BREAKING EDUCATIONAL BARRIERS WITH CONTEXTUALISED PERVASIVE AND GAMEFUL LEARNING

**Grant Agreement No. 687676**

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# D6.3: Validation and usability report

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**Statement of originality**

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

**LIST OF ABBREVIATIONS**

STEM: Science, Technology, Engineering and Mathematics

GLP: Gamified Lesson Plan

HWU: Heriot-Watt University

SQA: Scottish Qualification Authority

NOS: National Occupational Standards

SUS: System Usability Scale

AR: Augmented Reality

MR: Mixed Reality

PC: Personal Computer

TAM: Technology Acceptance Model Version

IRT: Interaction Response Theory

MCQ: Magistrates' Court Qualification

SEN: Special Education Needs

HE: Higher Education

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**EXECUTIVE SUMMARY**

One of the main BEACONING project objectives is to explore and measure the level of engagement, effectiveness and impact that is enabled by the BEACONING platform towards incentivising learners and fostering acquisition and transfer of knowledge and skills, validate this through large-scale pilots involving a community of stakeholders and practitioners in Europe, and provide an exploitation and business plan for the platform adoption.

This deliverable analyses the platform with respect to the evaluation framework in Task 6.2 in order to guarantee the consistency of the assessment methodology that will be deployed. In case inconsistencies appear, they will be addressed by: (i) determining their origin, (ii) determining the appropriate changes that will remedy inconsistencies, (iii) implementing these changes. Findings from the small-scale pilots (WP5) will also be considered.

We start by looking into the design of the large-scale pilots and provide examples and explanations of the design process from different partners of the project. We look at design frameworks, involved schools and other organisations and details of the design specifics for a number of large-scale pilots in different countries.

We continue with interesting reports on the lesson design process by various partners using a variety of BEACONING educational tools. These include gamified lesson paths, minigames, location-based challenges, and Virtual Reality enhanced courses. These plans are designed to include gaming activities that also yield evidences of competency achievement and the mapping of these evidence to a set of target competencies.

We continue with an overview of assessment methodologies, which focus, among other, on technical validation and usability evaluation for both teacher and students. This, very importantly, includes usability for participants with disabilities by using our accessibility bar, ACCESSABAR.

Small-scale pilots are then introduced, analysed and we focus on what we learnt from them and how this knowledge was used for the design and implementation of the large-scale pilots that followed.

Finally, we look at the data analysis tools and design which will be used for the analysis and presentation of the results in deliverable D6.4.

# 1 INTRODUCTION

## 1.1 BACKGROUND

This document details small-scale pilots and what we learnt from them, the design of lessons and their use in large-scale pilots and how the results from these pilots will be evaluated in order to inform the project's objectives.

## 1.2 ROLE OF THIS DELIVERABLE IN THE PROJECT

Linking to task 6.3 this deliverable analyses the platform with respect to the evaluation framework in Task 6.2 in order to guarantee the consistency of the assessment methodology that will be deployed. In case inconsistencies appear, they will be addressed by: (i) determining their origin, (ii) determining the appropriate changes that will remedy inconsistencies, (iii) implementing these changes. Findings from the small-scale pilots (WP5) will also be considered.

## 1.3 APPROACH

The goals of this final round are more market oriented, measuring acceptance, impact and viability of various business models.

G5 – Measuring the acceptance of BEACONING platform in schools

G6 – Evaluate the impact on introducing playfulness in school life

G7 – Evaluate the viability of BEACONING business models

Towards this goal we have designed a round of large-scale pilots. The pilots are taking place in various countries through partners, using a variety of tools from the BEACONING platform.

Gamified Lesson Plans are used for the design process of the pilot activities and are mapped to set off target competencies as part of the authoring process and are supported by the BEACONING authoring tool.

Hands-on methods, which are fundamental to learning, are used and while pedagogical techniques and approaches are subject dependent, there is still a requirement for Science, technology, engineering and mathematics (STEM), theory, feedback and reflection.

Small-scale pilots are used for testing both the lessons designed, the BEACONING platform and all its components. The observation, feedback and analysis of the small pilot results are invaluable for informing the partners for any necessary changes to be implemented for the large-scale pilots.

One of the aims of the small-scale pilots was to test the validity and usability of ACCESSABAR for students with special needs, and teachers for ease of use and productivity. This was completed successfully and enabled us to develop the functions and interface of the relevant tools.

We finish by providing a description of the data analysis process to assess usability and results from usability testing, what we planned to assess in D6.2 and what we assessed in reality.

## 1.4 STRUCTURE OF THE DOCUMENT

Section 1 – an introduction for describing the background, the approach and the structure of this deliverable.

Section 2 – describing the design of the large-scale pilots for different partners, the process followed, the participants, details of what was included, and the objectives fulfilled and so on.

Section 3 – an overview of the lesson design process for project partners. What tools were used and why, how the lessons were adapted to better work with BEACONING, challenges and how these were overcome, and how these were assessed.

Section 4 – design of the assessment methodology including use cases and technical and usability evaluations.

Section 5 – design and implementation of the small-scale pilots and how observations and feedback led to actions that improved the design and implementation of the large-scale pilots.

Section 6 - description of the data analysis process to assess usability and results from usability testing.

Section 7 – Conclusions including results and impact with user testimonials quotes.

# 2 LARGE-SCALE PILOT DESIGN

The main goal of the large-scale pilots is to evaluate the impact of the platform on various areas of education and validate the business viability.

By this round of pilots, the platform is at its most mature state, and essentially ready for a market implementation. The goals of this final round are therefore more market oriented, measuring acceptance, impact and viability of various business models.

G5 – Measuring the acceptance of BEACONING platform in schools

G6 – Evaluate the impact on introducing playfulness in school life

G7 – Evaluate the viability of BEACONING business models

## 2.1 EXAMPLES OF PILOT DESIGNS FOR SOME OF THE PARTNERS

### 2.1.1 SIVECO Large-Scale Pilot Design in Romania

As a National Coordinator of the Romanian Large-Scale Pilot, SIVECO:

1. Selected schools, teachers, classes
2. Produced resources, posts, tutorials in the local language and favourable medium. Maintain the local web site and community-sharing platform.
3. Organised and held a national workshop (face to face or online, specific objectives, content, outcomes…) and 1 or 2 follow up meetings. This is to identify, engage and prepare teachers, learning designers and local game designers.
4. BEACONING may have stimulated different degrees of engagement with gaming and different levels of studying amongst pilot teachers. NC works with teachers to optimize practices including these various degrees and levels. Relays the best practice to the teachers.
5. Employs local IT support to mitigate any technical problems, specific barriers.

*Table 1: Actions, resources and challenges for SIVECO*

| Action Step | Who? | Resources Needed (incl. outside people) | Potential Challenges |
|---|---|---|---|
| 1. First Contact with the School Leader | National Coordinator | • BEACONING Concept Presentation<br>• Video from a Small-Scale Pilot,<br>• School Requirements List | Cost for the school may be negotiated.<br>Had to have a win-win situation with the school. |
| 2. Recruit a teacher per each class that will participate | National Coordinator | • Recruit a teacher per each school to | Choose one teacher to be the Instructional |

| | | | |
|---|---|---|---|
| | | be a coordinator of the school activities. | Designer for his colleagues. |
| 3. Run a teacher's workshop to select lesson plans, provide training if a teacher chooses to be instructional designer and modify the plan. | National Coordinator | • An ID in RO BEACONING partners | If no teacher opts to have "instructional designer" role, but they would still demand revisions in the lesson plan, then contact an ID in your organization |
| 4. Create enough accounts for teachers in BEACONING platform. | National Coordinator | • Recruit a teacher per each school to create students' accounts. | If the RO teachers have their own accounts, they can create students accounts. If they are asking for help, the RO National Coordinator, SIVECO, create their students accounts. |
| 5.Follow-up sessions with the BEACONING RO Schools and Teachers | National Coordinator | • Collaborate with the RO teacher coordinator of each school to gather the feedback regarding the use of BEACONING platform. | |

The selected Romanian Schools and Teachers are listed in Table 2:

*Table 2: School details for Romania*

| No | City | School | Teacher |
|---|---|---|---|
| 1 | Bucuresti | "St. Mary" Special School for Hearing Impaired | Flori Stoica |
| 2 | Bucuresti | "St. Mary" Special School for Hearing Impaired | Roxana Berdei |
| 3 | Bucuresti | "St. Mary" Special School for Hearing Impaired | Cristina Girniceanu |

| | | | |
|---|---|---|---|
| 4 | Bucuresti | "St. Mary" Special School for Hearing Impaired | Georgeta Namolovan |
| 5 | Gaesti | Colegiul Național "Vladimir Streinu" | Laura Deaconu |
| 6 | Bucuresti | Colegiul Tehnic "Gheorghe Asachi" | Doina Bitoaica |
| 7 | Timisoara | Liceul „William Shakespeare” | Cristina Neagu |
| 8 | Timisoara | Liceul „William Shakespeare” | Marian Tache |
| 9 | Oradea | LICEUL TEORETIC AUREL LAZAR ORADEA | Viorel Muscas |
| 10 | Satu-Mare | "Mihai Eminescu" National College | Geta Cozma |
| 11 | Satu-Mare | "Mihai Eminescu" National College | Nicoleta Sandor |
| 12 | Ramnicu Valcea | “Mircea cel Batran” National College | Tatiana Marandici |
| 13 | Ramnicu Valcea | “Mircea cel Batran” National College | Octavian Roman |
| 14 | Constanta | Colegiul Tehnic Energetic | Adina-Elena Pitigoi |
| 15 | Bucuresti | Colegiul Tehnic "Mihai Bravu" | Iulian Stancu |
| 16 | Craiova | Colegiul "Stefan Odobleja" Craiova | Ileana Dogaru |
| 17 | | Liceul Tehnologic Transporturi Căi Ferate | Delia Ruicu |
| 18 | Videle | Liceul Teoretic Videle | Doina Dragoi |
| 19 | Videle | Liceul Teoretic Videle | Rodica Ionescu |
| 20 | Satu-Mare | Colegiul Național "Mihai Eminescu" | Claudia Pop |
| 21 | Bucuresti | “Grigore Moisil” National College | Dana Bobocea |
| 22 | Bucuresti | “Grigore Moisil” National College | Gabriela Alexandru |
| 23 | Bucuresti | “Grigore Moisil” National College | Oana Chiac |
| 24 | Bucuresti | “Grigore Moisil” National College | Magdalena Paslan |
| 25 | Bucuresti | “Grigore Moisil” National College | Adina Breaz |
| 26 | Bucuresti | “Grigore Moisil” National College | Violeta Radulescu |
| 27 | Bucuresti | “Grigore Moisil” National College | Ramona Stancurel |

| | | | |
|---|---|---|---|
| 28 | Bucuresti | “Grigore Moisil” National College | Gabriel Mirea |
| 29 | Bucuresti | “Grigore Moisil” National College | Nela Ion |
| 30 | Bucuresti | “Grigore Moisil” National College | Simona Buiu |
| 31 | Bucuresti | “Grigore Moisil” National College | Ion Neacsu |
| 32 | Bucuresti | “Grigore Moisil” National College | Denisa Glaje |
| 33 | Bucuresti | “Grigore Moisil” National College | Alexandra Dragomirescu |
| 34 | Bucuresti | “Grigore Moisil” National College | Elena Maftei |
| 35 | Bucuresti | "St. Mary" Special School for Hearing Impaired | Badea Emilia |
| 36 | Bucuresti | "St. Mary" Special School for Hearing Impaired | Ţîrlui Ileana |
| 37 | Bucuresti | "St. Mary" Special School for Hearing Impaired | Dumitrescu Daniela |
| 38 | Bucuresti | "St. Mary" Special School for Hearing Impaired | Mogâldea Claudia |
| 39 | Bucuresti | "St. Mary" Special School for Hearing Impaired | Popa Roxana |
| 40 | Bucuresti | "St. Mary" Special School for Hearing Impaired | Cristache Daniela |
| 41 | Timisoara | Liceul "Grigore Moisil" | Ivascu Simona |
| 42 | Satu-Mare | "Mihai Eminescu" National College | Liviu Rotaru |
| 43 | Satu-Mare | "Mihai Eminescu" National College | Chereches Nicoleta |
| 44 | Satu-Mare | "Mihai Eminescu" National College | Durla Elenita |
| 45 | Satu-Mare | "Mihai Eminescu" National College | Gigelia Silaghi |
| 46 | Satu-Mare | "Mihai Eminescu" National College | Molnar Vasile |
| 47 | Ramnicu Valcea | “Mircea cel Batran” National College | Manda Claudia |
| 48 | Ramnicu Valcea | “Mircea cel Batran” National College | Popescu Letitia |
| 49 | Ramnicu Valcea | “Mircea cel Batran” National College | MLISAN MIRELA |
| 50 | Bucuresti | “Grigore Moisil” National College | Garabet Mihaela |

14 of the RO recruited teachers are the most active as RO BEACONING Teachers. Until the 3rd of March, they managed to create 806 valid student accounts and they gathered feed-back from 531 students from regular schools and 95 students with hearing impairments

In the Romanian schools, the traditional methods of teaching are supplemented with creative activities using modern methods. Technology becomes a tool, supporting the learning process as students seek new knowledge and understanding. The students are involved in extracurricular activities.

### 2.1.2 ORT Large-Scale Pilot design in France

**STARTup For KIDS - Educatec Culture Générale**

This large pilot has been scheduled to take place in Paris, at 'Ecole 42', a private non-profit and tuition-free computer programming school using disruptive and state of the art innovative pedagogies. The pilot will be held over 2 days, open to the public (for children between 8 and 15 years of age) and designed to cater to groups of 20 students visiting BEACONING workshops with the presence of their teachers, parents or members of after classes associations such as Schoolab.

Beaconing will be used in two different fashions:

- On desktop computers, using the student platform with the possibility to take several lessons about robotics or general culture.
- On tablets or smartphones, in teams, to experiment BEACONING location-based challenges indoors through QR codes disseminated in many huge rooms.

Small-scale piloting helped the design of this pilot by informing the choice of the GLPs and lessons to use and helping with the experience of managing classes in the BEACONING system, both from the teachers and student point of view. Data analytics were not required as it's only a one-time event whose objective was to raise awareness about the usage of BEACONING.

**Post BAC–Mathematics UPEC**

This large-scale pilot has been organized with the University Paris-Est Créteil (UPEC). It targets students around age 20, in their second year of licence degree. It has been designed to fulfil three different objectives:

- Allow the students to evaluate themselves in their knowledge of trigonometry after their first semester of course.
- Help students understand the notion of reversed classroom.
- Help teachers track and monitor the results of their students, both in an individual fashion and to detect global trends.

About 150 students of the Mathematics Department are scheduled to take part in the pilot, which is managed by their teachers and the administrative staff of the university.

The experience garnered during the small-scale pilots about class management and analytics was crucial in the design of this pilot, as it is essential for the students and the teachers that all the analytics measurements are working properly.

**ORT MARSEILLE Robotics**

ORT France, in particular in Marseille, has already been running Coding Clubs with teachers and students as a STEM subject in the framework of extra-time activities. The coding curriculum empowers participants' confidence in their mathematical and science skills, design and technical

skills as well as computer skills. The Coding Clubs activities have been so successful and they are now set to be extended to other ORT French schools.

The pilot in Marseille targets 10 years old pupils and the coding and robotics learning paths designed during the course of the BEACONING project will be used with the support of the Lego MindStorm bricks.

The large-scale pilot here is organized with these objectives in mind:

- Allow the students to discover an alternative way of learning, using games and gamification and a different use of their computer lab
- Help the students having some issues at school to reconcile them with courses by discovering a more engaging, fun and dynamic way to learn by being allowed to move around during the course of geolocalised quests on the school campus
- Give the students a different point of view about games and serious games, allow them to take the point of view of teachers and design their own games

**Escape Game "EMBARQUEMENT IMMEDIAT" at the Roissy Charles de Gaulle airport**

This pilot has been designed with the participation of CMQ (CAMPUS DES MÉTIERS ET DES QUALIFICATIONS HUB DE L'AÉROPORTUAIRE ET DES ÉCHANGES INTERNATIONAUX), an organization dedicated to train the personnel of the Roissy airport, set in the Île de France region. It is targeting students of age ranging from 15 to 18. The main concept of the pilot has been imagined by the teachers in the framework of a student exchange with some foreign students. The objectives were to help students understand what all the challenges that entail logistic work in a real working place such as the Roissy Airport.

The small-scale piloting experience helped inform the choice of a cell phone-based location-based challenges using QR codes without the need for tracking or analytics.

**Les Prolympiades de la logistique - Workshop on computer**

This pilot has been designed with the participation of CMQ (CAMPUS DES MÉTIERS ET DES QUALIFICATIONS HUB DE L'AÉROPORTUAIRE ET DES ÉCHANGES INTERNATIONAUX), an organization dedicated to train the personnel of the Roissy airport. The target group here are students from 14 to 16 in the last year of general secondary school and students from 18 to 19 in PROMOTRANS vocational high schools. The main objective of the pilot is to help those young students discover all the jobs related to logistics, while being mentored by the older students already engaged into learning the trade.

Four schools have been involved in the pilot, along with the vocational organization PROMOTRANS and several key actors from the French Ministry of Education.

The small-scale piloting informed the choice of relevant GLPs for this pilot and was especially precious as an extensive use of the cloning function was required.

**Escape Game «JEU ORIENTATION»**

This large-scale pilot has been designed by the teachers of the ORT Montreuil school with the support of the ICT service and the school management. It was destined to students from 17 to 19 attending the Terminale STMG (the last year of school which leads to trying to pass the baccalauréat). The pilot objectives were to:

- Help the students to be able to self-evaluate their knowledge in the framework of their possible orientation post-baccalaureat
- Simulate the conditions of a professional environment

- Foster communication, collaboration, management of project, social soft skills

The small-scale piloting experience with location-based games helped with organizing the experience in the best possible way, especially in regards with the required schedule, needed materials and most appropriate minigames.

### 2.1.3 SEBIT Large-scale pilot design in Turkey

*Pilot Study 3.1*

Date: July 2018

System Version: 2.0

Context: Mars Camp. 50 student groups, a total of 200 students involved (and QR Codes as place-holders).

This study was among the large-scale pilot and involved nearly 200 students of ages 10-16 who joined a Summer Camp, called the Mars Camp. Students arrived in 2 weeks terms, and at each term, a round of BEACONING pilot took place involving a total of 50 student groups from who the survey data was collected. The topic was “water chemistry” which was matched with the game plot: Water Crisis at the Mars Settlement. The game scenario and the minigame challenges matched. Visuals in the minigames were convenient to create some logical link between the challenges and the scenario. BEACONING minigames are not very much “playful” – therefore, the minigame configuration involved word play, or funny examples or surprising facts to create a feeling of gamefulness. The GLP was created together with 3 supervising teachers who also had a chance to experience the authoring tools and the BEACONING ecosystem. The activity lasted around 2 hours. The Points of Interest were a mix of indoor/outdoor locations which somehow related to the mini game challenge (such as the location of the water tank, a meteor like rock, etc) and QR codes were used to check-in.

*Pilot Study 3.2*

Date: January 2019

System Version: 2.0

Context: Ankara, Doğa Private School. 70 students from 7th grade (age 12-13). In this pilot, beacons were used as place-holders. The event was advertised for a week with fly-posters. There was a half hour presentation to guide the students to download the app and launch the BEACONING porta. It was emphasized that the aim is to complete all the tasks, rather than finishing first. Students formed groups of 2-4. Larger groups had two students or more with mobile phones that ran the game. Once again, the game scenario and the minigame challenges matched. The GLP was created together with 3 supervising science teachers and the topic was “Atomic Elements” and Pure Substances.” The teachers also used their phones to play the game together with their students. The activity lasted around 2 hours. All Points of Interest were indoor. Despite technical challenges, the event was both entertaining AND educational. The students as well as their teachers and the school principal got more than satisfied with the outcome.

# 3 LESSON DESIGN

## 3.1 DESIGN PROCESS AND EXAMPLES

### 3.1.1 SIVECO

Some of the BEACONING Gamified Lesson Plans are given in D4.8 Gamified lesson plans (M18). These plans are designed to include gaming activities that also yield evidences of competency achievement. The mapping of these evidence to a set of target competencies is a part of the authoring process and is supported by the BEACONING authoring tool. However, the process by which this mapping to levels of achievement is evaluated can be either by quest completion rates (triadic approach), by rubrics (that teachers can use) or by probabilistic measures (such as Belief Networks), depending on the pilot study.

**ROMANIAN BEACONING LESSONS**

***The Effects of Electricity Generation on the Environment – Physics- High school***

In this plan, players are asked to complete some missions against time which are mini-games/challenges about the impact of energy production over the environment. These challenges involve quizzes, comparisons and matching that would require critical thinking and collaborative problem-solving competencies. Figures 1 to 17 illustrate the design and implementation of the lesson plan.

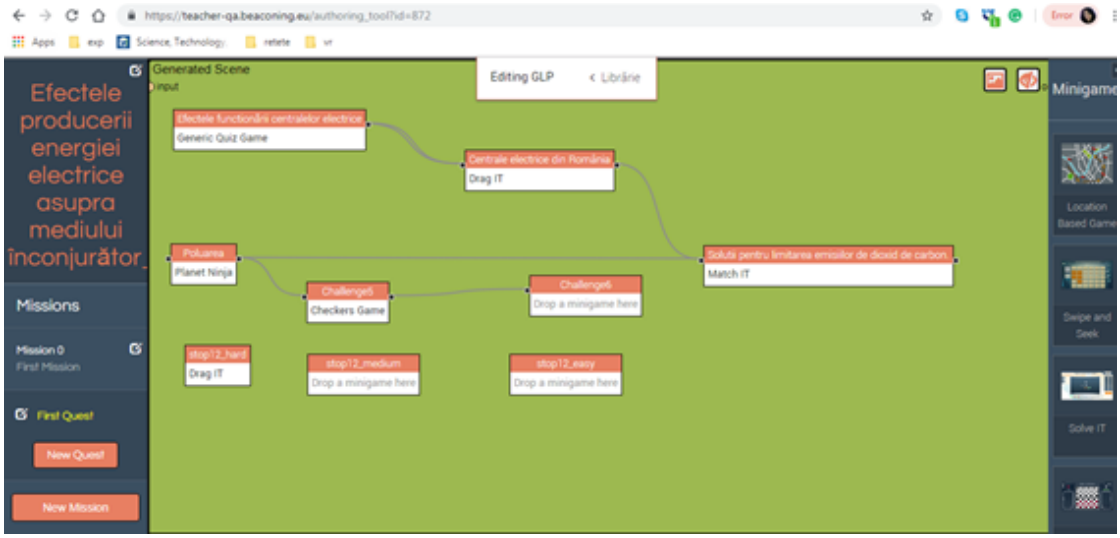


*Figure 1: GLP design*

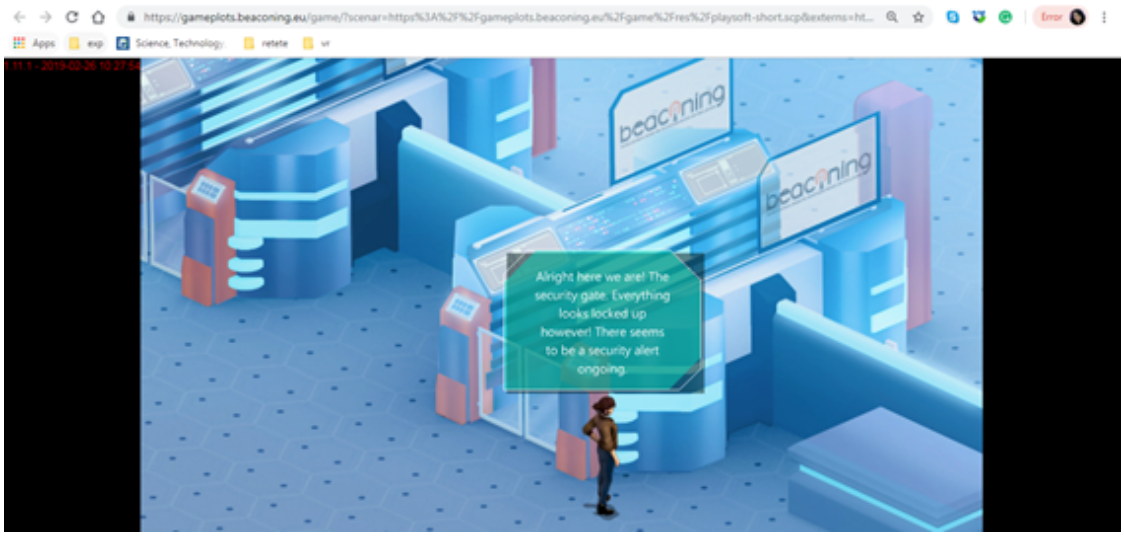


*Figure 2: 3D Scenario*

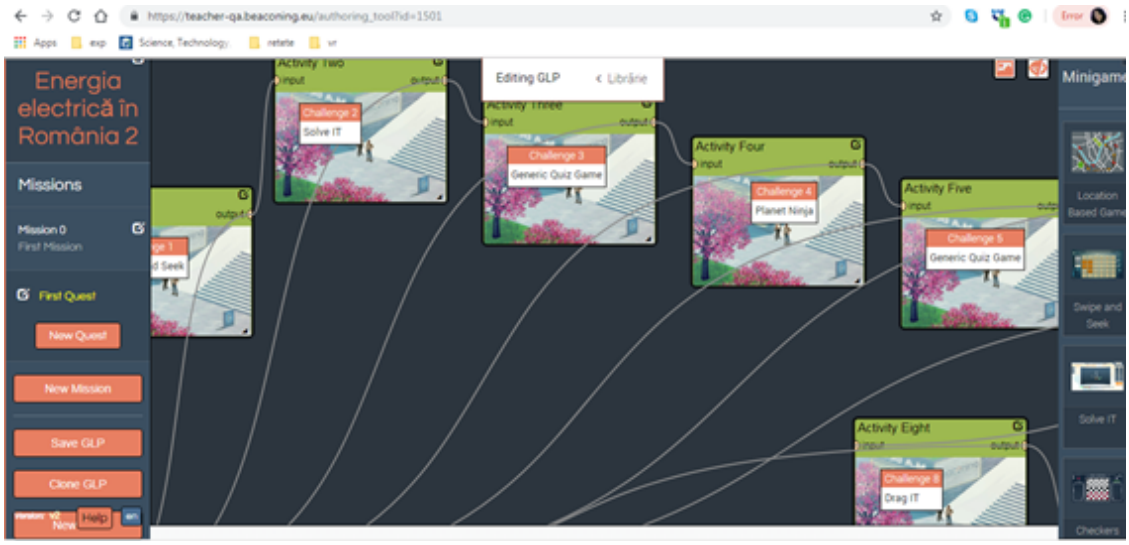


*Figure 3: Electrical energy in Romania – Physics- High school*

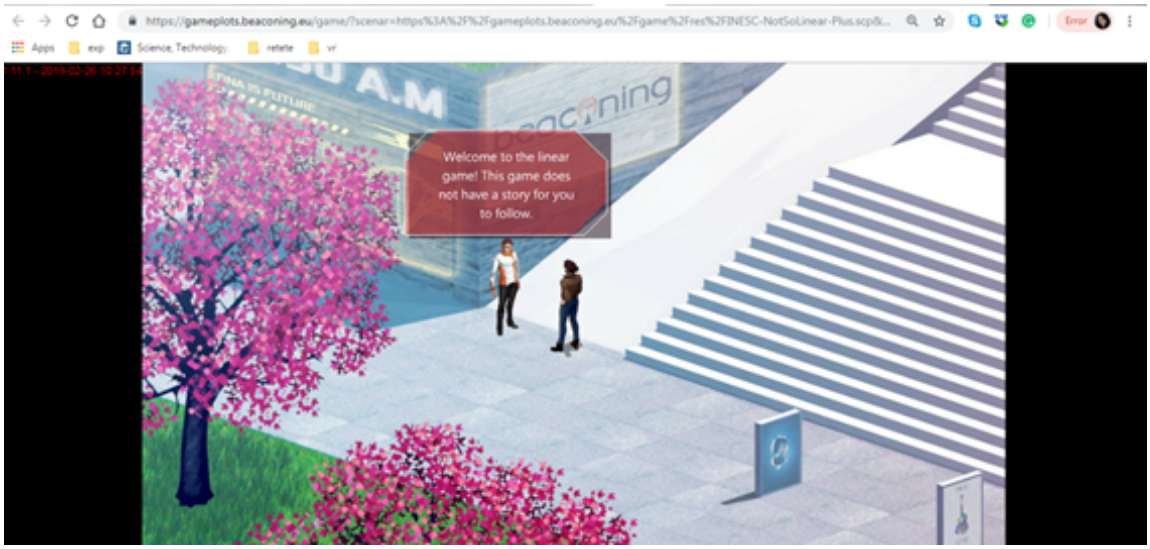


*Figure 4: Scenario dialogue*

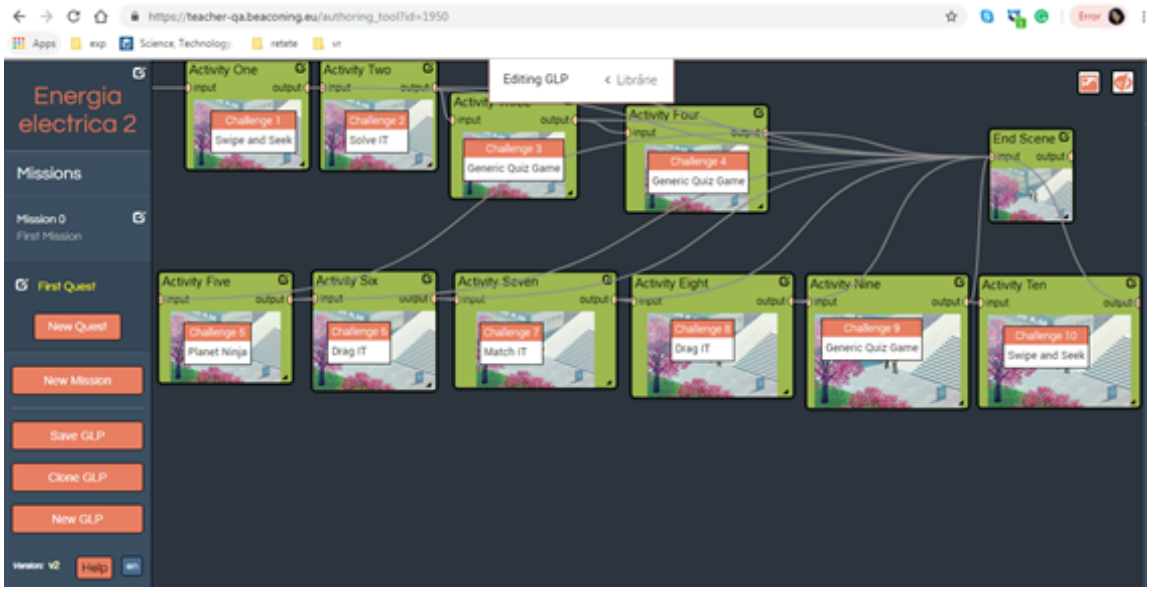


*Figure 5: GLP Activities*

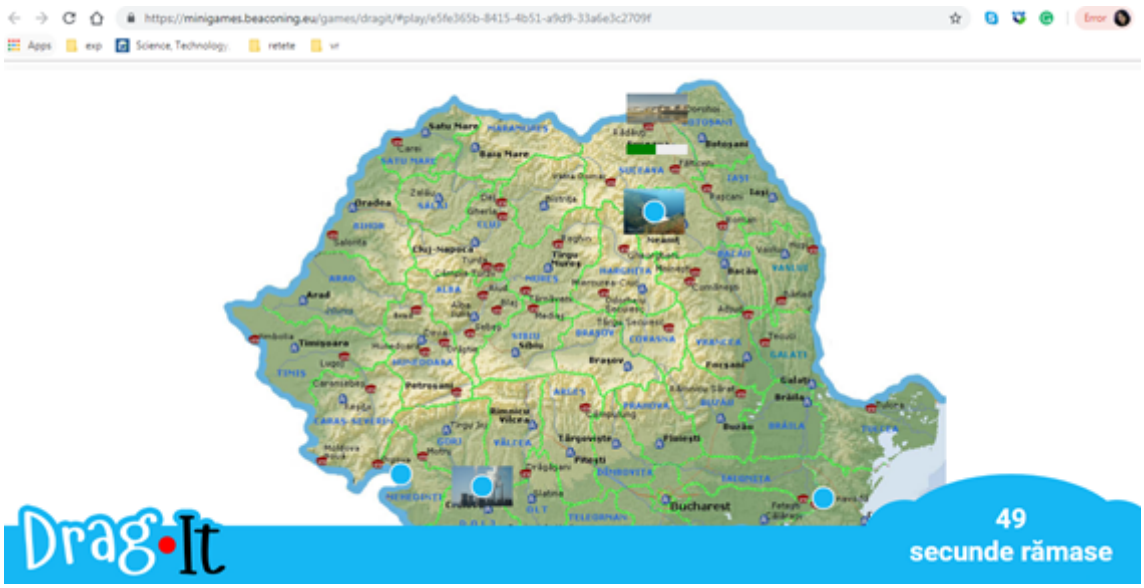


*Figure 6: Drag It minigame*

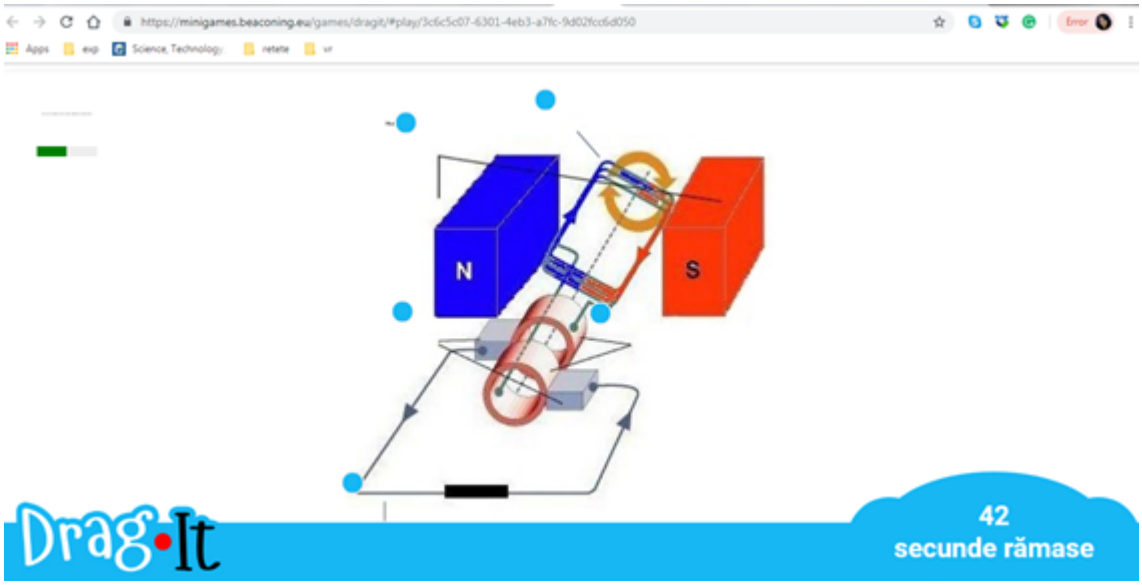


*Figure 7: Electrical Energy demo lesson*

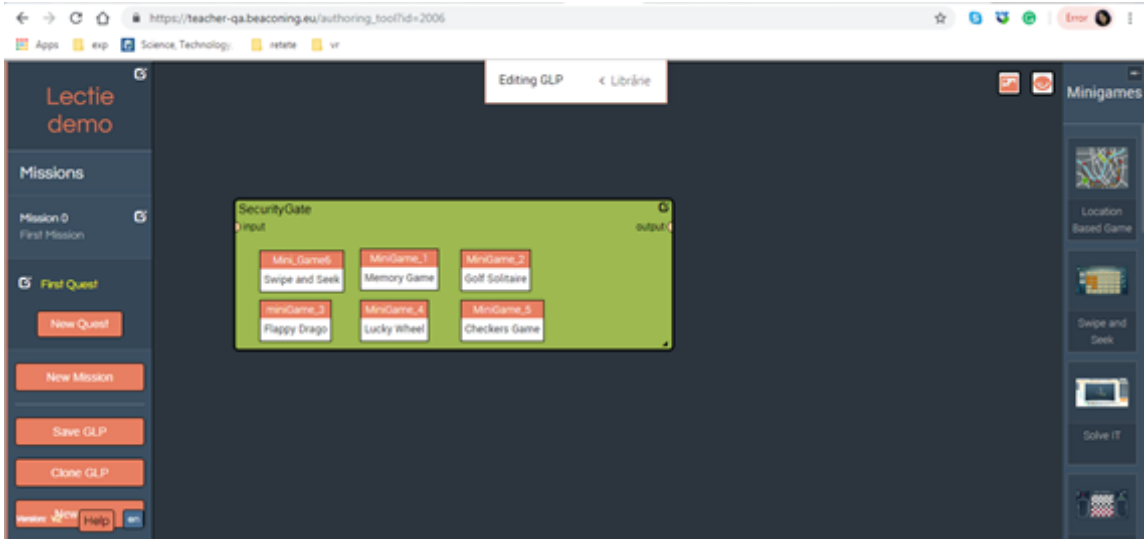


*Figure 8: Minigame selection for the Security Gate part of the scenario*


*Figure 9: 2D scenario screenshot*


*Figure 10: General knowledge test*

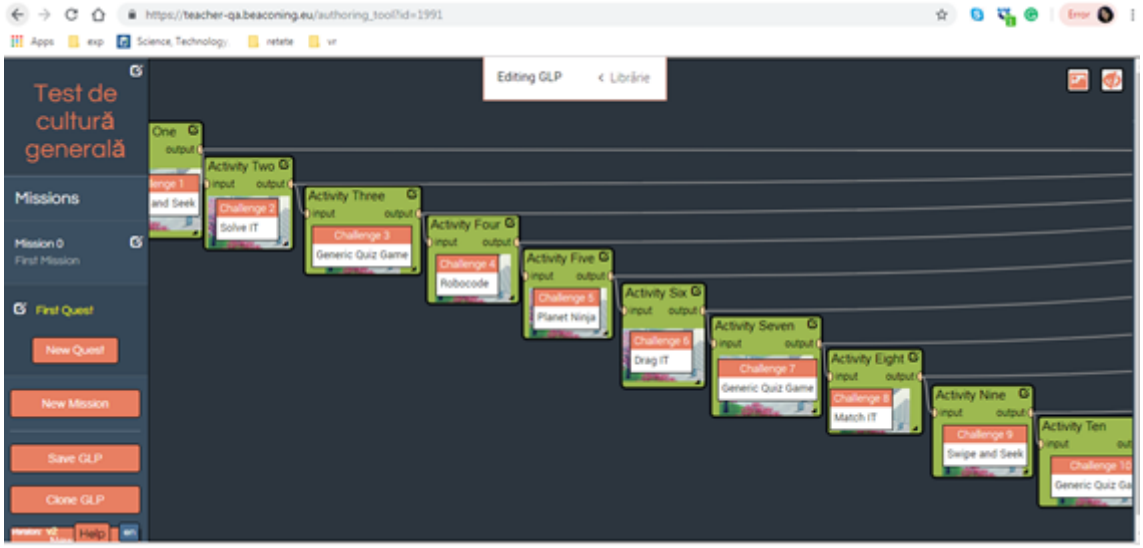


*Figure 11: GLP activities*


*Figure 12: Drag It minigame*


*Figure 13: Match It minigame*

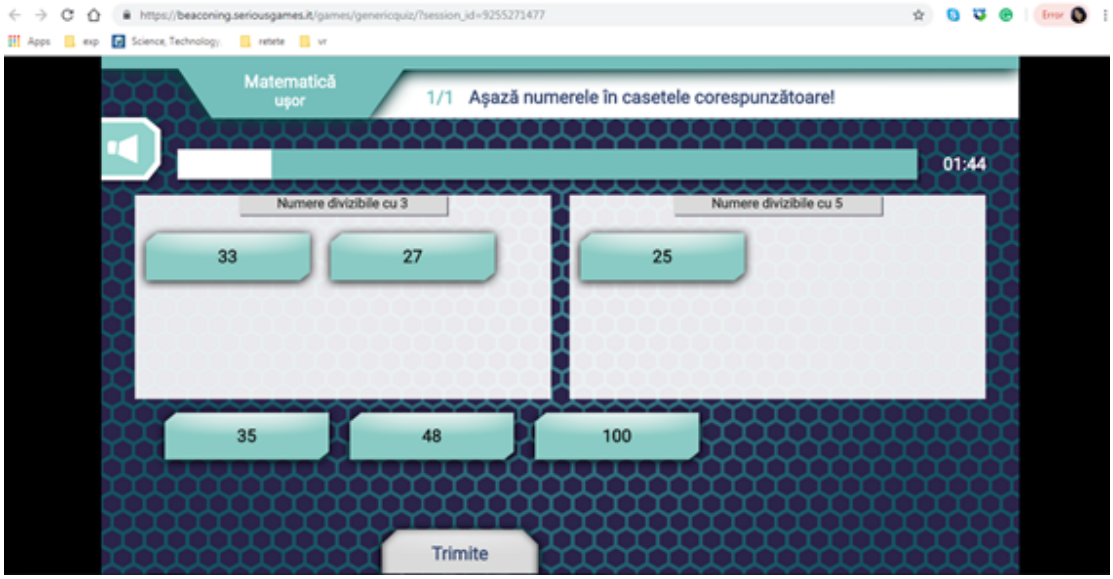


*Figure 14: Generating electricity quiz*

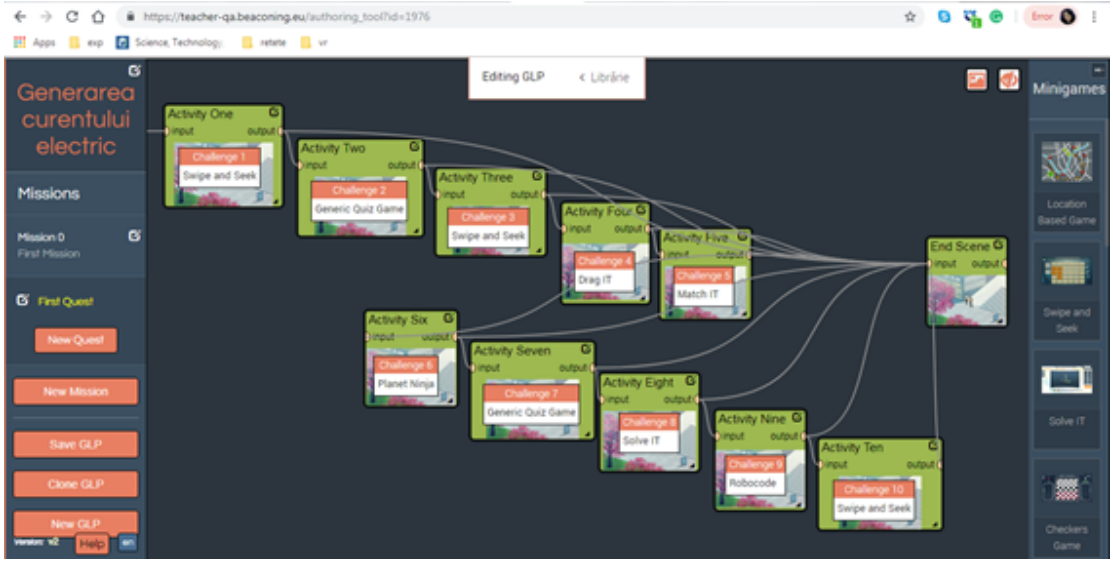


*Figure 15: Branching activities GLP*

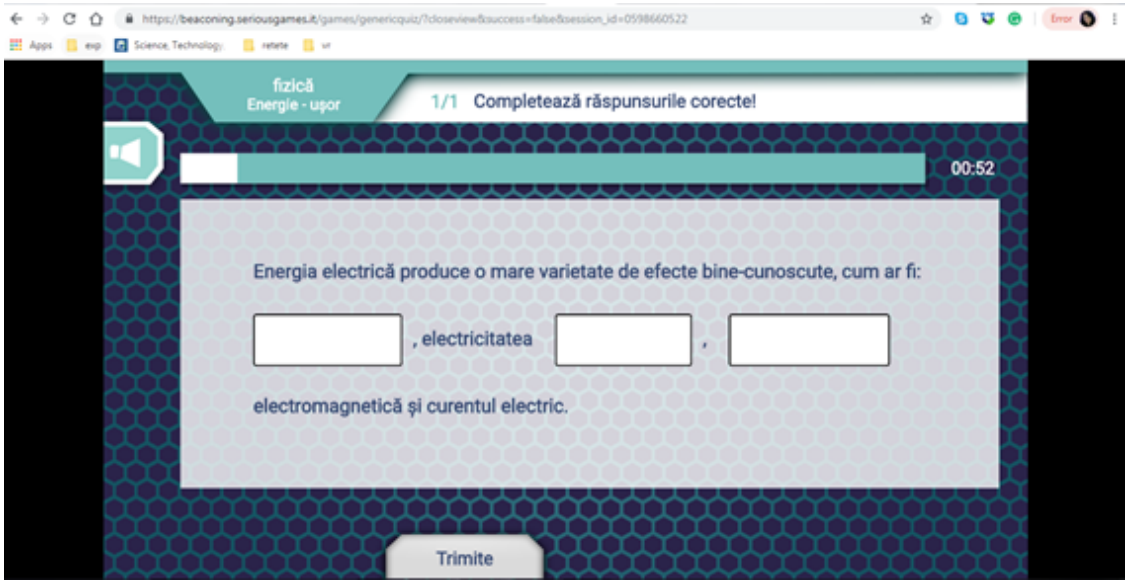


*Figure 16: Fill in the gaps minigame*

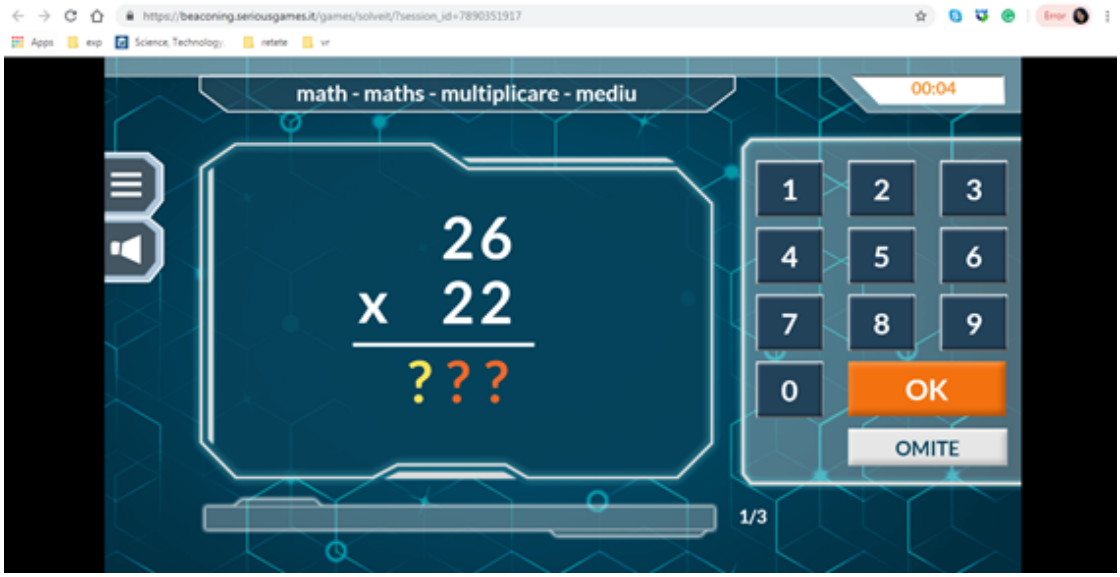


*Figure 17: Find the maths solution minigame*

### 3.1.2 Heriot-Watt University (HWU)

Features to a successful vocational pedagogy begins with realizing that VET is largely an experiential learning experience, i.e. hands-on methods are fundamental to learning. While pedagogical techniques and approaches are subject dependent, there is still a requirement for STEM, theory, feedback and reflection. The ability to apply learned material in one context to another is evidence of competency and knowledge transfer.

**CREATING A VET GAMIFIED LESSON PATH (GLP)**

All VET GLPs are designed from learning outcomes specific to a VET course or program, in this case stone masonry. They follow the requirements of SQA (Scottish Qualification Authority) and the NOS (National Occupational Standards). Both standards are required for VET level accreditation and they specify UK standards of performance expected knowledge and skills in stone masonry to perform effectively. The GLPs implementation adheres to the COSVR195 guidelines (18), a UK National Occupational Standard for people working in the occupational area of stonemasonry and can be used by operatives, supervisors and managers.

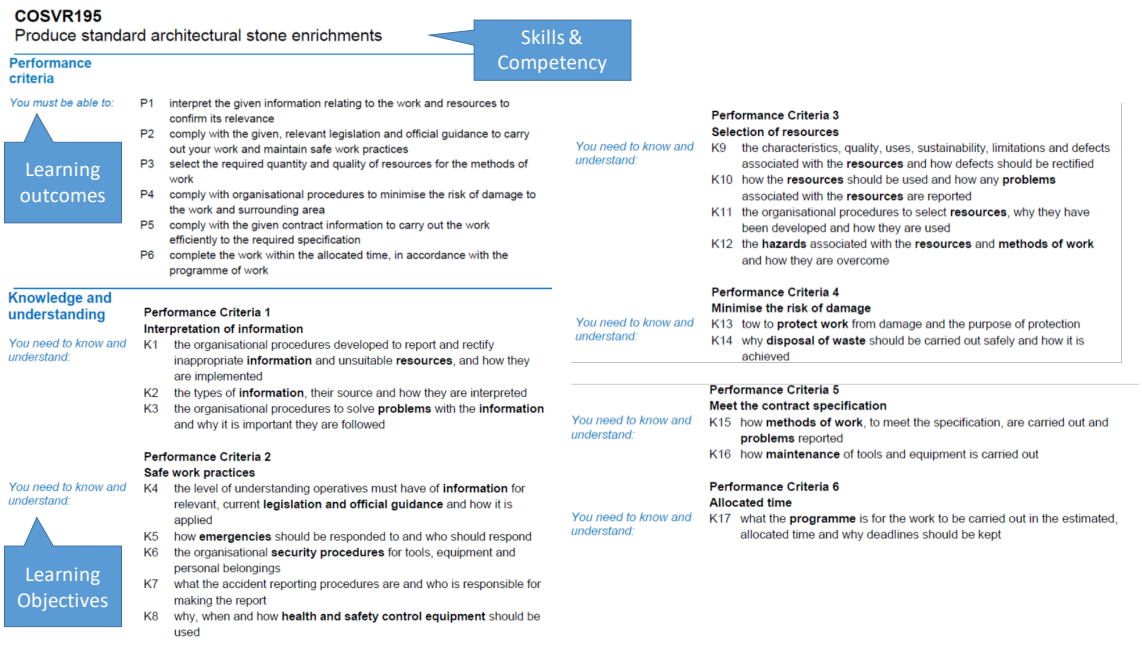


*Figure 18: COSVR195 guidelines*

### *Translating/Adapting a lesson into a GLP*

- Identify and map the primary objective of the lesson. A narrative is useful here and can be drafted based from the existing course/program descriptor.
- Determine gamification, learning and pedagogical dimensions e.g. consider visual communications, sound, role-play, reasoning, affective development, empowerment, analytic and argumentative events, player-defined goals, feedback.
- Determine the range of activities and sub-activities in order to reach one or more learning outcomes.
- Activities comprise primary tasks (Mission), which are the equivalent of structured and sequenced subject material to be taught. Sub-activities (Quest) break primary tasks into secondary elements or 'bite size' learning units (mini-game). There can be a number of sub-activities; the recommendation is to consolidate where appropriate. This reduces the number of sub-activities while ensuring the learning experience has a better flow. Note: it is not necessary or a requirement to have sub-activities if the scope can be handled through a single primary task.
- Establish points of assessment. Assessments do not necessarily have to be continuous. Consider that certain skills and competency development require the use of props, proxies or other tangible interfaces. Consider if props/interfaces are integral to the learning content/context or simply an interactive activity to the gamified lesson path.
- Define the level and representation of Feedback. Establish if feedback is passive or active, summative or formative, continuous or staggered. Alternatively, is feedback to be visceral, somatosensory or a combination?

**Instantiating a new VET GLP**

Process storyboarding digital pedagogy for VET (and STEM in general) calls for two main prerequisites:

- The game itself must not be simply considered a vessel that supports the pedagogy, rather it and all external peripheries are associated to the learning goal or outcome.

- The lesson plans and delivery fully waypoint the learning objectives and continually reinforces motives that empower the learner.
- Five basic steps:
- Problem mapping: Establish the domain/vocation 'Mission'. Is the Mission cross-sectorial and are there accreditations to be met, i.e. education, professional body, industry? Who are the players? What is the Mission's goal? What is the supporting narrative that will lead to achieving the learning outcomes?
- Outcome: Is the outcome solely for subject mastery? If competencies lead, which competencies are mission and time critical?
- Assessment: When and where in the Mission must a criterion be accomplished? What is to be assessed? How is the assessment validated and what format is the evidence base?
- Challenge: Which/what pedagogical approach serves to empower the user? Which technological appropriation benefits context and content to deliver a lesson pathway that develops the player? How can cheating be limited or handled?
- Personalisation: What level of preferential adaptivity and customisation? What level of accessibility and security?

**VET GLP features**

General features:

- Create/Modify content and/or narratives
- Download/Upload content
- Save/Save As capability
- Continue/Recall functionality
- Search (on all elements and entities)
- Mind map/Crosslink/Network of GLPs with Missions/Quests/Mini games
- Status dashboards
- Communications (intra/inter)
- Configuration (view ports, menus, activity access and sharing, mini games)
- Auto platform detect, Language conversion

VET specific features:

- Support for IoT, CPS and other sensors
- Multidimensional data
- Geo-location: Field or workplace learning
- Blended/Augmented/Alternate reality environment logging

**Example**

Health and Safety controls for 9" Angle Grinder in stone cutting use. Mission D: Quantification of resources, trade skills, STEM.

Quest 1 - Player enters the scene and is greeted with a stone on a pedestal, which needs to be shaped. Player then interacts with tools, stone and scene to start the activity.

Authoring requirements: Able to specify a mini-game for a slot, to change the scene entities, the stone objective, the assessment objective and the narrative. Add/delete tools, alter dashboards, and information push (interactive resources) to the user.

Mini-game requirements: VET challenge from Imaginary that allows students to select stone and job objectives as required when solving the mini-game puzzle.

Quest 2 - The player reaches a new slot, where the activity defined is supposed to happen in real life. Before and after completion, the player experiences some more generic narrative content, which does not need to be customised.

Authoring requirements: To display content to users in a slot and for interactive devices, e.g. tangible interfaces, as learning material within the GLP. For example, this could be implemented in a way where some digital content is shown/accessed via a digital device. In this case, the content will instruct users to implement something using sensors to collect data of the environment, activity and task on their school computers, the workplace or at home.

Quest 3 - The GLP will present users with a new slot that combines Quests 1 and 2, dash boarding what they achieved on their computer as they work in a mixed reality environment.

Authoring requirements: Upload activity/data defined for a slot, sensor configuration, data streaming setting, assessment settings. Define where these uploads will end up (in a central storage, via email to the teacher, etc.).

# 4 ASSESSMENT METHODOLOGY

Design of data collection instruments for the assessment of the platform, taking into consideration the variety of end users as well as cultural and other considerations.

## 4.1 ASSESSMENT METHODOLOGY DESIGN

### 4.1.1 Design of assessment methodology for small-scale pilots by HWU

Two small-scale pilots were conducted at Edinburgh College and The City of Glasgow College on VET for stone masonry. Assessment format uses surveys, interviews and user trials. A system usability scale (SUS) report is used to convert qualitative data into quantitative data (see Section 6).

**ASSESSMENT PLAN**

The technology representing the GLPs are PC based and X-Reality based. X-Reality refers to an umbrella of different forms of virtualised capabilities. For the VET Game these were augmented reality (AR) and mixed reality (MR). In all cases, the PC version serves as a benchmark.

Small-scale pilot 1

The first small-scale pilots were conducted with the Personal Computer (PC) version and AR.

Protocol:

- Presentation of PC and AR versions
- Interface familiarisation (5 mins)
- Trials (20 mins) – General waste removal planning
- Questionnaire
- Interview
- Discussion

**Small-scale pilot 2**

The second small-scale pilots were divided into two sessions where one focused on PC and the other MR.

Protocol:

- Presentation of PC and MR versions
- Interface familiarisation (5 mins)
- Trials (20 mins) – Specific waste removal plan to reproduce a dogleg profile
- Questionnaire
- Interview
- Discussion

### 4.1.2 Design of assessment methodology for large-scale pilots by SEBIT

**Use Case 1: Playing a GLP that has no geolocation mini game at the Computer Lab**

Technical Validation: During sessions the game has frozen on some occasions and students killed the browser screen or pressed the back button or reload button to kick it off and they lost all the advance they had in the game. They had to restart. The development partners were informed, and these issues were fixed at the next version of the system.

Students with Disabilities: There was one student among the group who had attention deficit. Being a part of an immersive activity with his class mates positively affected this student and he successfully completed the game mission.

Usability Evaluation with the Teachers: Teachers were asked to complete a survey, at which they completed open ended sentences about their experience.

Usability Evaluation with the Students: The standard "Technology Acceptance Model Version 3" (TAM3) was used for evaluating the "intention to use." Observe in Deliverable 6.1 Section 4 that this model has a set of hypotheses on which factors positively relate to the intention to use. The data to confirm/deny these hypotheses in the given use case of BEACONING was collected using a standard TAM3 Survey (again refer to D6.1). TAM3 is shown to have largest explanatory power among all acceptance theories. The main hypothesis of TAM3 are as follows:

H1. Perceived ease of use will have a positive effect on attitude towards using BEACONING

H2. Perceived usefulness will have a positive effect on attitude towards using BEACONING

H3. Perceived ease of use will have a positive effect on perceived usefulness

H4. Attitude will have a positive effect on intention to use a BEACONING

Where:

Perceived Usefulness refers to the regards of students about the educational value of the product. For typical technology products Perceived Usefulness is shown to be positively influenced by Result Demonstrability (H5), Job Relevance (H6) and Output Quality (H7) among others

And perceived Ease of Use refers to the regards of students about how easily they gain control of the system. System Anxiety (H8) , Self-efficacy (H9), Perceptions of External Control (H10), Information Quality (H11) and Perceived Playfulness (i.e. Flexibility) (H12) influence the perceived ease of use.

**Use Case 3: Playing a Geolocation Game at the school campus with mobile phones**

Technical Validation: A few test runs were essential to determine if i) the PoI is on the map in case GPS is used ii) if there is a place to attach QR codes or iii) if the time allocation is reasonable (assuming some teams would make errors and go to a wrong spot). The game ran rather long, so some phone batteries drain. Those student groups were supplied with a power bank with BEACONING logo. The login credentials must be arranged with the hosting partner well in advance and a tracking code for the analytics service must be guaranteed. Since the students would participate in small groups, and the group info (who is teaming up with who) is not likely to be available prior to the event, the organizer may need to take notes on the spot. Finally, once a game is played on a mobile phone, phone cache needs to be cleaned to be able to play again.

Students with Disabilities: There were 3 students among the group who had attention deficit. They were matched and included within groups of rather older age. This configuration worked fine, and all 3 students participated without any difficulties.

Usability Evaluation with the Teachers: Teachers were asked to complete a survey, at which they completed open ended sentences about their experience. The outcome of this evaluation was as follows:

Usability Evaluation with the Students: The standard TAM3 was updated for evaluating the "intention to use" in the particular case of BEACONING game-based learning system. BEACONING Evaluation Framework makes use of Structural Equation Modelling which is a

statistical approach to discover what variables explain the variations on desired outcomes to what degree. The structural equation that will be used is named as the BEACONING Acceptance Construct, because the core of the construct is also adopted from TAM3.

Perceived usefulness refers to the regards of students and teachers about the educational value of the product. For typical technology products Perceived Usefulness is shown to be positively influenced by perceived quality of the product, relevance to studying (H5) and result demonstrability (H6) among others. Perceived quality may include the information quality (H7) and service quality (H8) of the product. Subjective norm is the external influence a user feels. It is moderated by experience and it effects the attitude towards using (H9) the technology.

Perceived ease of use refers to the regards of students and teachers about how easily they gain control of the system. Perceptions of External Control (H10) and Perceived Enjoyment (H11) influence the perceived ease of use. However, it's also shown that "cognitive absorption," such as that which is experienced during gaming also positively influence (H12) ease of use perception. Finally, "perceived playfulness" is considered as it is shown to positively influence the attitude towards using (H13) the technology.

# 5 SMALL-SCALE PILOTS

## 5.1 RESULTS AND LESSONS LEARNED FROM THE SMALL CASE PILOTS.

### 5.1.1 HWU – Pilot design and Summary conclusions of questionnaires and focus groups

VET GAME FUNCTIONAL ANALYSIS

Desktop, Virtual, Augmented and Mixed Reality

Four digital learning environments for VET skills in stone masonry were developed, each with specific interaction methods for that technology (**Error! Reference source not found.**). However, all learning content and aims are similar. Interaction is a key component to engaging with the digital content and thus a fundamental measure of linkage between pedagogy and usability. The common features listed below are to allow interoperability from both a technology perspective and for assessment.

Interoperability:

- Built using Unity3D
- Similar learning content targeted for stone masonry covering up to TVET Level 10
- Embedded requirements for course accreditation (SQA) and national occupational standards (NOS) in the GLP
- Objective measures of learning cycle captured with a data synchronisation framework
- Bayesian analytics and interaction response theory (IRT) implemented for control-display gain
- Execution modality
    - Beaconing GLP
    - Standalone

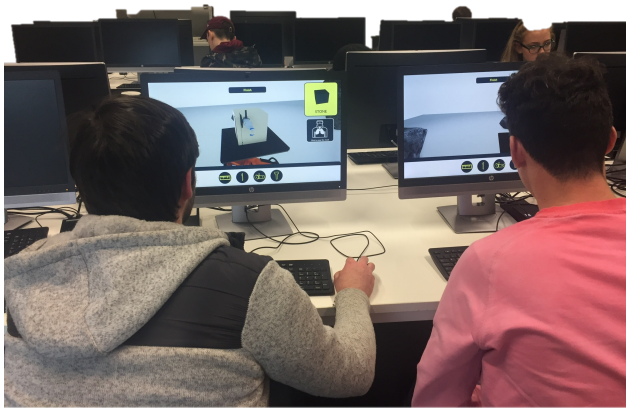

*Figure 19: Desktop version*

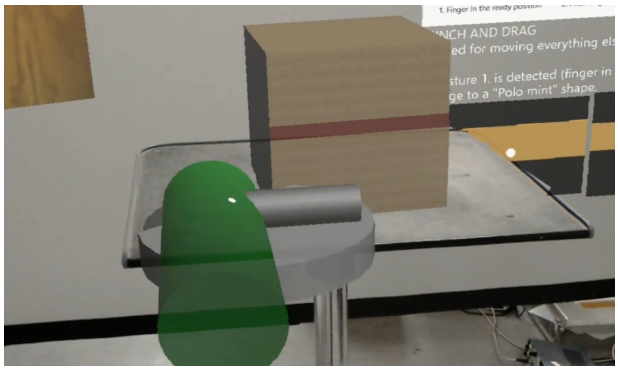


*Figure 20: Augmented reality version*

*Figure 21: Mixed reality with cyber-physical system version*

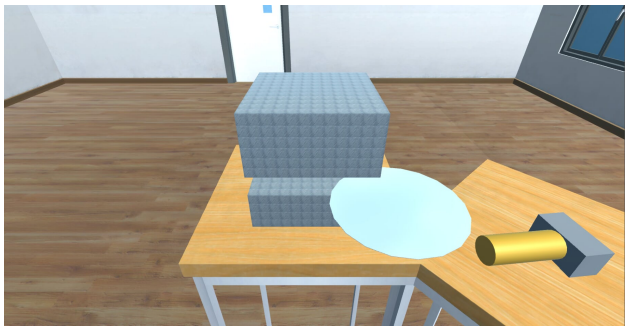

*Figure 22: Immersive virtual reality version*

**Interactive capability**

Specific interactive functionality implemented to enhance learning experience are only available for the virtual, augmented and mixed reality technology. Table 3 illustrates the interaction capability in each VET Game environment.

*Table 3: Interaction capability for VET*

| VET GAME environment | Windows, icons, menus and pointing device (WIMP) | Wands, Trackers, Haptic | Cyber-physical system, Real physical objects, speech |
|---|---|---|---|
| Desktop | ✓ | × | × |
| Augmented Reality | ✓ | ✓ | × |
| Mixed Reality | ✓ | ✓ | ✓ |
| Virtual Reality | ✓ | ✓ | × |

The most recent development is an immersive virtual reality VET GAME. This development has not undergone user trials but reported here for functional comparison and targeted as future work based on the feedback of the small-scale pilots and a needs assessment with the construction sector. The augmented reality VET GAME underwent early user trials and subsequently developed into the now current mixed reality version. The augmented reality version is available in the event mixed reality training is not required.

*Table 4: Approaches and observations for the VET game*

| | **Strong Points** | **Weaknesses of BEACONING or of the protocol of use of BEACONING** |
|---|---|---|
| **Pedagogical Approach** | Experiential learning by engaging with real world contexts, real-time problem solving and planning (tactical and strategic) | Clumsy interface with complex GLP design. Tools and functionality require competent content developer and not on teachers who are required to implement the required pedagogical necessities. Protocol is well received however issues raised on pedagogical purpose, accreditation and matching material. Concerns raised on the gamification used to embed learning and skills transfer. |
| **Methodological Approach : materiel, organization** | Learning outcomes based on VET national qualifications accreditation body and occupational standards. Different VET levels assessed | Direct link to beaconing LMS is limited under current architecture although GLP is launched from beaconing site. GLP design and test not |

| | | |
|---|---|---|
| | with the same GLP content. Content and assessment metrics easily changed to fit new standards and transferrable across different technology platforms. | intuitive. Visual programming of content and interactions is useful however; current default content is not suitable for VET other than the VET game itself. |
| **Others, Visions for FUTURE, Price questions: Are they ready to pay and How much? Which kind of pricing?** | VET academia and industry users praise the concept and implementation. Interest in the integration of VET Game with geo-location and other ICT capability. Subscription not discussed though comparison was made with Moodle. Overall students enjoyed the desktop and mixed reality VET game. | Issues raised on IP and data management of content and users. Concerns of interfacing with current systems in used. Questioned beaconing platform capability and capacity to operate with same quality as industry standard moocs offerings and systems such as Moodle. |

**Pilot Observations**

*Table 5: Pilot observations for the VET game*

| Observation | User feedback | Action |
|---|---|---|
| Teachers at all venues were responsive to the PC version but not all were adept at using the UI tools | Some help needed to work the UI, perhaps a short frontend tutorial | UI control information provided in splash page prior to actual GLP execution |
| PC based GLP authoring and testing complicated | Authoring GLP is complex and unintuitive; not designed with teacher in mind; requires understanding of game-based pedagogy; useful for setting up the Magistrates' Court Qualification (MCQ) level but is laborious; geolocation is the best feature; unclear how to set up and delete content; limited resources in the editor; VET game not tied in fully to LMS and cannot be launched from site; overall concept is good but implementation needs work; approved how SQA and NOS | Reported needs. |

| | | |
|---|---|---|
| | were implemented in the scoring | |
| Teachers at all venues were highly receptive to the MR version | Brings more reality and connects content and context more effectively; would like to have more functionality in terms of grinder kick back and cutting feedback; would like more responsiveness from the UI; addition of and ease of editing the environment; unsure about mass usage in curriculum; familiarisation to actual work practice is clear but need to get use to interface gestures; | New updates to the Hololens have addressed some of the issues raised; implemented new tracking methods to improve responsiveness and user interaction |
| Teachers generally preferred the MR based GLP to PC version. However, all agreed that either format would be a step change in VET | Able to relate SQA and NOS foundations better than PC version; able to connect learning material to learning outcomes better; better understanding of planning strategies; feedback based on actions is more comprehensive; like how assessment and feedback is instantaneous | Outstanding issues:<br>- unable to edit via authoring tool<br>- unable to launch or connect to LMS<br>Current running as standalone is acceptable by the FEs |
| Students at all venues were able to familiarise with the PC version within an average of 6 minutes. | Easy to understand GUI and interaction requirements. However, certain UI functions were limiting their ability to concentrate on the task | Improvement to UI relayed to Imaginary based on user feedback. Tools such as marking up the model, placement of grinder and path plan overlays were implemented |
| Students found the PC GLP meaningful in general but raised concerns on level of learning implemented | Did not find experience stimulating even though process resembles real world; prefer to work with real tools if there is a choice; content currently is limited although the learning pathway is clear; will enjoy more when there is greater content and functionality; happy to use again or for daily learning; like the | To focus on content in future versions, Gamification mechanisms will need to be improved engagement and enhance the play-learn experience |

| | | |
|---|---|---|
| | dashboard and cutter planning overlays for feedback | |
| Students at all venues were receptive to the MR version indicating that would be their preferred choice in class and lab activities | Preferred learning experience with MR; liked that model and interaction is 360 and in 3D; Able to connect to real-world experiences so learning is more meaningful because real tools can be used; would like to have grinder feedback in future; some interactions response slow | Continue to develop MR version. Implemented control-display gains to improve interaction response. New firmware updates expected to resolve other issues. |
| MR based GLP received better by students than PC version | Able to connect better with the taught material; Understand the waste removal planning process better; Found interaction more natural and engaging; would like a dashboard and planning overlays post exercise; | Dashboard to be implemented |

#### 5.1.2 SEBIT small-scale pilot

**PILOT STUDY 1.1**

**Date**: May 2018

**System Version**: 1.0

**Context**: This study was among the small pilots and involved 25 students of ages 11-13 of a private school in Ankara. The GLP was created together with 3 teachers who also had a chance to experience the authoring tools and the BEACONING ecosystem. An Earth-Space Agents plot was selected (Save the Boss) as the meta game and the mini games was about the Science topic: "Humans and their Environment." The plot was about a sabotage on the diesel engine of the agents' premises and the contextualisation is made by relating this event to the pollution caused by the engine and activities. The study time lasted around 40 minutes (1 class hour) and it took place during school hours.


*Figure 23: Private school pilot study*

**Technical Validation**: During sessions the game has frozen on some occasions and students killed the browser screen or pressed the back button or reload button to kick it off and they lost all the advance they had in the game. They had to restart. The development partners were informed and these issues were fixed at the next version of the system.

**Students with Disabilities**: There was one student among the group who had attention deficit. Being a part of an immersive activity with his class mates positively affected this student and he successfully completed the game mission.

### 5.1.3 ORT small-scale pilots

*General overview*

The small-scale pilots have been conducted in France with the seven ORT French schools and other stakeholders. The objective of that first round of piloting was to train stakeholders and do some first experimental teaching with beaconing to get at the end some experience and then be able to conduct successfully the large-scale pilots. The pilots have been organised between August 2017 and September 2018, considering the different fields of each School, and also encouraging the exchanges between all the stakeholders, management and teachers involved. More precisely, in France the pilot's activities were organized in the ORT France schools covering four different regions of France: Île De France (Montreuil, Villiers le Bel, Choisy Le Roi), Rhone-Alps (with Lyon and Marseille), Alsace (with Strasbourg) and Pyrenees (with Toulouse), and also in the whole country with the participation of diverse stakeholders.

The small-scale pilots were decomposed and held into consecutive steps:

- Step1
  Some general Information about the project and ORT's involvement has been given to the head management of each school during a Management Comity. The main goals of BEACONING have been explained and a central plan devised for setting up the small and large-scale pilots in the different schools. This meeting took places in Paris at the seat of ORT France. Consecutively the head management transferred all the relevant the information to their teachers' teams, along with an invitation to participate to the small-scale pilots.

- Step2:
  A workshop has been organized at the seat of ORT France in order to explain the BEACONING toolset directly to teachers in a face to face fashion. It was the very first use of the BEACONING platform by teachers In France. Some scenarios had been already

prepared in advance by our team, to show some examples of how courses could be developed with the platform. Two fields were tackled: Basic Algebraic Skills and Digital Literacy. This workshop took place during 2 days, the 30 and 31st August 2017 and 60 Teachers from all the 7 schools attended. They all came from diverse fields and background and the face to face interaction prompted some very interesting exchanges about what the teachers wanted and desired. The BEACONING platform was still under construction so they had more of a glimpse of its possibilities than a real access, but they gave precious feedback to improve the project, especially in regards of pedagogics.

- Step3:
  Teachers having participated in the above workshop and being motivated began working on their own about different possible scenarios adapted to their teaching. Contact with the teachers was kept by using Skype and email.

- Step4:
  Teachers participated to a new face to face workshop at the beginning of January 2018 in Paris, for one day. They discovered a new version of the BEACONING platform, much improved since last workshop. They were given explanations about geolocalised quests and how to use them and also some information about the analytics and tracking elements.
  From now on, the small-scale pilot turned around the three following phases: first informing teachers about the project and have them reflect about how to adapt it to their teaching, second presenting and using the first set of available BEACONING tools and finally engaging their own students with the resulting GLPs.

As the maturity of the BEACONING tools took some time to reach a satisfying level for classroom deployment, the third part of the aforementioned process was postponed in several occasions. During this time the teachers have been trained to use the BEACONING authoring tools and encouraged to create gamified learning paths for the students. A special focus had been made on the pedagogical added values brought by BEACONING in teaching with gaming using PBL (Problem Based Learning) approaches.

As outlined in the deliverable D6.2, different goals were targeted during this time:

G1 – Test the scalability of the BEACONING technology

G2 – Test the integration of BEACONING to national platforms and local platforms (such as LMS installed inside the schools)

G3 – Test standardization offers of BEACONING

G4 – Validate the learning outcomes of BEACONING play-lesson paths

- Analytics for STEM Competencies
- Inclusion of special needs students
- Radical Scenarios

The following table summarizes the efforts in reaching G1 and G4 (as G2 and G3 were more complicated to test given the maturity of the platform).

*Table 6: Efforts required for reaching G1 and G4*

| Goals | G1 and G4 |
|---|---|
| IMPLICATED SCHOOLS | 7 Schools in ORT France: Montreuil , Villiers Le Bel, Choisy le roi, Marseille, Toulouse, Strasbourg, Lyon |
| Number of trained Teachers | 60 |
| Number of Students potentially touched during the sl and large-scale pilots | 800 |
| demographic of students engaged | State school students ( 10 – 20 years old) |
| Other stakeholders | Academia of Versailles schools<br>and other educational stakeholders |
| Context | Once the ORT BEACONING platform had been finalised (version 2) the French schools had their own access to the different tools and could pilot their own different activities |
| Technical Setup | Own BEACONING platform (France) had not been integrated to the LMS of the ORT schools because many corrections were done. And the choice had been made to wait till the modifications and improvements were finished to organise it. Then the Small-Scale Pilot had been made from the consortium server. |
| The lesson path | The lessons paths designed by ORT in WP3 and WP4 had been taken as examples and the Teachers worked to adapt the scenario to their own class, and students, and field. |
| Evaluation Tool | Focus Groups during the Small-Scale Pilots and feedback with proximity exchanges with the BEACONING TEAM, via Skype, email, and Telephone. |
| National Coordinator | ORT |
| Inclusion | Some ORT schools had Students who belong to inclusion category, especially ORT MARSEILLE and ORT MONTREUIL. |

The objective of this testing had been to prepare the teachers to be accustomed to and familiar with BEACONING in order to use it as quickly as possible during the second round of large piloting activities.

ORT also held many different small-scale pilots that were not foreseen or scheduled originally in the DOA because ORT was in contact with many different stakeholders and thought it was an interesting idea to enlarge the scope of the teachers outside of uniquely ORT schools.

This table summarises the different small-scale pilots conducted by ORT in France.

*Table 7: ORT small-scale pilots*

| Number | Computer (c) / Quest based (q) | Name of all the small-scale pilots by ORT in France | nb Teachers or Students |
|---|---|---|---|
| 1 | cq | Training ORT teachers. 2 face to face workshops at the ORT France seat and many conference calls and meeting with different teachers | 60 |
| 2 | c | ORT Montreuil experiment with Mr Igal and his students in the class of 'seconde', in the context of molecular biology classes, October 2018 | 50 |
| 3 | cq | Face to face meeting at the 'Forum des Enseignants Innovants', February 2018 | 60 |
| 4 | q | ORT Pilot in Marseille with CANOPE Atlan using geolocalized quests, May 2018 | 50 |
| 5 | cq | Workshop during the seminar 'Classe Inversée' in the framework of CLIC 2018, 29/06/2018 | 60 |
| 6 | q | Presentation at the fair Futur en seine June 2018 | 50 |
| 7 | q | ORT pilot 'Quête Journée de Rentrée C1', September 2018 | 200 |
| 8 | cq | ORT Canope with the teachers Lachise, Xavier and Aubrun for the class of 3eme, in the context of Biology classes 27/09/2018 | 20 |
| | | **TOTAL** | **550** |

**Details on the presented small-scale pilots**

The pilot referred as number (3) concerned a special group of teachers participating in 'Le Forum des Enseignants Innovants'. The participating teachers were all already very educated about new pedagogical technologies and likely involved with or presently using some of them. This meant it was a great opportunity to collect the informed feedback about BEACONING, even if it the teachers might not have been specialized in the GLPs available at this.

The pilot referred as number (5) corresponds to the experience of working with the CLIC 2018, by holding a workshop during the seminar 'Classe Inversée' in Paris, at the 'Collège de France', under the supervision of the French Ministry of Education. BEACONING has been presented during this workshop to 60 teachers, all very implicated in the new pedagogical methodologies. A presentation of the different possibility to use BEACONING with a class was shown, and it insisted on the different possible scenarios of usage in the different fields of training. Then, the workshop detailed the technical aspects relative to of the use of the platform.

The pilot referred as number (6) corresponds to the 'FUTUR en SEINE' exhibition, in June 2018, at Paris La Villette, where 50 students came with their teachers and used a geolocalized quest pertaining to an environmental issue. The workshops were decomposed in different phases: at first an explanation of BEACONING and the objectives of a serious games and new pedagogical methods in general, then some practice by using the geolocalized quest inside the Exhibition truly gigantesque hall with the GPS detection, and finally exchange and feedback.

The pilot referred as number (7) corresponds to the use of a geolocalized quest during the Integration Day in an association with 200 young 19 years old, in September 2018. During the

afternoon, the association used BEACONING to create a team building opportunity for the new promotion of students. The quest had been organized to last 2 hours, to take place around the headquarters of the association, with groups of 6 students per available smartphone. One adult was available per team to monitor the evolution of the students in the street.

The pilot referred as number (7) corresponds to the small-scale pilot ORT organized with the stakeholder CANOPE. RESEAU CANOPE is a network for creation of resources using new technologies and responsible for mentoring and training of teachers in order to help them better understand the digital transformation of their work as teachers in France. This network is working under the responsibility of the French Ministry of Education. (https://www.reseau-canope.fr/)

This event lasted one day and was held in Vanves, near Paris. The schedule was the following:

1h: Introduction of BEACONING, objectives and available tools, platform of the teacher
2h: Workshop for getting acquainted with the teacher's platform, study of a user case
1h: Workshop on quest creation
30': Testing of the games available on computer,
1h: Testing of the quest designed by each team using geolocalisation, walking around the building to get GPS detection.
1h: Feedback

The 20 involved teachers had the title of Mediators, meaning that they were active mentors in the CANOPE network. This gives an opportunity for them after this session to train many teachers in their own department of the Region Île de France.

The pilot presented above, referred to as number (4), corresponds to a training day similar to the CANOPE one happening in Vanves. During two days, 50 teachers were taught how to use BEACONING using a similar programme to the one used in Vanves. The quest they were tasked to create was on the theme of organizing the visit of the city of Marseille, using geolocation through GPS to go from one interest point to another, with the opportunity to answer minigames at each stop.

*Results and lessons learned from the small-scale pilots.*

As small pilots took place during a time software was in a very early stage and before questionnaires could be drafted, there was no formal questionnaire used. Discussions and focus groups were the preferred method to gather feedback and information about how the public and target groups perceived BEACONING.

Summary conclusions of **focus groups**: What do we learn from this pilot?

*Table 8: Focus group conclusions*

| | Strong Points | Weaknesses of BEACONING or of the protocol of use of BEACONING |
|---|---|---|
| Pedagogical Approach | Allows the teacher to open a new dimension in their teaching (geolocalisation)<br><br>Allow the teachers to raise the interest in the course (gamification)<br><br>Allows the students to regain interest into the course (games + gamification)<br><br>Allows to reach all type of learners, especially those more tuned to dynamic types of learning | Difficult to transfer a whole course, tool is more adapted to small-scale lessons<br><br>Teachers are not used to gamify and gamification in general<br><br>Lack of flexibility of BEACONING tools, there are only a limited amount of them (mini-games)<br><br>Lack of flexibility of available game scenarios, there are too few of them covering only certain cases of courses<br><br>In general lack of flexibility of the BEACONING solution to cover all possible existing courses |
| Methodological Approach: materiel, organization | The teacher can easily adapt its course to many different types of students and learning approaches<br><br>BEACONING only requires a Wi-Fi access and nothing else without any installation (not fully true for mobile) | BEACONING requires the students to have enough smartphones, charged, with the right software (QR code reader) and able to connect to a network.<br><br>Lack of support for complex mathematical and physical formulas |
| Others, Visions for FUTURE, Price questions: Are they ready to pay and How much? Which kind of pricing? | Difficult to have any clear vision of adoption and pricing after small-scale pilots and focus groups, users need more time with the product in their hand | Difficulty of integration of BEACONING into the existing pedagogical software infrastructure<br><br>Adds another layer to the already sometimes complex toolbox of teachers |

Pilot Observations

*Table 9: Pilot observations*

| **Observation** | **User feedback** | **Action** |
|---|---|---|
| Problems with minigames | Unable to display images in quiz minigames | Fixed by the relevant partner, bug declared through the Mantis bug feedback system |
| Problems with minigames | The displayed images/videos were too small on low resolution like mobile devices | Fixed by the relevant partner, bug declared through the Mantis bug feedback system |
| Problems with minigames | Using some videos might have been cumbersome | Uses can now only select a part of a video to display in a minigame |
| Problems with game scenario | Some game scenarios didn't close properly | Fixed by the relevant partner, bug declared through the Mantis bug feedback system |
| Several issues with drag and drop minigames | Those minigames were not displaying properly | Fixed by the relevant partner, bug declared through the Mantis bug feedback system |
| Several issues were plaguing the teacher BEACONING interface | Search would net wrong results, navigation was cumbersome, problems in loading times | Fixed by the relevant partner, bug declared through the Mantis bug feedback system |
| Several issues were plaguing the teacher BEACONING GLP editor | Display issues, save issues, loading issues, minigame editing issues. | Fixed by the relevant partner, bug declared through the Mantis bug feedback system |
| Several issues were plaguing the teacher BEACONING Analytics | Tracking was not working properly | Fixed by the relevant partner, bug declared through the Mantis bug feedback system |
| Several issues were plaguing the student BEACONING interface | Calendar issues | Fixed by the relevant partner, bug declared through the Mantis bug feedback system |

### 5.1.4 Coventry University small-scale pilots

Coventry University is in the process of running a series of small-scale pilots within the University and with stakeholders from CU Coventry (CUC) the University's partner HE College and from local Primary and Secondary schools. The pilots cover a range of subject areas, contexts and types of GLP. The Coventry pilots have been adaptive to ensure inclusion of any User Cases only minimally included by other partners and to research areas deemed complementary with potential to add value to the tests proposed by the main pilot partners:

- Address of User Case 6 (UC6): ' Teacher Configuring a GLP for Assigning to Class' by focusing on the authoring of GLPs by non-programmer teaching and trainee-teaching staff, including the development of easy-use quick guides, sample GLPs to inform teachers' approach to authoring, training model and support programme for teachers using the platform to then assign and run these GLPs with their students or peers and which include scenarios of UC1, UC2, UC4.
- accessibility testing by teachers and students including teachers of Special Education Needs (SEN) students, and Undergraduate students from the University's Disabled Student Community
- developing a work flow for student contribution of narrative artwork for the creation of new gameplots, by directing and managing content creation with two student interns from the University's Illustration/Fine Art and Illustration/Animation BA(Hons) courses
- creating different narrative structures of gameplot meta-narrative (Basic, Linear and Interactive) as exemplars for use by the BEACONING consortium in the small- and large-scale pilots, and conducting our own research on the effectiveness of these structures in support of player experience

This report focuses on small-scale pilot work completed during the 'educational pilot' period of the BEACONING project, September – December 2018, and how it has informed Coventry's ongoing small-scale pilots from January-April 2019.

Approach:

In order to address the above bullet points, meetings were held with new and existing contacts to gauge interest in the pilot and establish the type of User Case that could be piloted in a range of stakeholder contexts. The approach to the pilot was thus a hybrid combination of responsive to the macro context of European pilots, proactive, emergent and responsive to the micro context of local stakeholders.

Interested parties were recruited to attend a 3-hour BEACONING training workshop on 12th November 2019, with a follow-up session on 3rd December. Training Participants included a CUC IT lecturer, 4 Coventry University Modern Language lecturers and an Innovation Project Manager, a visiting scholar in gamification and a recent Masters graduate working in Environmental Psychology who had used an early iteration of the location-based games in her research with a local SEN school. Teachers from that school were invited but unable to attend.

Schools were not targeted in this initial round of training.

Changes from D.10

The proposed plan from D.10 was to install BEACONING locally to meet requirements of an intended partner SEN school. However, as BEACONING was not yet ready for local installation, this testing partnership was no longer viable.

Instead, we contacted the SEN school that a former Masters student of the University had worked with in her Environmental Psychology research, using an early iteration of location-based games. Riverbank Academy deputy head, Jayne Heavey, expressed interest in staff developing their own location-based challenges using QR codes. The school had recently begun to use QR codes as a way of accessing media evidence of student learning, so some staff were already familiar with QR technology. We have worked with the deputy head to tailor training to the school's needs, providing on-site workshops and support for 3 staff to each create their own location-based challenge for use within the school grounds, during the January – April 2019 period.

Case Study: CUC Pilot

One teacher (CUC lecturer IT: Data Management) with an existing interest in gamification and prior experience of collaboration with the DMLL, was keen to start piloting within her next module cohort, commencing in November, and so 1:1 training was provided, with ongoing support for the teacher to learn the authoring platform and create 4 GLPs to use with her students at key points during the 6-week module. This training programme consisted of:

1 hour planning meeting

1.5 hours training session

2 hours training session

Support in classroom for four upto-4 hour lessons, to test and finalize the teacher's game plots and support student use of BEACONING GLPs.

In addition, the lecturer attended the training workshops, contributing feedback to the group on the game plots already introduced to her students.

Gameplots included Teacher – authored and Researcher authored for teacher, with desktop GLPs using the Professor Rob and Professor Tibia Basic and Linear Narratives, and a location-based game triggered by QR code, played inside the Lanchester Library which re-used minigames from previous GLPs as a revision tool, whilst also introducing students to the facilities available in the University Library.

CUC. Information Management, 3rd year undergraduates

- 20 students in total
- 3 Desktop GLPs trialed:
  - 18 educational minigames
  - 3 metagame narratives
- 1 LBG using QR codes trialed:
  - QR play, 12 locations, Lanchester Library
  - Re-use of minigames for revision
- Data collection:
  - observation, informal discussion, paper and online surveys, BEACONING analytics, focus group, teacher observation/feedback
- Analysis: Data from this pilot will be included in pilot data to be reported in D 6.4

Initial Findings CUC

- Teacher confident to author GLPs & LBGs
- Strong interest in cascading through all IT lecturers
- Best placement: Foundation & Year 1 students
- Clash with assignments for 3rd year
- Those who engaged enjoyed, especially LBGs

- LBG effective & fun – would like to extend into city
- Could imagine using GLPs in every lesson
- Ideal to support Open Access teaching

From September-December 2018 the Coventry pilots engaged with 13 staff and 23 students aged 18+ in a total of 6 planning meetings, 4 pilot sessions, 1 focus group, 2 training workshops, 2 one-to-one training sessions.

Initial Findings Coventry Pilots

- Interest from STEM and beyond STEM, across primary, secondary & HE
- Importance of co-creative approach to engage stakeholders
- Requests for teacher-authorable metagame and student authoring
- LBGs popular with staff and students
- Positive feedback on Accessabar
- Student narrative artwork produced characters with appeal and contemporary relevance which have subsequently been adopted by several of the partners in their promotional and documentary material.
- Partner feedback on the two initial Basic Narratives (Professor Rob Basic Narrative and Professor Tibia Basic Narrative) welcomed the straightforward linear structure (that includes 6 minigames in sequence) and character acting as a guide or mentor to the player, and the requirement for students to play a minigame up to three times if initially unsuccessful. Due to partner requests, a 'Step 2' Basic Narrative was created for each character, enabling teachers to reuse the Step 2 as many times as they want to, easily creating a series of GLPs with the same characters. Also due to partner requests, versions of the Basic Narratives were created in Turkish and French.

From the initial September – December 2018 pilots we learnt:

- the type and amount of support needed for teachers to run with (beta) platform
- Opportunities within curriculum, beyond STEM, beyond 16-24 age group, for embedding this kind of learning
- Inclusion and differentiation scope
- Feedback from students – minigame, metagame, narrative structure, platform, GLP/LBG

Additionally, preparations were made to develop pilots in the January-April 2019 period, which will engage with a further 19 teaching staff from primary and special secondary education and with students from primary and secondary schools and Coventry University.

During this period, we are working in partnership with staff and students from

- Coventry University: Disabled Student Community and from Modern Languages.
- Primary: Howes Primary School
- Secondary SEN: Riverbank Academy

Gamified Lesson Plans will be:

- Teacher – authored
- Student authored by trainee teachers

Beyond STEM – with a focus on language teaching, and opportunities drawing on the affordances of BEACONING to support curriculum delivery within primary and SEN secondary education.

GLPs will be played:

- On desktop and personal laptop in IT teaching rooms

- On mobile devices
    - beyond the classroom e.g. corridors and open areas within the Modern Languages building
    - outdoors e.g. Herb Gardens in school grounds

Data will be collected from teaching staff and University students via survey, observation and focus group.

### 5.1.4 BIBA University small-scale pilots

We have had 3 pilots carried out in the period from July 2018 till November 2018, in addition to several tests carried out with assistants and internal students. The pilots were carried out with external students as well as with students enrolled in a course on logistics at the University of Bremen (where we teach).

*Table 10: BIBA small-scale pilots*

| **Date** | **event** | **Target group** | **No. of participants** | **ILO** | **Learning objective of the event (besides testing the GLP)** |
|---|---|---|---|---|---|
| 16.07.18 | Summer School LogDynamics | Post graduate students<br><br>Operational research and logistics | 22 | Technologies in logistics | How to use games for teaching logistics |
| 09.08.2018 | Summe rschool Informatica and Ingenieurinnen | Teachers and Master students in engineering and informatics | 18 | Technologies in logistics | How to teach with games in STEM |
| 16.11.2019 | Master class | Master students<br><br>Production and logistics | 16 | Introductory to technologies supporting logistics operations | None, this unit replaced the normal introduction unit we have on the topic |

We used a GLP developed at BIBA on Logistics. We have currently two GLPs that we use for teaching purposes, but for the piloting we decided to use one. The reason for that is that we had twofold ideas for the piloting. First, we selected a topic, which can be taught to a broad audience, so that we could show how the same GLP can be used for different purposes and different target groups and how the GLP could be re-purposed. This was mainly done for creating more awareness among the PhD students and the professors, since all of them need to teach. The second reason for selecting the introductory to technologies in logistics, was that we had

inhomogeneous user groups, so that we could use the same GLP for people with good IT skills, but no logistics skills and vice versa. Furthermore, we would like to test if we could use the GLP as a replacement in our master course for the standard introduction (currently a lecture).

GLP- location based with 6 quests.

This lesson path gives an overview to inbound logistics from procurement of the goods till it is stored in the warehouse. The player will learn both about the process as well as how and which technologies can be used for supporting the logistics operation. The GLP is based upon that the players will explore observe, analyse and then learn from what they see. The game takes place within the BIBA production hall. The user has to physically walk through the hall and carry out the different processes (Procurement, goods receipt – taking goods from containers, goods receipt & RFID tags, goods receipt – checking volume/condition of pallet/photo for insurance, warehousing – storage types/shelve systems, warehouse strategies – FIFO/LIFO, etc.) in the BIBA hall. At beginning, the players receive a map with each stop. In order to proceed to next stop, they had to answer the quest correctly after observing and solving the problem. Each stop has either a Beacon or a QR code.

*Table 11*: BIBA pilot approaches

| | Strong Points | Weaknesses of BEACONING or of the protocol of use of BEACONING |
|---|---|---|
| Pedagogical Approach | Experiential learning by engaging with real world contexts, real-time problem solving and planning (tactical and strategic) | The GLP is not easy to change. It requires much more training than normally time for preparing a class, specifically because most of the teachers just teaches 1-2 courses a year, and therefore would not reach the competence level in dealing with the meta-game and how to connect it to the pedagogical approach. Important discussion was on why- most of the university teachers do not have a pedagogical background (in comparison to teachers in general). |
| Methodological Approach: materiel, organization | Learning outcomes based on curriculum of engineering students in logistics.<br><br>Experimental learning is well known teaching form; both students and teachers are open to use such forms. | It will be hard to connect the game play to the different LMS, however most participants meant it could be very useful to as a stand-alone version. |

| | | |
|---|---|---|
| | | Not useful on smartphones- too small |
| Technical issues | Works well on tablets | Problems with the connectivity. Sometimes not sufficient and then it has really bad impact on the learning outcome |
| The usage of quest | Works technically ok | Is perceived as a testing instrument and not for exploring. |

Pilot Observations

*Table 12*: BIBA pilot observations

| **Observation** | **User feedback** | **Action** |
|---|---|---|
| Teachers and PhD students played the GLP enthusiastic and explored a lot. | Even if it went well, it would have been preferable to have a better introduction to before (tutorial) perhaps a short frontend tutorial | information provided in splash page prior to actual GLP execution |
| GLP authoring and testing complicated | Authoring GLP is complex, is not intuitive nor is it based on the need of the teachers. Requires too much understanding of computer science. The professors and PhD students coming from this area reported much less problems with the authoring tool | We look at how we can improve the guidelines for how to change and to prepare more logistics GLPs |
| GLP Quests did not work as intended | The GLP had 6 quests, 90 % of the students reported that this felt like a test question and not an explorative exercise nurturing the interest of the topic and to explore the impact of technologies on a process.<br>The same issue was not reported from the teachers. | We plan to change the type of quests- from a testing to more a sort of- tell us what you think of quest.<br>Currently we play the GLP as location based without the quests. |

### 5.1.5 HFC – Accessibility design for small-scale pilots

**ACCESSABAR Feedback**

One of the aims of the small-scale pilots was to test the validity and usability of ACCESSABAR for students with special needs, and teachers for ease of use and productivity.

A number of pilots were running spanning 2017-2018 where valuable feedback was received which enabled us to develop the functions and interface of the relevant tools.

*Table 13: Small-Scale Pilots with Accessibility Feedback*

| Location | **Date** | **Participants** | **Procedure** | - **Feedback for Accessabar** |
|---|---|---|---|---|
| SIVECO, Bucharest, Romania | 22/23rd January 2018 | 14 Teachers & 35 Students | 2 small-scale pilot workshops were organised, one for teachers and one for students.<br><br>Teachers had to create a Gamified Lesson Plan within the Beaconing Platform teacher Interface, assign it and view analytics pages once the game had been played.<br><br>Participants were asked to use the Accessibility tools 'Accessabar' to make navigation and viewing easier in the process.<br><br>Students had to receive their assigned lesson plans via the Beaconing student interface, play through the game in the Beaconing Platform and review their scores in the analytics pages.<br><br>Participants were asked to use the Accessibility tools 'Accessabar' to make navigation and viewing easier in the process. Some users had Dyslexia. | Students were delighted with the game and the ease at which Accessabar could be opened from the interface<br><br>Accessabar tools are easy to identify and use<br><br>Text to Speech is excellent in different languages<br><br>Great magnification of fonts and screen<br><br>A really great and useful accessibility tool for teachers and students<br><br>More high contrast fonts needed |
| SEBIT, Ankara, Turkey | December 2016 & June 2017 | 100 Teachers at each event | Recruitment event to introduce Beaconing Platform, its tools and functions to schools and teachers in order to be included in the large-scale pilots in September 2018.<br><br>Functions were discussed and demonstrated, and teachers were allowed to experience the Authoring Tool and the Accessibility features in Accessabar | A very worthwhile tool for students and teachers<br><br>Some great accessibility features, especially the font and reading functions<br><br>On a par with paid solutions in accessibility |
| SEBIT, Ankara, Turkey / Milan, Italy / Bremen, Germany / Bucharest, Romania / Barcelona, Spain / Paris, | 10th February 2018 | 500+ Students | Geo Localised Cross EU game based Beaconing Event.<br><br>Students across Europe were able to try the Beaconing Platform at the same day and date using min games which were geo localised and gps tracked on mobile devices. | Easy to use toolbar<br><br>Great for seeing finer detail<br><br>Nice magnification for presentation<br><br>Good for individual student needs<br><br>Very adaptable |

| | | | | |
|---|---|---|---|---|
| France/ Madrid, Spain/ Porto, Portugal | | | Results were viewed after the event on the Desktop Beaconing interface using Accessabar tools | Thought of all disabilities and functions for each |
| SEBIT, Anakara, Turkey | 7th June 2018 | 21 students + 3 teachers | Full run through of Gamified lesson plan on desktop and mobile devices at Maya School, PC Lab setting.<br>Students were able to experience the Beaconing experience from start to finish and teachers were able to view the results on desktop | Good for individual student needs<br>Easily accessible<br>Needs to be translated into different languages<br>Nice design |
| Vila Real University, Portugal | 17th July 2017 | 5 users - Blind & Low Vision | Accessibility Assessment using Accessabar as a navigation and accessibility aid to complete a structured script and carry out various tasks on the computer. | Good magnification for low vision users<br>Text to speech is useful especially when used in conjunction with keyboard shortcut keys<br>Good use of tags for elements so users can identify what each element is if blind or low vision.<br>Some work needed on layout and access to functions. |

# 6 DATA ANALYSIS

Description of the data analysis process to assess usability and results from usability testing. What did we plan to assess in 6.2 and what did we assess in reality. Based on pilot implementation we need to document observations and feedback from pilot leads (see end of this document for some emails with feedback from the partners).

Please refer to D6.4 for the full findings and evaluation.

## 6.1 DATA ANALYSIS TOOLS AND DESIGN BY THE PARTNERS

### 6.1.1 SIVECO - Romanian large-scale analysis

The large-scale piloting sessions were taking place at "Grigore Moisil" National College from Bucharest, Romania, between November 2018 - January 2019 and at the "Gheorghe Asachi" Technical College in January 2019. The students between 15-19 years old participated with a great deal of enthusiasm, showing a special interest in following these lessons.

We were piloting:

UC1: Playing a GLP that has no geolocation mini game at the Computer Lab

UC2: Playing a GLP without any geolocation minigames in a Classroom with Laptops

We created interdisciplinary lessons like: Electric energy in Romania, The effects of electricity production on the environment, Rehearsal for Physics, Professor Tibia's exercises.

We tested them with over 800 students from schools all over Romania.

The Romanian students loved that the Beaconing lessons are very catchy and offers them the possibility to play during the classes, to test their knowledge and abilities.

### 6.1.2 HWU – Data analysis design for the VET pilot

Only the second small-scale VET pilot is reported herein as it is the final trial and implements the feedback of the first study. A systems usability scale (SUS)[1] is a Likert scale constructed of 10 questions with close inter-correlations between all items (Figure 1). To prevent biasness the items questioned ensures that the common response splits equally to strong agreement and strong disagreement.

1. I think that I would like to use this system frequently.
2. I found the system unnecessarily complex.
3. I thought the system was easy to use.
4. I think that I would need the support of a technical person to be able to use this system.
5. I found the various functions in this system were well integrated.
6. I thought there was too much inconsistency in this system.
7. I would imagine that most people would learn to use this system very quickly.
8. I found the system very cumbersome to use.
9. I felt very confident using the system.
10. I needed to learn a lot of things before I could get going with this system.

[1] Brooke, J. (1996). SUS-A quick and dirty usability scale. *Usability evaluation in industry*, *189*(194), 4-7.

### 6.1.3 SEBIT– Data analysis for usability evaluations

**Usability Evaluation with the Teachers:** Teachers were asked to complete a survey, at which they completed open ended sentences about their experience. The outcome of this evaluation was as follows:

Evaluation Finding #1: Teachers were informed that, while doing the learning design the aim is to cover the subject topic, in order to gain on 3 STEM competencies (problem solving, communication and info literacy), NOT particular subject competencies. Rather "knowledge" of the subject topic is utilized by the STEM competencies.

Evaluation Finding #2: The PoI determination and the decoration of the location was done with the teachers which made it easy for them to conceptualize the experience.

**Usability Evaluation with the Students:** The standard " Technology Acceptance Model Version 3" (TAM3) was updated for evaluating the "intention to use" in the particular case of BEACONING game-based learning system. BEACONING Evaluation Framework makes use of Structural Equation Modelling which is a statistical approach to discover what variables explain the variations on desired outcomes to what degree. The structural equation that will be used is named as the BEACONING Acceptance Construct, because the core of the construct is adopted from Technology Acceptance Model (TAM). TAM is shown to have largest explanatory power among all acceptance theories[2]. The main hypothesis of TAM are as follows:

H1. Perceived ease of use will have a positive effect on perceived usefulness.
H2. Perceived usefulness will have a positive effect on attitude towards using BEACONING.
H3. Perceived ease of use will have a positive effect on attitude towards using BEACONING.
H4. Attitude will have a positive effect on intention to use a BEACONING.

Perceived usefulness refers to the regards of students and teachers about the educational value of the product. For typical technology products Perceived Usefulness is shown to be positively influenced by perceived quality of the product[3], relevance to studying (H5) and result demonstrability (H6) among others[4]. Perceived quality may include the information quality (H7) and service quality (H8) of the product. Subjective norm is the external influence a user feels. It is moderated by experience and it effects the attitude towards using (H9) the technology.

Perceived ease of use refers to the regards of students and teachers about how easily they gain control of the system. Perceptions of External Control (H10) and Perceived Enjoyment (H11) influence the perceived ease of use. However, it's also shown that "cognitive absorbtion," such as that which is experienced during gaming also positively influence (H12) ease of use perception[5]. Finally, "perceived playfulness" is considered as it is shown to positively influence the attitude towards using (H13) the technology[6].

These nine variables and the four items of TAM will be measured by thirteen questions through a seven-point Likert scale from "strongly disagree" to "strongly agree." In analyzing the collected

[2] Samaradiwakara, G. D. M. N. & Gunawardena, C. G. (2014) "Comparison Of Existing Technology Acceptance Theories And Models To Suggest A Well Improved Theory/Model," International Technical Sciences Journal (ITSJ), June 2014 edition Vol.1, No.1

[3] Delone, W. & McLean, E. (1992). "Information Systems Success: The Quest for the Dependent Variable," in Journal of Management Information Systems 3(4):60-95 · March 1992

[4] Venkatesh, V., & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. Decision Sciences, 39(2), 273–315

[5] Agarwal, R. & Karahanna, E. (2000). "Time Flies When You're Having Fun: Cognitive Absorption and Beliefs about Information Technology Usage," in MIS Quarterly 24(4):665-694 · December 2000

[6] Padilla-Meléndez, A et al. (2013). "Perceived playfulness, gender differences and technology acceptance model in a blended learning scenario," in Computers & Education · April 2013

data, a two-step procedure will be followed[7]. Before checking if the thirteen hypothesis holds and to what degree, the internal consistency (reliability) of the measurements will be calculated using Cronbach's Alpha values and the internal validity of the model will be calculated using some goodness-of-fit indicators. Then, to check the hypothesis correlations will be calculated. Note that, Perceived Usefulness is considered to be influenced by four variables, Perceived Ease of Use is considered to be influenced by three variables and Attitude Towards Using is influenced by four variables. Therefore, to complete the analysis percent variance of these three items as explained by the influencing variables will be checked.

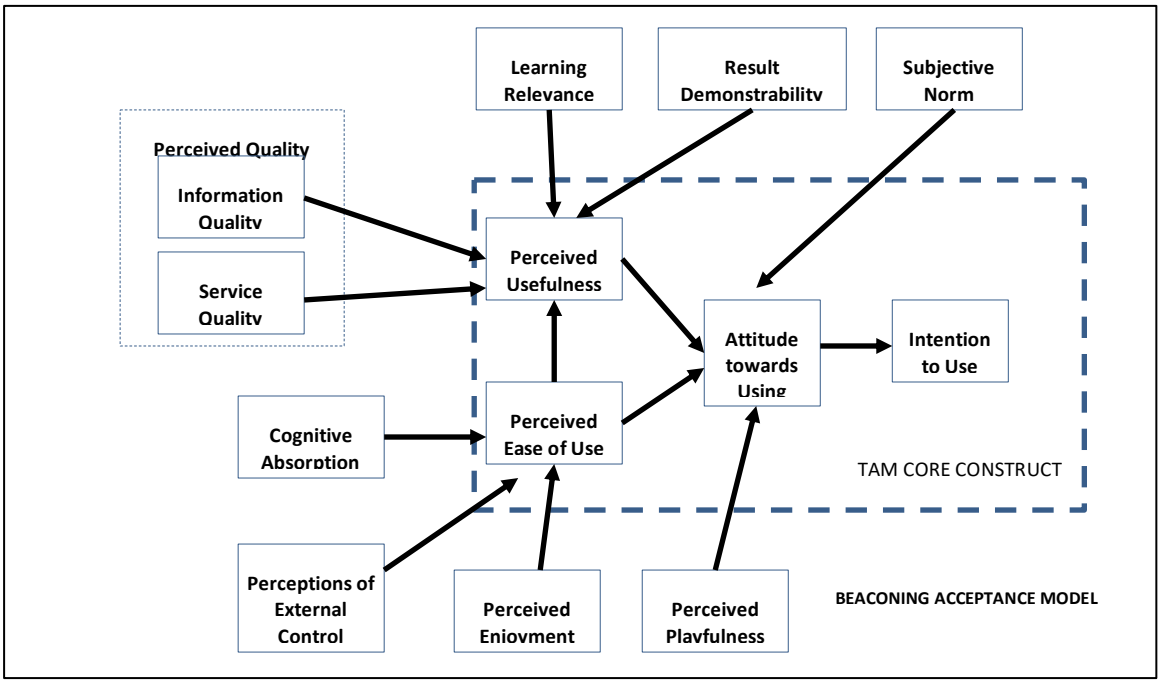


*Figure 24: Beaconing acceptance model*

The above model depicts all the relationships that are chosen to be a part of the model which would explain how and why the intentions of users would vary towards using BEACONING. The arrows signify the relationship hypothesis. The below survey questions for measuring the variables in the model are all picked from the references given at the footnotes of the previous page:

**Learning Relevance:** The use of BEACONING is pertinent to my educational goals.

**Result Demonstrability**: I would have no problem explaining to someone else the benefits BEACONING.

**Information Quality**: BEACONING provides meaningful information in an appropriate format.

**Service Quality**: BEACONING has a visually appealing interface and logical steps to complete the gamified learning tasks.

**Perceived Usefulness**: I find using BEACONING effective in improving my learning performance.

**Cognitive Absorption**: I could block out distractions and loose the sense of time while using BEACONING.

**Perceptions of External Control**: I would find it easy to get BEACONING do what I want it to do.

[7] Anderson, J. C., & Gerbing, D. W. (1988). "Structural equation modeling in practice: A review and recommended two - step approach." Psychological Bulletin, 103, 411-423.

**Perceived Enjoyment**: I feel joyful when I am doing BEACONING activities.

**Perceived Ease of Use:** It is easy to interact with and get skilful at using BEACONING**.**

**Subjective Norm**: My classmates and/or the school administration think I should use BEACONING.

**Perceived Playfulness**: I felt creative and had fun when using BEACONING for learning.

**Attitude towards using:** I can imagine making good use of BEACONING in my learning plans.

**Intention to use:** I would use BEACONING on a regular basis and recommend others to use it in the future.

# 7 CONCLUSION

The small-scale pilots and the feedback received, along with observations and preliminary analyses allowed us to design suitable lesson plans and initiate the implementation of high-quality large-scale pilots towards the fulfilment of the BEACONING project's objectives.

## 7.1 RESULTS

The results of this deliverable and how these have been used to inform the large-scale pilots are various and worthwhile and can be found within the main sections of the document, in the form of figures and tables (e.g. Pilot Observations in section 5.1.1).

## 7.2 IMPACT

Perhaps the most interesting outcome of the study was that the subjective norm (how teachers are affected from each other in adopting the system) was indeed related to the attitude to use, but it had the highest variance. This means that they are likely to use the system, but would hesitate to refer it to other teachers or stakeholders. Secondly, teachers seem to expect more educational material to be available in GLPs. This shows in the relation between the informational quality and perceived usefulness. Finally, even though there is strong influence of perceptions of usefulness and ease of use over the attitude to use the system, but that incentive just moderately translates to acting to actually using it in their schools. Perceived Usefulness is most effected by relevance to studying. This is expected, considering teachers are likely to regard educational priorities first. However, the weak reliance on visible results points to scepticism.

The natural outcome of this study is that the even though there is strong influence of perceptions of usefulness and ease of use over the attitude to use the system, that incentive just moderately translates to acting to actually using it in their schools. These outcomes should inform the exploitation plans, in that school leaders and managing stakeholders must be on boarded before teachers are engaged with the system.

**Testimonials from users**

- *"During BEACONING Platform testing we found a real interest of the students for the virtual lessons. I think this platform attracts the pupil and captures it for the duration of the themes accessed. Learning through the game is a method that meets the expectations of today's students. "*- **Tatiana Marandici – Physics teacher - "Mircea cel Batran" National College, Ramnicu Valcea, Romania**

- "*Since I've been using Beaconing platform, I've noticed that lessons, usually taught written down on paper/whiteboard, can be different, in a more interesting and interactive way for students. Usually, I would get bored pretty quick doing calculations or learning physics formulas, but Beaconing makes me want more, pass through all levels with maximum points, it's what makes me want to study more, possibly without even notice. I like the colourful design of the platform, it's easy to use and I can also communicate with my teacher in case I do not know something or I need an additional clarifying statement. I highly recommended Beaconing, especially if you want to get rid*

*of the boring part of the studying process.*"- **Mihalache Danut Florian** - **student - "Grigore Moisil" National College, Bucharest, Romania**

- *"It was such a fascinating experience at the Beaconing platform. Besides the fact that the idea of that kind of platform is innovative and original, the thing that was positively impressed was its easy way of use. The pretty design and the simple interface attracted me in the first place. While using it, I discovered a study environment fit for me. The exercises not only helped me study better and more logical, but it also improved my reaction time and spontaneous thinking. For me, the Beaconing platform changed the way I saw studying, making it into a fun and efficient activity."* **- Laurentiu Oancea - student - "Grigore Moisil" National College, Bucharest, Romania**

- *"BEACONING Platform has a big impact on my life because of the mathematical calculations that require to be solved in a given time period and I'm not accustomed working these exercises with my mind, but with a pen and paper. This platform should involve children's mind and, in this way, they will develop their thinking skills. I consider this platform a great method for keeping their mind active and this is such a good idea due to the exercises. I recommend this application to children from the earliest age."-* **Irina Rusu –student - "Mircea cel Batran" National College, Ramnicu Valcea, Romania**

- *"BEACONING...Well, I had a great experience with this platform and I love the way it works. It's a really great way of learning and/or practicing math or science and many other subjects. I hope in the future, this will be a very used type of learning. I would love if there would be more lesons/games added. It is, also, a great way of testing your common knowledge. I just loved it and hope it gets bigger and better as time passes. I would definitely recommend this to a student to use, for school or in their free time and I use it myself. Good job!"* - **Cătălina Făsui– student- "Mircea cel Batran" National College, Ramnicu Valcea, Romania**

- **"***The games used are a modern learning method that students can easily adapt to. They combine useful with pleasure, so that learning time passes faster and more pleasantly. Lesson "The Effects of Electricity Generation on the Environment" offers a transdisciplinary approach through which STEM content is sweetened*."**- Florina Petre – teacher - "St. Mary" Special School for Hearing Impaired, Bucharest**

- **"**I enjoyed all the games in my lessons. I am amused by Fun Mathematics, and the General Culture Test triggered my curiosity. The biggest challenge was, however, *"The Effects of Electricity Generation on the Environment'*"**- Adrian Niculae – student- "St. Mary" Special School for Hearing Impaired, Bucharest**