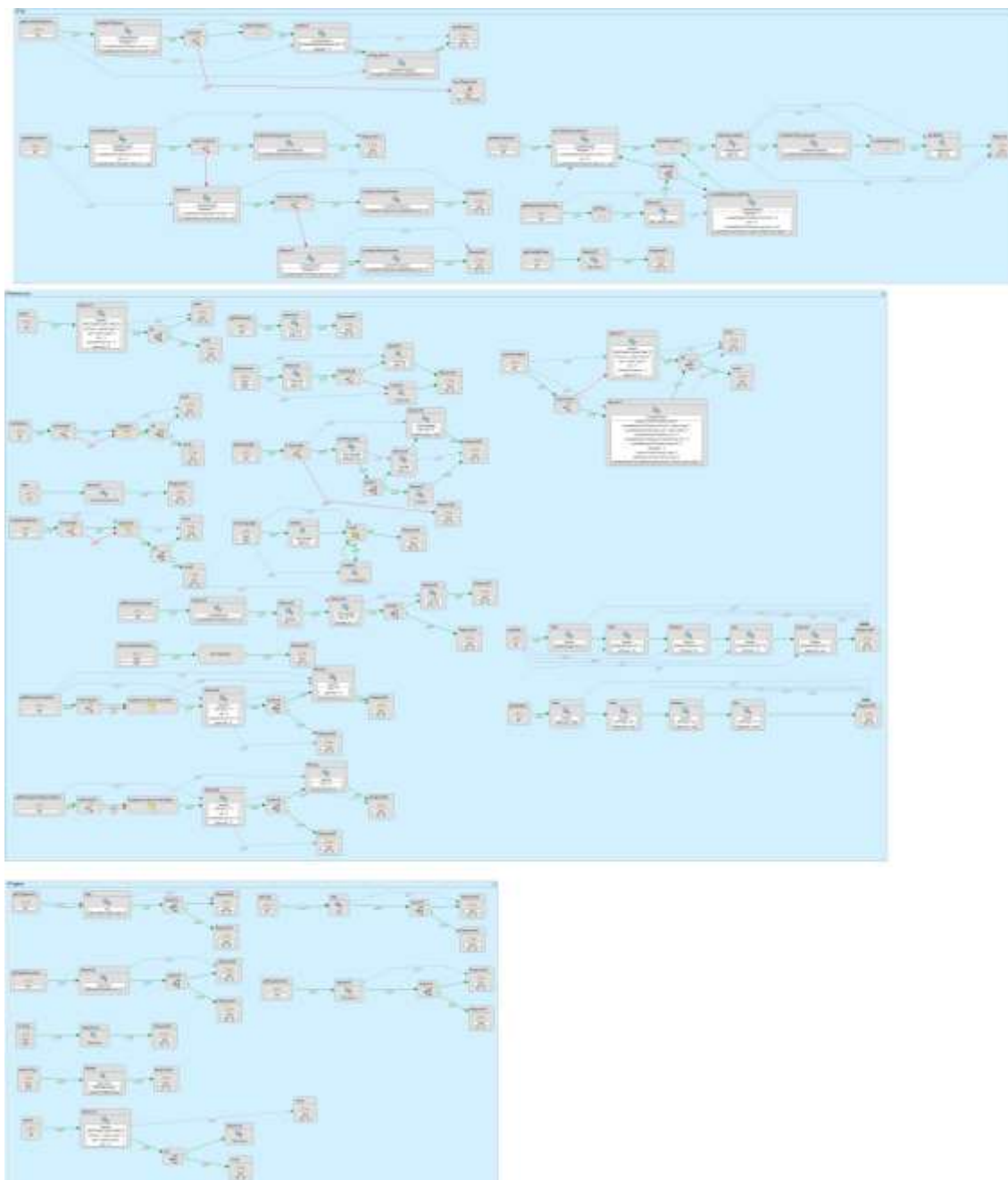


Figure 24: Service view of the back-end service integrating the FuneryAR game and the content management application