**621547-EPP-1-2020-1-RO-EPPA3-IPI-SOC-IN**

## Social inclusion and common values: the contribution in the field of education and training

**EACEA/34/2019**

# D1.2 Technology Repository Booklet

| Due date | 15.07.2021 |
|---|---|
| Actual date | 02.09.2021 |
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| Version | 1.4 |
| Status | Final |
| Dissemination level | Public |

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**Version control**

| Version | Date | Author | Institution | Change and where applicable reason for change |
|---|---|---|---|---|
| 1.0 | 20.05.2021 | Neil Judd | HFC | First draft |
| 1.1 | 23.07.2021 | Ancuta Gheorghe | ATS | Internal review |
| 1.1 | 26.08.2021 | Olivier Heidmann | UTH | Internal review |
| 2.0 | 30.08.2021 | Neil Judd | HFC | Corrections |

**Quality control**

| QA Version | Date | QA Responsible | Institution | Change and where applicable reason for change |
|---|---|---|---|---|
| 2.0 | 01.09.2021 | Ioana Andreea Ștefan | ATS | Minor revision to the content |

**Release approval**

| Version | Date | Name | Institution | Role |
|---|---|---|---|---|
| 2.0 | 02.09.2021 | INCLUDEME_D1.2 Technology Repository Booklet | ATS | CO |

**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This deliverable contains original unpublished work except where clearly indicated otherwise.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.

The project is co-funded by the European Commission through the Erasmus+ program. However, the European Commission cannot be held responsible for any use, which may be made of the information contained therein.

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# EXECUTIVE SUMMARY

The project Inclusive Digital Environments to Enable High-Quality Education for Disadvantaged and Disabled Learners (INCLUDEME) addresses core challenges associated with inclusive and accessible education and envisions technology-enriched interventions that target the specifics of disadvantaged and disabled learners, and that are directly enabled by teacher and stakeholder training initiatives to equip them with knowledge and skills.

The overall platform encompasses a range of elements such as the INCLUDEME Sandbox and Authoring Tool, INCLUDEME Repository of games and gamified learning paths, INCLUDEME Learning Resource Centre, INCLUDEME Information Booth and INCLUDEME Analytics.

All these elements have their varying components that are required to be accessible to all. Therefore, the objective of this deliverable is to provide an overview of existing software and hardware that exists within the consortium that may serve as a foundation. The findings have been classified for usage into the following Technology Repository Booklet.

The information was collected by using an online questionnaire completed by each partner. The overall INCLUDEME Repository shows that we can build upon an established range of accessibility tools to provide a means of access to information presented and adaption to individual needs at platform level. Content can be adapted for those direct target groups with neurodiversity's such as Dyslexia, Autism, ADHD, Visual, Hearing and Physical Impairment. There is a solid pool of serious games that cover a broad range of subject fields and key skills essential for entry in the labour market. Furthermore, tools are shared for collaboration and co-creation, creating lesson plans and social interaction which will provide the building blocks for a comprehensive Authoring Tool. Infrastructure for testing and hosting is provided and adequate to cope with the usage demands of the project.

As the consortium had foreseen, the analysis shows that a good basis for the INCLUDEME project does already exist. Development will, however, be needed to extend the authoring and editing tools and to define standards for their integration with the games, analytics, gamified learning paths and information UIs.

Accessibility standards will need to start at ground level for the creation of the front-end interfaces and gaming accessibility guidelines followed for the implementation of essential features within the games for inclusivity.

The games as well as all other learning components will be connected to the learning analytics infrastructure which is an area lacking in the technology repository at present. The analysis of existing components also showed that the consortium will need to develop an interface and feedback system, but there is a huge skill key set amongst the partners to successfully achieve this alongside the improvement of existing assets.

The INCLUDEME Project promises to be a ground-breaking accessible collaborative learning and gaming environment providing relevant accessible knowledge and information to our direct target groups.

# 1 INTRODUCTION

The INCLUDEME Project aims to create an accessible and inclusive online learning environment in which teachers and students of all backgrounds and abilities can co-create gamified learning paths incorporating digital game-based learning as well as providing the means to access mainstream learning content for those that would otherwise be excluded.

Exclusion from these learning resources can be due to inaccessible content for those with impairments or a lack of opportunity to access content on digital devices as a result of environmental factors and availability of equipment.

With a multitude of educational technologies available on the market to support accessible and inclusive education, it can be difficult to adopt the right blend to fit the needs of the project target audience.

It is therefore important to provide comprehensive guidelines on the key features of educational technologies that we have available within the consortium that are of particular relevance for the Direct Target Groups (DTG), with special attention given to technologies that support access to learning resources and applications for disabled learners.

By doing this mapping process we can start to build a foundation for the development of the INCLUDEME ecosystem and realise the areas we need to develop or create technologies from scratch.

This document will provide a repository booklet of existing software, hardware and infrastructure components within the consortium that can be directly used in the platform itself or developed further to meet the technological requirements and the different needs of the stakeholder DTG.

The following sub- chapters of the introduction describe the role of the article within the project, the approach taken, as well as its structure.

## 1.1 ROLE OF THIS DELIVERABLE IN THE PROJECT

This deliverable will provide a repository of applicable existing technologies within the consortium that include software, hardware and infastructure components.

This repository will give us a better insight into the starting point for the project and its differernt components.

The report will provide an in depth technolgy mapping of these existing and replicable technologies, how they are being used currently and how they can integrate effectively within the INCLUDEME Platform.

It forms a basis for further development, where all components that we can re-use as an asset will be listed, thus giving more time and resources for the development of the platform and such technologies.

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The present document is complimentary to the outcome of the D1.1 INCLUDEME Stakeholder Requirements which will inform the pedagogical approaches undertaken in the project, the features of the technologies that will be provided, the teachers' training needs, as well as the information, awareness, and dissemination actions.

The repository booklet, along with the stakeholder analysis, features desired and technologies provided, will all be the benchmark for the ongoing development of the platform in Work Package 3 and 4 and the subsequent piloting phase of the project.

## 1.2  APPROACH

In order to prepare a repository of existing and replicable technologies it is necessary to collect the relevant information for categorisation from the consortium partners.

The best approach in gathering the information was to create an online questionnaire comprising of questions grouped into software and hardware components.

Each partner was asked to complete the questionnaire and submit their contributions with supporting documentation. The results were gathered by means of a shareable Google Form and results could be viewed and stored with ease and without time constraints for each contributor.

Information was gathered about the type of software which can be re used or developed upon. These could include accessibility tools, gaming technologies, tools that support co-creativity, co-creation, and co-design of educational resources, processing of personal data, their technical details and requirements, open source availablity and their suitability for those with disabilities.

A further set of questions asked about the contribution of hardware and infastructure available for the hosting of the INCLUDEME platform.

Once the information collected, a full repository booklet of existing technologies for the project could be devised and is outlined in Section 2 of this document.

This repository forms  the basis of development for the individual components of the platform as well as to give insight into possible adaptations and ideas for innovative features within the games, interfaces and content of the many parts of INCLUDEME.

## 1.3    STRUCTURE OF DOCUMENT

The deliverable is structured as follows:

**Chapter 1** (this chapter) provides an introduction to the deliverable.

**Chapter 2** shows the results of the questionnaire all partners of the INCLUDEME Project were asked to fill out. It is divided into two parts. The first part describes the software and hardware

available within the consortium for the project.  The second part gives a classification of the technology partner by partner into a Repository Booklet.

**Chapter 3** discusses the relevance of the available input, current best practices and further categorising the software into sections according to the different components of the INCLUDEME platform - accessibility tools, serious games, and tools for co-creativity, creation, and infrastructure. We further discuss opportunities and limitations of the repository and what may need to be developed to fulfil the obligations of the project.

## 2   TECHNOLOGY REPOSITORY

The main objective of the technology repository is to gather all the relevant existing available technology and software resources from the project partners into one place. By doing this we can ensure all partners know what tools are already available and what resources can be re-used and/or developed further for use within the INCLUDEME components.

By discovering and appreciating all our common existing resources, we can reduce potential development time and establish a basis from which the INCLUDEME platform can develop and grow.

It is important to categorise the available software into the different components of the platform and understand whether re-usable software within the consortium can be mapped and integrated into the technological framework that the INCLUDEME Project will base itself upon.

### 2.1   SOFTWARE & HARDWARE REPOSITORY

This section gives an overview if what each partner can provide. In Chapter 3 we will discuss further the potential for these offerings and how they can be integrated into the project.

Table 1 provides an overview of existing software and hardware within the INCLUDEME consortium and categorises the resources into the platform elements.

From this we note that **Hands Free Computing (Ireland) Limited** (**HFC)** provides **ACE** - an online assisitive toolbar with a number of high quality accessiblity features to aid those with Dyslexia, Neurodiversity's, Visual and Physical Impairment.



*Figure 1. ACE Toolbar*

This will be implemented at platform level across the front end interfaces, sandbox authoring tool, and within any online resource applications to allow disadvantaged and disabled users to access and manipulate the interface, content and documents to suit their needs in a variety of different ways. ACE offers the following features:

- Text to Speech (40 languages)
- Speech Recognition (100 Languages)
- Magnification
- Changeable Font; including Size, Style and Colour
- Changeable Line & Character Spacing
- Screen Tinting
- Reading Rulers
- Overlay Bars
- Page Translation (100 languages)
- Simplify Page

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*Figure 2. ACE Font & Text Options*

**HFC** further contribute their **suite of online games for children with cognitive impairments.**

These accessible online games provide educational and fun learning through gaming and stimualtion as well as offereing a number of different access methods for playing such as keyboard, mouse and switch scanning modes.



*Figure 3. Farm Counting Accessible Game*

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*Figure 4. Farm Counting Game Play*



*Figure 5. Farm Counting Questions*

They are a great resource for acquiring skills in cause and effect, problem solving and basic mathematics.The key concepts of these games can be applied to the INCLUDEME platform where the base structure can be changed for our direct target groups in the project.

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*Figure 6. Accessible Treasure Game*

The games provide accessible settings and adaptable game play for impaired users such as difficulty levels and removing background images.
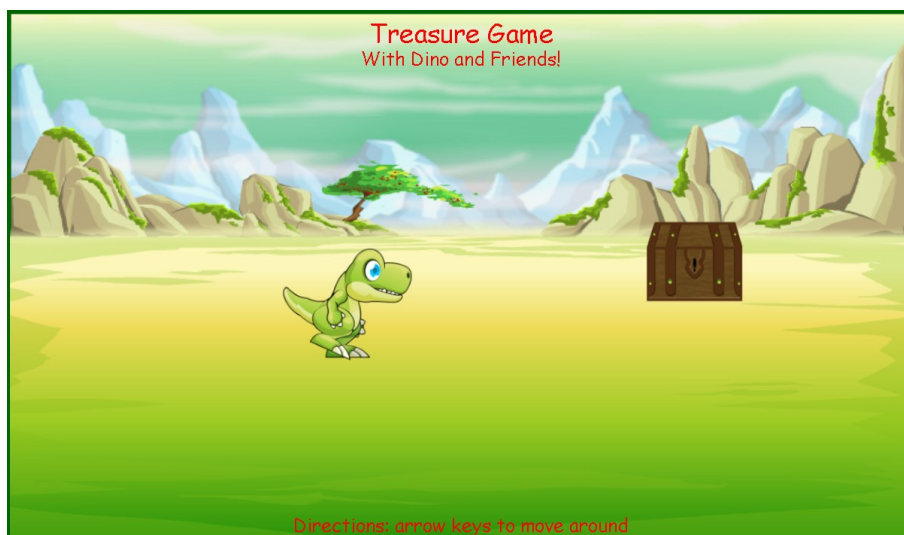


*Figure 7. Accessible Treasure Gameplay*

**HFC** have the possibility to offer a **suite of educational serious games specifically designed for dsiadvantaged students and specifically those with hearing impairments.**

These games include a wide range of different gameplay styles including platform, role play, racing, maze, problem solving, shoot em up, however all aimed at learning mathematics.

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*Figure 8. Racing Style Accessible Game*

The games are split into learning categories from the 1st to 3rd cycle (levels) of difficulty.
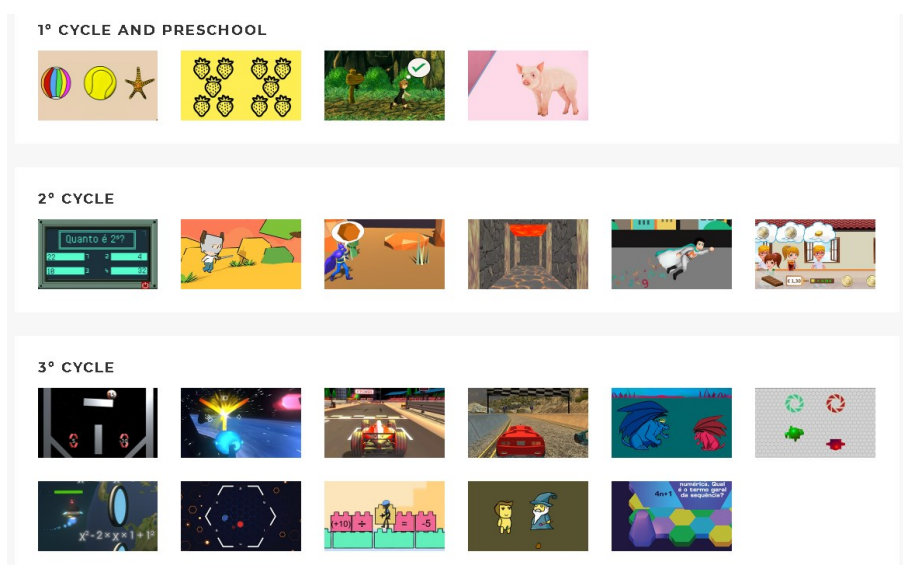


*Figure 9. Suite of Hearing Impairment Games*

Accessible gaming is at the heart of these applications with multiple control methods, instructions and content in written and Sign Language form and customisable options.

*Figure 10. Sign Language Instructions and Questions within the Games*

The games are Unity based and would need to be carefully integrated into the INCLUDEME platform or offered as a downloadable resource.
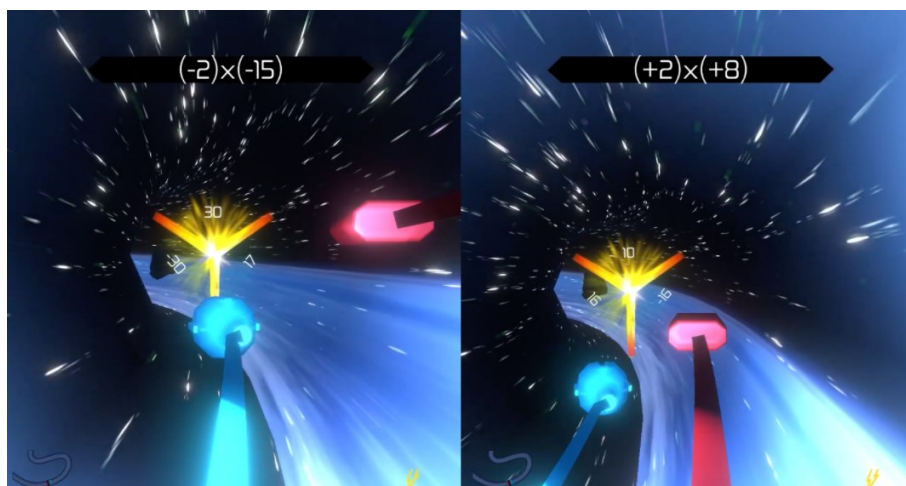


*Figure 11. Interactive Shoot em up Hearing Impairment Game*

**HFC** will also contribute their Microsoft Word Assistive Tool named **Docs Made Easy.**

This Word Add in helps to make documents more accessible by providing a host of features available within Microsoft Word together in one place and easily applying those elements to text and document style in real time.

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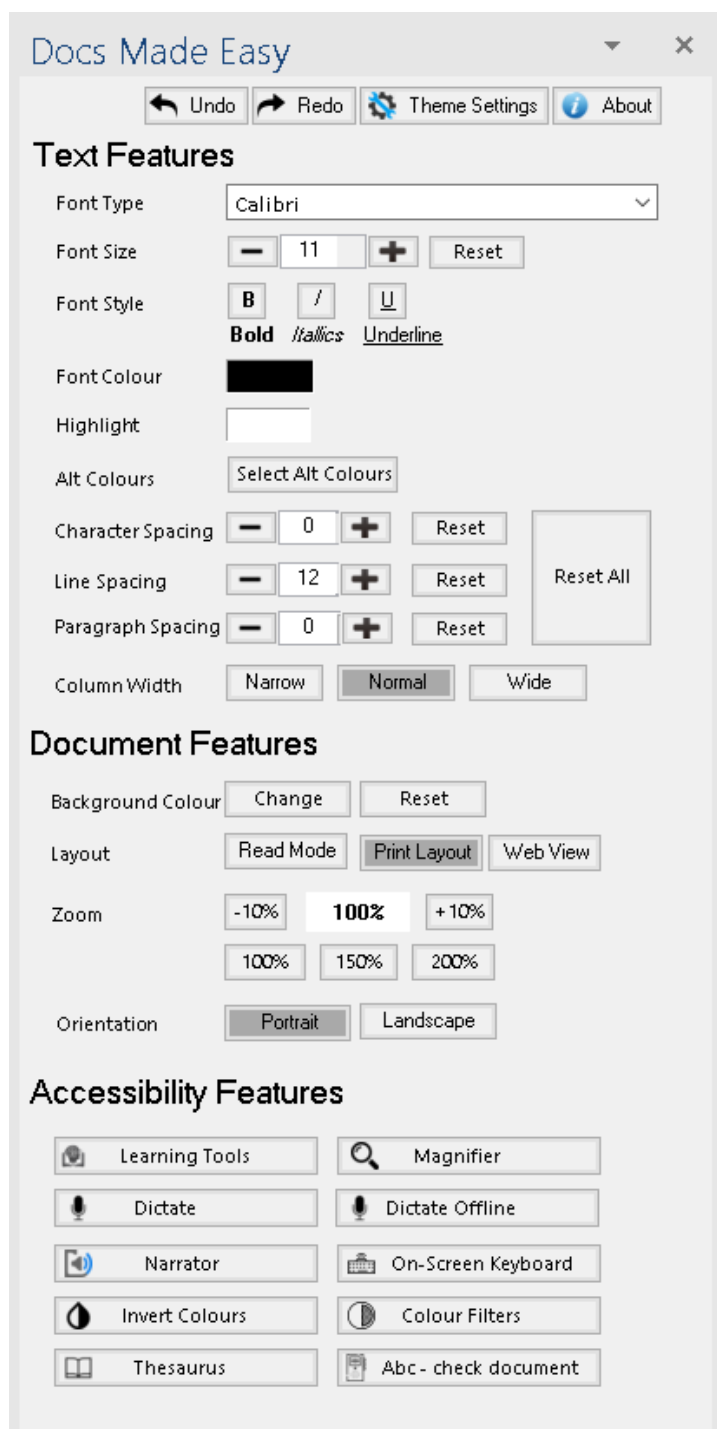
*Figure 11.Docs Made Easy*

As well as having text and document features, **Docs Made Easy** gives instant access to the in built accessibility features of Windows and Microsoft Word. These are often hard to find in their own right within the operating system so giving easy access to these essential tools is an effective feature. Tools such as *Magnifier*, *Speech Recognition*, *Narrator* and *Colour Filters* are found in the **Accessibility Features section**.

The great thing about **Docs Made Easy** is that it can be used as an accessible document builder, an assistive helper for those with neurodiversity's or a productivity tool for finding features of Microsoft Word so much quicker.

**University of Thessaly (UTH)** contributes to the repository by bringing a range of serious games which are targeted to secondary and higher education. Covering areas of environmental problem solving, engineering, organisation, language acquisation and project management, these games could really add pedagogical value focussing on the key skills needed for further employment opportunities.

**Hera project** is a standalone 3D environment in which students have to build and manage a city according to varying challenges that are put their way to do with ustainable growth, quality in education, sustainable natural resource management, mitigating climate change, addressing natural risks, fighting poverty, informing global health, pollution, inhabitant contentment, electricity usage and more.

The **HERA project** aims to build problem solving skills among higher education students through a game-based educational approach that challenges students to combine skills from diverse subjects towards solving complex, multidisciplinary problems inspired by real life in the areas of engineering and economics.

Students are assigned roles and scenarios and manage the city throughout the game lifecycle.



The HERA game is organized around two pillars:

- A base functionality.

- A set of educational scenarios.

*Figure 12. HERA Project*

The **HERA** game challenges students to solve realistic, non-trivial problems inspired by real-life. It livens up the classroom, promotes learner engagement, enriches interaction, and encourages experimentation.

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The software is open source, scalable and Windows installable. It certainly promotes the concepts of social learning and social interaction with built in chat functions, digital whiteboard and brainstroming with collaboration features.

The product is multulingual and is provided to INCLUDEME as a product free of charge.

**LEAP** is a suite of 3 serious games, 2 Windows/1 Android, single player for Higher Education, developed by **UTH.**

**LEAP** deploys serious games that encourage learners to adopt industry roles, to think critically, addressing community and societal needs through agile engineering solutions, to practice on the application of industrial process management in the context of their higher education curricula, and to take into account environmental responsibility issues in service design and implementation.

All 3 of the games within **LEAP** are simulations. The first game is a simple Android app, simulating a standard Agile sprint.

The second game is a Windows-based simulation of the utility of the 5S principle in 3 very different situations. The "5S" implementation model is often applied in lean processes. The model refers to the actions sort, set in order, shine, standardize, and sustain.

A basic functionality is developed, which has the main features of gameplay. The application is developed both in 2D and 3D. The player is challenged to deploy the 5S methodology in order to improve the work space and thus reduce implementation time. The player is asked to move a character on the game canvas by clicking on the ground. The player can interact with other characters and objects of the game by clicking on them.

The basic gameplay moves the player around on the screen in order to fulfill a task. By applying each of the 5S principles, naming, sorting, ordering, shining/cleaning, and standardizing, the player will significantly improve the work flow. Three learning scenarios are developed following this idea. It can be defined in a various number of manners, to demonstrate lean design and more specifically 5S. The scenarios address the needs of different industries, such as: ordering a pharmacy inventory (medical engineering), ordering a scrapyard (manufacturing), and ordering a desktop space on a computer (ICT and wider sectors). These diverse scenarios demonstrate the fact that lean production can be applied in different engineering and wider sectors, thus going beyond the traditional software engineering and manufacturing applications of the process.



*Figure 13. LEAP Serious Games*

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The third game is a role playing game in a development team (2 different scenarios) working on a project. The player can play any of the 3 traditional roles in that team. This demonstrator refers the "SCRUM" model that is deployed in the context of agile design. The SCRUM model is applicable in small teams that work in small to medium sized projects. Team members have different roles. For example, the SCRUM master is the overall coordinator; the product owner is the person that decides whether the outcome of implementation actually meets the needs; typically this person is the customer. Team members work with the SCRUM master to implement a project.

The related application will be a single player game that will recreate the development of a product using the SCRUM methodology. The player will be able to assume any of the traditional SCRUM roles, namely SCRUM master, product owner, or team member. The following scenarios are planned, which demonstrate that the SCRUM methodology can be applied beyond its traditional use in software engineering, such as: designing an university campus (civil engineer), designing a garden (agricultural engineering).



*Figure 14. LEAP SCRUM Agile Design Serious Game*

The serious games provided by the LEAP project are a valuable resource in their own right. They are available to the INCLUDEME Project as open source therefore scalable and adaptable, however need separate PC installation. They are multilingual although collaboration and social interaction are not the focus of these games as they are primarliy single player games. Furthermore they do not currently provide many features for adaption to special needs such as control methods and interface adaptability.

**Coding4Girls (C4G)** is a Windows based, single player serious game developed by **UTH.**
**C4G** is an online platform in which teachers can create courses around  Scratch coding principles (using Snap, a derivative of Scratch) that students will see in the context of mini games and a 3D world.

It is designed to introduce students to the world of coding via game based principles. Students are assigned a course in which they can enter the 3D environment, explore and play mini games.

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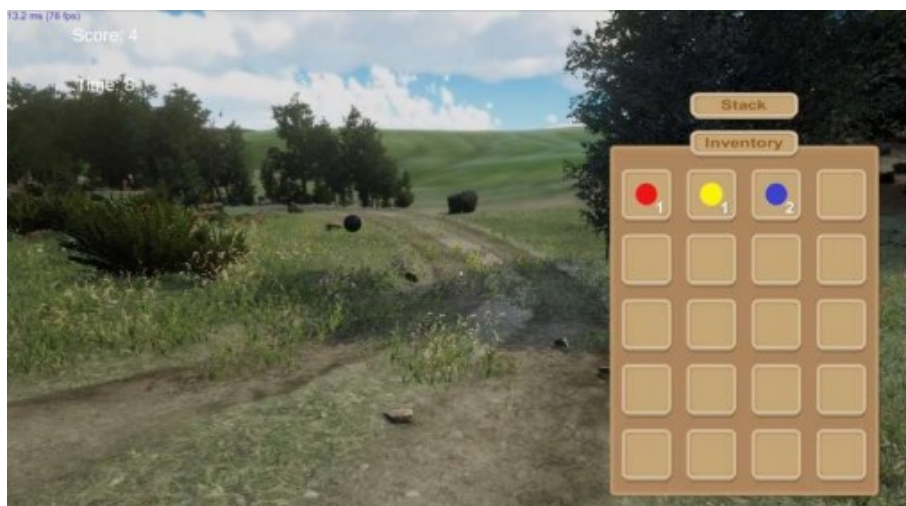
*Figure 15. Minigame Example within the 3D environment*

These mini games illustrate the programming concept at hand leading onto instructions and exercises to create working prototypes of the desired learning actions and gaming activity within the Snap coding interface.
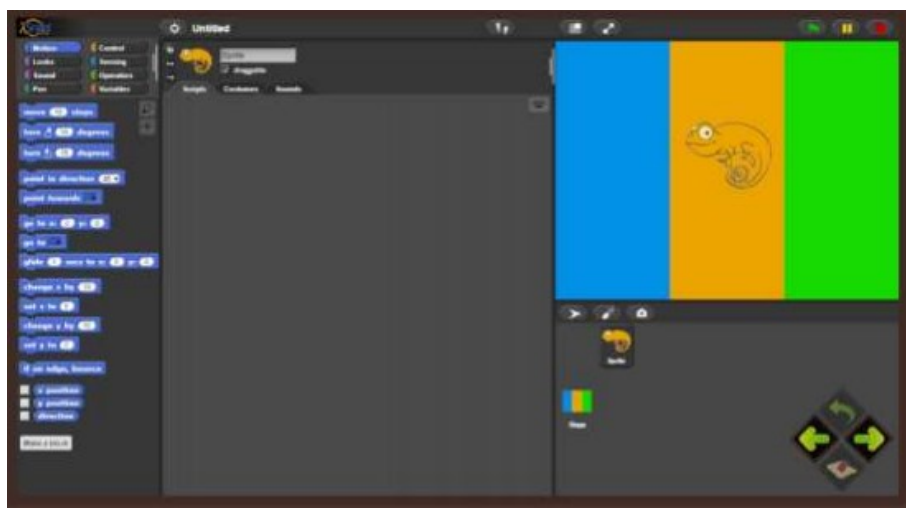


*Figure 16. Snap! Canvas for the global problem*

**C4G** is a fantastic online educational platform that could be intergrated into INCLUDEME as a learning resource in this key area of employment skills. Figure 18 illustrates the process of creation of course, presentation to the student and progression through the task.
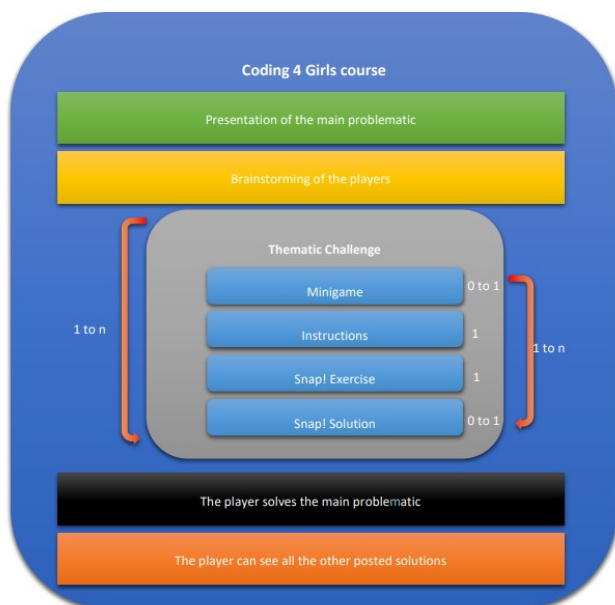
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Figure 17. Structure of a C4G Course

The C4G platform is multilingual and presented as open source for the use within INCLUDEME.

Further to the **C4G** platfrom, **UTH** brings us a similar visual programming experience with the **Cminds** serious game.
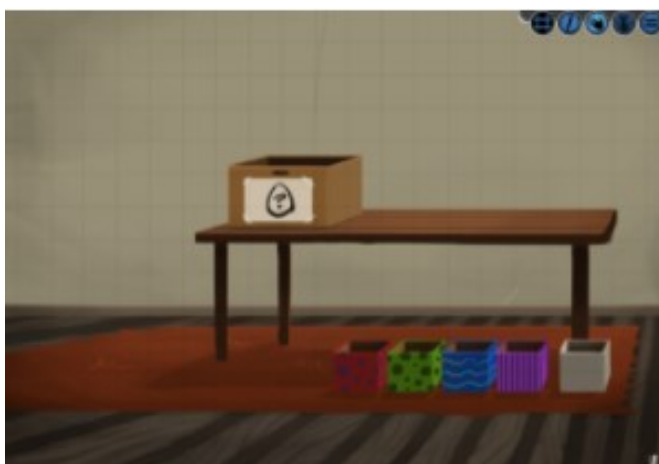


Figure 18. Cminds Visual Programming Serious Game

Cminds is a Windows based, single player Unity game aimed at the Primary Education level. Its focus is building logical thinking skills through structured, visual programming. It is based on 9 different problems that the players need to solve using visual programming.

The game is open source, scalable and can be used within INCLUDEME free of charge. There are multilingual options but no specific features for the impaired user.

Another set of serious games based around the concepts of environmental education for the primary sector are put forward by **UTH**.

This combination of games under the branch name of **EnvKids**, promotes problem solving and awareness of sustainable homes and cities. They can be used as a colloborative exercise or single player game.

## Games for environmental education



Sustainable homes

My home

Learning goal: Building awareness on environmentally friendly behavior at home.

Target group: Primary education.

Sustainable cities

My town

Learning goal: Building awareness on green cities.

Target group: Primary education.

*Figure 19. EnvKids Serious Games*

**My home** is based on the idea to show the users (i.e. the pupils) that their house and the way they live in it, which is something they know quite well, do directly affect the environment.

This game allows the user to build and furnish (to a small extent) a house and shows at each decision the consequences in terms of pollution. Some good practices for day to day life are also presented.



*Figure 20. Example of Kitchen Interface*

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The game is multilingual: English, French, Swedish, Norwegian, Greek and Czech are supported languages.

However, the whole interface of the program was designed to be without a single line of text. It's only through tooltips (which appear when you let the mouse linger on an important object) that some text will appear. By creating the interface this way, the aim was to have an intuitive, easy to use and easy to understand piece of software. At each moment, the user can go back one or several step and change the choices he made, which allows him to better understand the consequences of them.



*Figure 21. Final Phase and Evaluation of Pollution*

The second game - **My Town** energy demonstrator aims to bring the focus on a higher level: the city in which the user lives.

*Figure 22. My Town Serious Game Interface*

This demonstrator allows the user to build its own city and to try to manage it as efficiently as possible, struggling between the need to produce energy, the happiness of the citizens and the impact of it's decision on the environment.

The game is multilingual: English, French, Swedish, Norwegian, Greek and Czech are supported Language and the interface is again simplistic and intuitive.

The combination of these games would compliment the offerings of Hera Project for higher education due to the similar gaming techniques and subject matter.

Both are offered as open source and open to further developent as necessary for INCLUDEME.

Learning another foreign language is always a valuable asset to acquire. This is where the **Language Games** developed by **UTH** can play a key role.

Offered as an Windows Unity installable serious game, they are aimed early years learning but the content and pedagogical content is to a high standard.

*Figure 23. Language Games Opening Screen*

This software contains a collection of simple problems set in the framework of the visit of a kind alien kid, named Lingo, to Earth.

**Language Games** introduces game-based learning activities to promote the acquisition of a second language in pre-school and early primary education. This game-based learning approach offers specific educational advantages: It integrates active learning using ICT into blended learning that helps learners scaffold knowledge and skills.
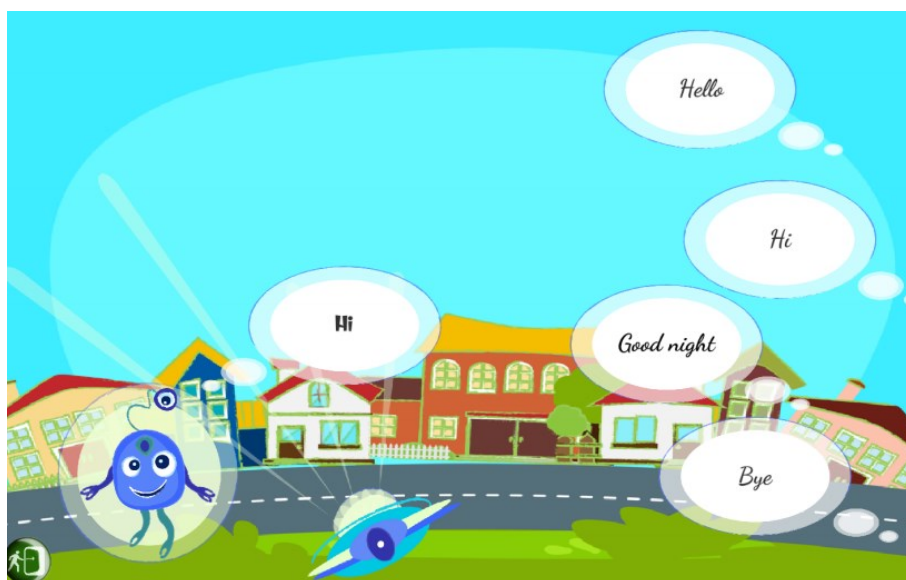


*Figure 24. Learning Basic Greetings*

It promotes learning engagement through gaming mechanisms including story-telling, collaboration, and rewards. It reinforces new knowledge through feedback mechanisms.

**Language Games** also provides educators with digital tools which are designed to be complementary to educational content, to enrich language activities in the classroom.

The players need to explain and demonstrate t some basic words, learning them in the process. There are 9 challenges all in all, each challenge being divided between an exercise of discovery and an exercise of knowledge retention.
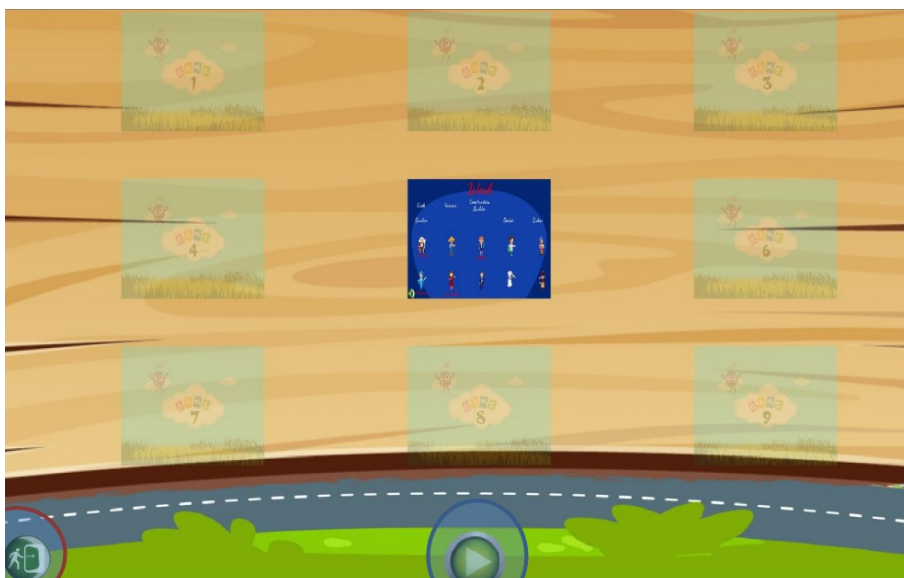


*Figure 25. Challenge Selection Screen*

The game is multilingual: English, Romanian, Portuguese, Estonian, Greek and French are the supported languages. But the whole interface of the program was designed to display a bare minimum amount of lines of text outside of the content of the lesson itself. By creating the interface this way, the aim was to have an intuitive, easy to use and to understand piece of software.

This makes the games a valuable addition for those with Neurodiversity's such as Dyslexia, Autism, ADHD and cognitive impairments.
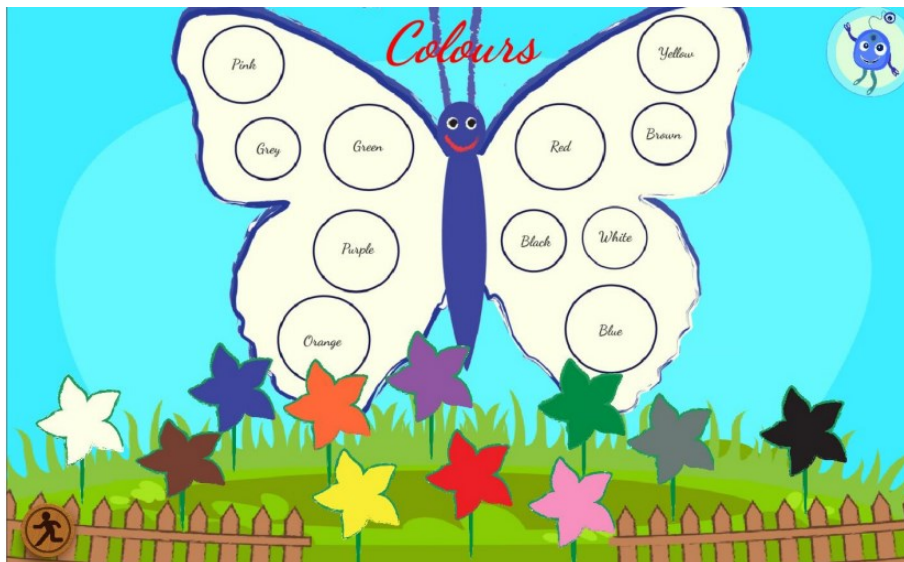
*Figure 26. Learning the Colours*

Continuing the suite of resources via **UTH** we present **SiLang**, a serious game for adults and higher education.
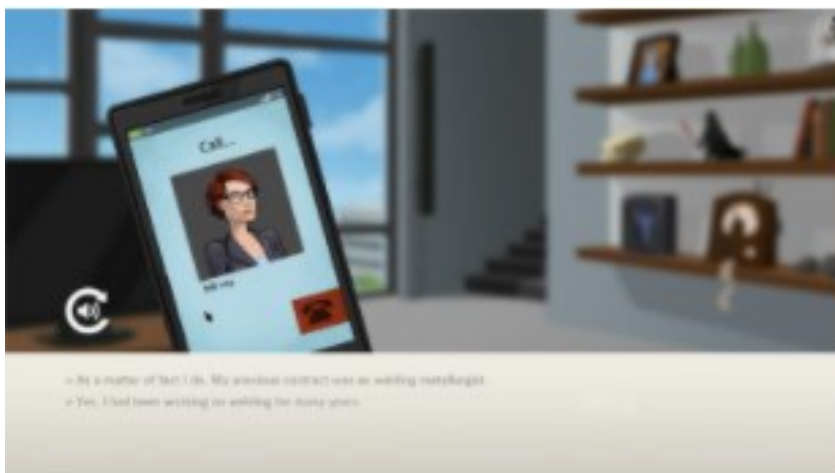


*Figure 27. SiLang Language at Work Serious Game*

The theme of the game is to raise its user awareness about how, even when speaking a common language (English), we are all influenced by our speech patterns and vocabulary from our mother tongue. It's not a game to learn English, but to see that "speaking English" may recover very different realities depending on the person.

The learning aim of this resource is Vehicular (or commonly understood) languages as work tools. Building communication skills in English as a foreign language in professional situations.

Offered as a Windows Unity based installable game. It is open source and multilingual.

Collaboration and Co-creation platforms have been provided to the project from our partners **UTH and ATS. The Design Thinking For Sustainability (DT4S)** platform is essentially a Learning

Management System (LMS) for teachers to create courses and for the students it's an activity source. The platform is accessed online via any web browser and via desktop or mobile device.

The platform is based on the Design Thinking methodology, and is tailored to reflect that by offering a digital support for this methodology. Beyond being a repository of activities, the platform allows the activities to be slotted in courses in order to follow groups of students working on the activities.
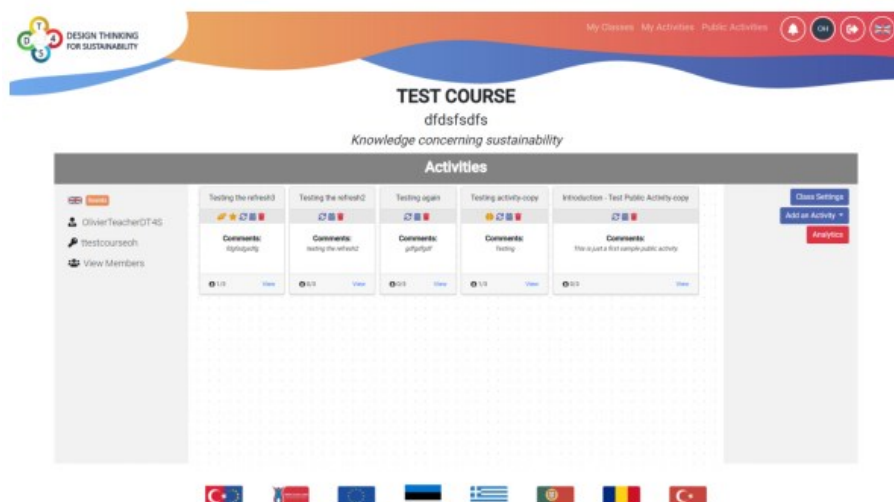


*Figure 28. DT4S Activities Within a Course*

The DT4S Platform integrates experiential and active learning design to digital collaboration tools promoting enriched educational experiences through enhanced communication and collaboration. In addition, experiential and active learning design promote the retaining of knowledge and its transferability from the educational environment to the world of work, further facilitating employability through the development of industry demanded skills.

It is a truly collaborative process from start to finish where students are presented with a problem via a pin board interface with post it note activities. Working in a team together or remotely discussion can take place on the issues posed. Ideas can be brainstromed in that dedicated mode, help can be asked from the teacher, new interactive notes can be added and shared in real time, help can be shared amongst students and a review requested of the activity so the teacher can progress the team onto the subsequent level.

All these modes and functions exist to create a working flow of information and sense of co-creation and social interaction to solve a common problem.

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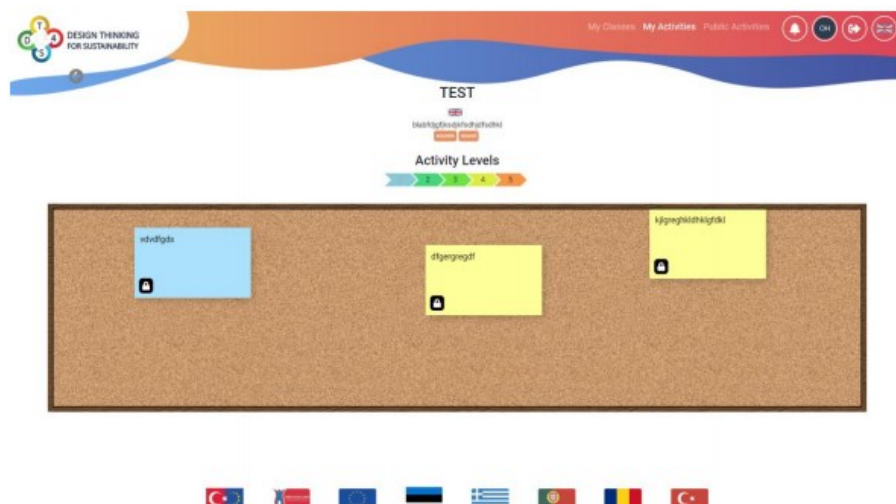
*Figure 29. Presentation of Activity to Class via Interactive Pinboard*

DT4S targets to develop design thinking skills of students. It aims to build problem solving skills, collaboration ability, and capacity to integrate knowledge among secondary students for preparing them to actively engage in sustainable development and business practices in the future as young professionals. It helps to motivate them to introduce design thinking principles in problem solving, such as ideation, brainstorming, designing action plans, evaluation, and synthesis of knowledge innovative, viable solutions to complex issues even when none appears to exist at first glance due to a problem's complexity.
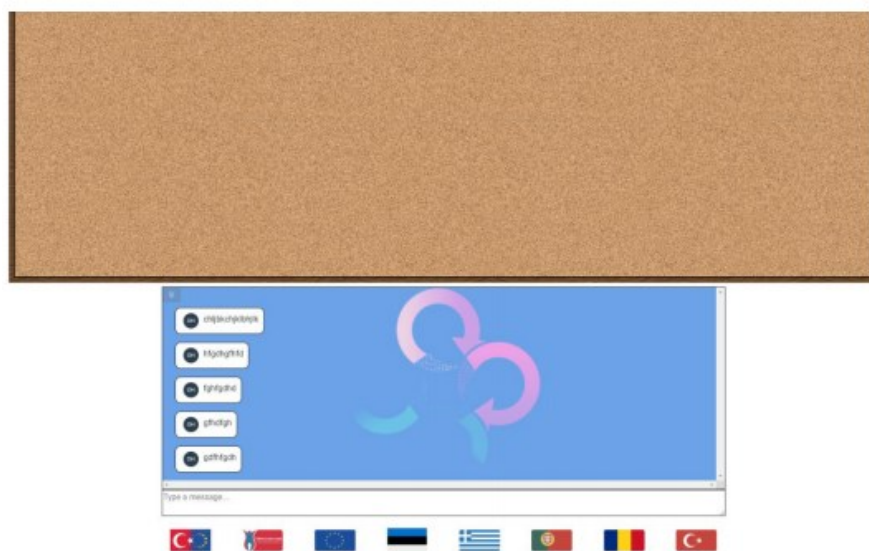


*Figure 30. Interactive Chat Function*

In regards to the INCLUDEME project this tool could form the basis of the Sandbox collaborative environmentand authoring tool, where gamified learning paths will be created together and activities and gaming resources chosen, to include in the journey.

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DT4S is an open source platform, programmed in Angular2 and JavaScript and is multilingual. It currently offers some accessibility adjustments for the interface such as colour and sizing, however being online, accessibility tools can be added to bring extra accesisbility functionality.

Project partner **Bremer Institute fuer Produktion und Logistik an der Universität Bremen (BIBA)** share two serious games that could add another dimension to the pool of gaming resources in the project.

The first game, **E.Civeles** is a Unity Windows based game in which players are immersed into a 3D environment based upon various cities in the European Union.

The game presents an interesting concept in which users are invited to explore the city and find buildings of historical and cultural heritage. Collecting moments or images is done via an interactive camera option when approaching these sites of interest. Players can collect all the points of interest and then learn about the history of the areas and city by being transported to websites and visual information with the use of QR codes embedded in the game next to the buildings.

Explore the city

An effect appears nearby a photo and you can open your camera for revealing and collecting the photo

When dissapeared. it is collected
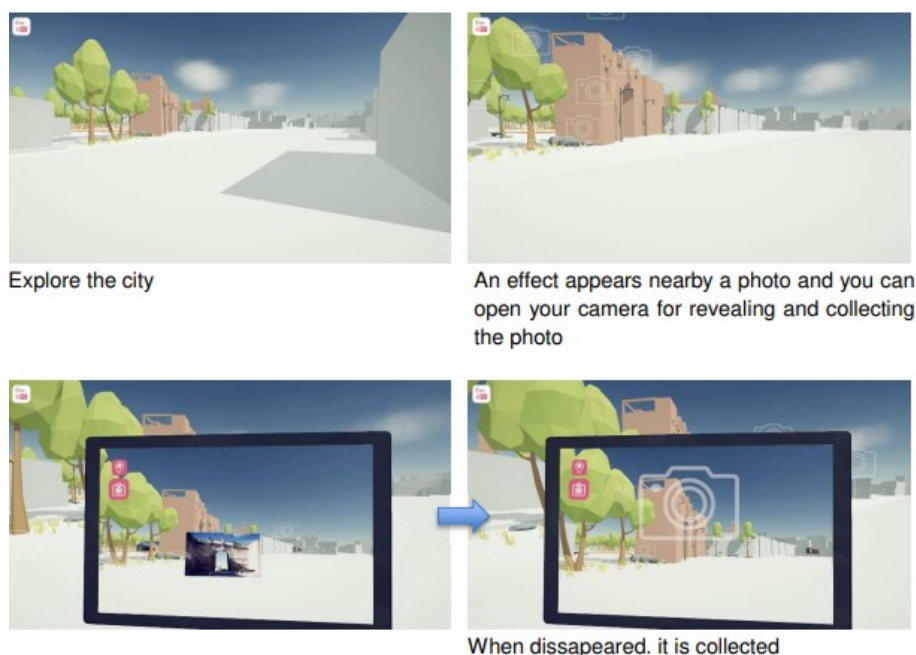
*Figure 31. E.Civeles Game Environment*

In pedagogical terms **E.Civeles** is a useful resource aiming to foster social inclusion by raising awareness of the historical and cultural heritage in a European context. It further promotes the development of digital, linguistic and cognitive skills by providing topics for discussion in a group class setting. Computer access and exploration is practiced and developed as well as the skill of research and values of cultural awareness.

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To get more information about a point of interest use the camera reveals QR-Codes

*Figure 32. Accessing Additional Information via QR Codes*

The game offers a good set of control options which promotes effective access as well as inbuilt options that can cater for visual impairment such as sound proximity effects. Being simplistic in its graphical context without distracting animations can help users with neurodiversity's such as Autism, Dyslexia and ADHD.

**Movement**
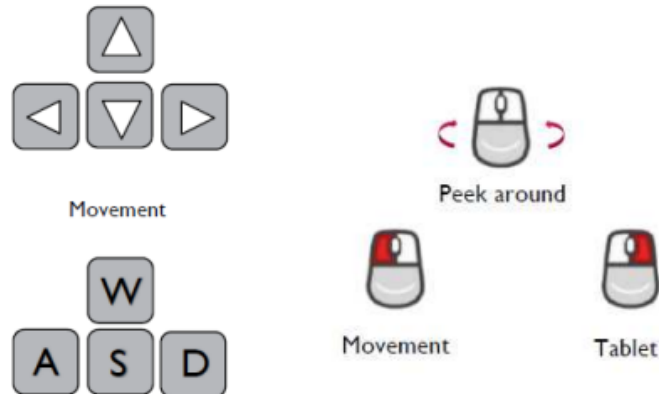


*Figure 33. Control Options*

The second game from **BIBA** is named **RUEU?**

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*Figure 34. RUEU? Game*

**RUEU?** is a project targeted to research, design, develop and evaluate an innovative, interactive game that will help young people to explore national and European identity and values. It has an approach to present young Europeans with different problems that they can understand and relate to from their environment and surroundings. These problems are to be resolved by making decisions that will have considerable impact on their skills to perceive, connect and increase their understanding of Europe and European identity and values.



*Figure 35. RUEU? Homescreen*

The aim of this game is to teach, nourish, test, and extend the knowledge of European identity, values, cultures and traditions while keeping it interesting for the young learners. The topic regarding the conflict between national and European identity keeps on returning to surface from time to time. It will solve challenging problems along the line of conflicts, which are rooted

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to the discussion of identity. As it also has a social dimension to it, the players will need to collaborate with others to tackle the problems at hand and make decisions to resolve the situation to win or complete the game.

The game is played out in a scenario type environment in which the player has to collect different information via interviews, articles and research to form their own opinions on the assignments and present their newspaper article.



*Figure 36. Choosing an Assignment*

**RUEU?** develops reasoning and problem-solving skills as well as improving cultural and identity awareness. It does this by exposing different points of view from various backgrounds and encourages you as the player to form your own opinions on important cultural and political issues.



*Figure 37. Interview Scenarios Formulating Opinions*

The concept of **RUEU?** is a novel one and the scenario type game base structure could well be used for a number of educational purposes in game-based contexts throughout the INCLUDEME platform. However, the content in this specific game could become dated and lose some of its relevance if not developed upon.

**RUEU?** is shared with the project as a prototype which can be upscaled and adapted to be more accessible.

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The majority of the technology repository will be software based due to the nature of the INCLUDEME platform and the need for efficient access to the resources by its users. However, **BIBA** have in their arsenal the ability to provide the project with **IOT Devices and Sensors.**

Sensors have a unique role to play in serious games as when combined with GPS technology on many mobile devices they can be used to trigger events and learning material on screen to further enhance the pedagogical experience and gamification. Furthermore, sensors can add a layer of accessibility in terms of access to information that may not have been able via traditional means. If a user is unable to play a game in the conventional means due to impairment or disability, having a sensor trigger information due to proximity or certain event type can directly involve that user in the activity if they were otherwise unable. In effect, sensors can replace missing senses.

INCLUDEME is not just about gaming and gamified learning path. It is heavily rooted in providing access to information and educational content, whether that be online or in downloadable resources. An aim of the project is to educate teachers and trainers and the wider community on the best practices when teaching those who are disadvantaged, neurodiversity or impaired.

We therefore need accessible documents – created in a way that is accessible to assistive software and adhere to accessibility standards of creating document in this way. Information could be presented and available to download from the platform in the form of Microsoft Word docs, PDF, PowerPoint, Excel Spreadsheets, video, and audio files.

Partner **Advanced Technology Systems** (**ATS)** will be creating and sharing these **accessible documents** to be a comprehensive resource for the platform users.



## Accessibility of WORD documents

In order for **Word Documents** to be fully accessible, authors must use the following core principles:

- Use Headings and Lists
- Use Meaningful Hyperlinks
- Add Alternate Text for Images
- Identify Document Language
- Make Table Accessible
- Save as Accessible PDF
- Use the Accessibility Checker
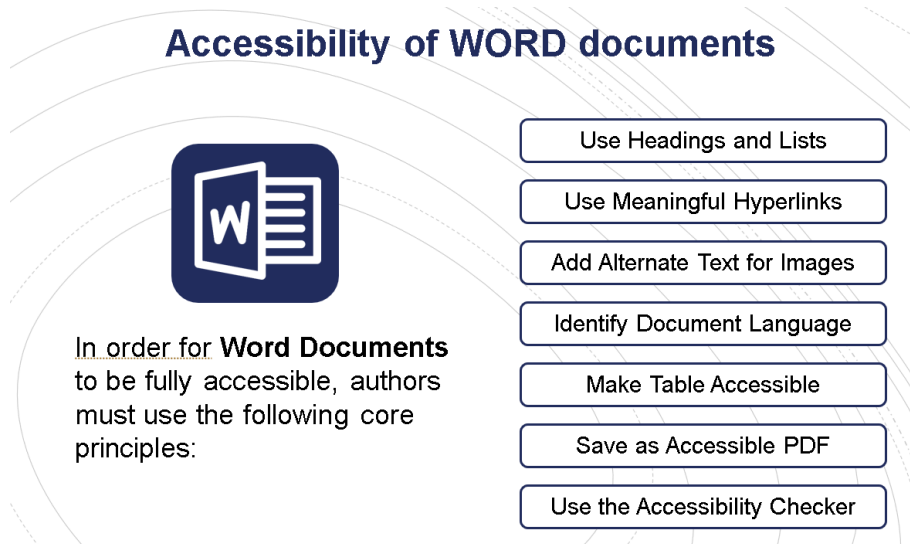
*Figure 38. Elements to Consider for Accessible Word Documents*

The technological infastructure of the platform needs a host, a stable server location giving reliable service to our target groups. **ATS** gives the means for this to happen by providing **cloud based hosting services** for the INCLUDEME project.

**Technology Repository – Collection of Supporting Technologies and Devices:**

| No. | Partner Name | Software & Hardware | Classification |
|-----|--------------|---------------------|----------------|
| 1 | HFC | ACE Toolbar | ¨ Accessibiity Tool |

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| | | | | |
|---|---|---|---|---|
| | | | An online suite of accessibilty tools at platform level | ¨ **All Age Groups** <br> ¨ Web-based <br> ¨ Product <br> ¨ Adaptable <br> ¨ Scalable <br> ¨ JavaScript & TypeScript <br> ¨ PC & Mobile Device <br> ¨ Multilingual |
| | | | **Docs Made Easy** <br><br> Word Add in – Accessibility Tool and Accessible document creator / checker | ¨ **Accessibiity Tool** <br> ¨ **All Age Groups** <br> ¨ Product <br> ¨ Windows / Word Installable <br> ¨ Adaptable <br> ¨ Scalable <br> ¨ Visual Basic / C# <br> ¨ PC |
| | | | **Suite of Games for Cognitive and Physical Impairment** <br><br> Online games with educational content and visuals | ¨ **Serious Games** <br> ¨ **Age 3 - 12** <br> ¨ Web-based <br> ¨ Product <br> ¨ Adaptable <br> ¨ Scalable <br> ¨ JavaScript & html <br> ¨ PC & Mobile Device |
| | | | **Suite of Accessible Games for Hearing Impaired & Disadvantaged Students** <br><br> Educational games with a focus on accessibility/sign language and mathmatics | ¨ **Serious Games** <br> ¨ **Age 3 - 24** <br> ¨ Unity based <br> ¨ Product <br> ¨ Windows Installable <br> ¨ Adaptable <br> ¨ C# <br> ¨ PC <br> ¨ Multilingual |
| 2 | UTH | | **Hera Project** <br><br> A 3D City builder game with a built-in CMS for both teachers and students | ¨ **Serious Games** <br> ¨ **Secondary / Higher Education** <br> ¨ **Collaborative / Social** <br> ¨ Unity based <br> ¨ Product <br> ¨ Windows Installable <br> ¨ Open Source <br> ¨ Adaptable <br> ¨ Scalable <br> ¨ C# <br> ¨ PC <br> ¨ Multilingual |
| | | | **LEAP Project** | ¨ **Serious Games** <br> ¨ **Secondary Education** <br> ¨ Unity based |

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| | | | |
|---|---|---|---|
| | | A suite of 3 serious games to encourage learners to adopt industry roles | ¨ Product<br>¨ Windows Installable<br>¨ Open Source<br>¨ Adaptable<br>¨ Scalable<br>¨ C#<br>¨ PC<br>¨ Multilingual |
| | | **Coding4Girls**<br><br>Online gaming platform for creating and learning coding courses | **¨ Serious Games**<br>**¨ Secondary Education**<br>**¨ Collaborative**<br>¨ Web-based<br>¨ Product<br>¨ Windows Installable<br>¨ Open Source<br>¨ Adaptable<br>¨ Scalable<br>¨ Unity & C#<br>¨ PC<br>¨ Multilingual |
| | | **Cminds**<br><br>Visual coding serious game | **¨ Serious Games**<br>**¨ Secondary Education**<br>¨ Unity based<br>¨ Product<br>¨ Windows Installable<br>¨ Open Source<br>¨ Adaptable<br>¨ Scalable<br>¨ C#<br>¨ PC<br>¨ Multilingual |
| | | **EnvKids**<br><br>2 different serious games about basic environmental sensibility for primary school children | **¨ Serious Games**<br>**¨ Primary Education**<br>**¨ Collaborative**<br>¨ Unity based<br>¨ Product<br>¨ Windows Installable<br>¨ Open Source<br>¨ Adaptable<br>¨ Scalable<br>¨ C#<br>¨ PC<br>¨ Multilingual |
| | | **Language Games**<br><br>Set of Language games for learning a secondary language | **¨ Serious Games**<br>**¨ Primary Education**<br>**¨ Collaborative**<br>¨ Unity based<br>¨ Product<br>¨ Windows Installable<br>¨ Open Source |

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| | | | |
|---|---|---|---|
| | | | ¨ Adaptable<br>¨ Scalable<br>¨ C#<br>¨ PC<br>¨ Multilingual |
| | | **SiLang**<br><br>Serious game to learn language in the working environment | ¨ **Serious Games**<br>¨ **Secondary Education**<br>¨ Unity based<br>¨ Product<br>¨ Windows Installable<br>¨ Open Source<br>¨ Adaptable<br>¨ Scalable<br>¨ C#<br>¨ PC<br>¨ Multilingual |
| | | **DT4S**<br><br>Design Thinking web platform, courses and collaborative features | ¨ **Serious Games**<br>¨ **Secondary / Higher Education**<br>¨ **Collaborative**<br>¨ **Social Interaction**<br>¨ Web-based<br>¨ Product<br>¨ Open Source<br>¨ Adaptable<br>¨ Scalable<br>¨ Angular & JavaScript<br>¨ PC & Mobile Device<br>¨ Multilingual |
| 3 | **BIBA** | **E.Civeles**<br><br>3D exploratory game for learning culture and heritage | ¨ **Serious Games**<br>¨ **Secondary / Higher Education**<br>¨ **Collaborative**<br>¨ Unity based<br>¨ Product<br>¨ Windows Installable<br>¨ Open Source<br>¨ Adaptable<br>¨ Scalable<br>¨ C#<br>¨ PC<br>¨ Multilingual |
| | | **RUEU?**<br><br>Scenario based game learning cultural identity and values | ¨ **Serious Games**<br>¨ **Secondary / Higher Education**<br>¨ **Collaborative**<br>¨ Unity based<br>¨ Product<br>¨ Windows Installable<br>¨ Open Source<br>¨ Adaptable<br>¨ Scalable<br>¨ C# |

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| | | | ¨ PC |
|---|---|---|---|
| | | **IOT Devices and Sensors**<br><br>Hardware devices for use with software and GPS on mobile devices | ¨ **Hardware**<br>¨ **All Age Groups**<br>¨ **Collaborative**<br>¨ Product<br>¨ Prototype<br>¨ Adaptable<br>¨ Arduino IDE, Raspberry Pi, esp32, Unity |
| 4 | **ATS** | **Accessible Documents** | ¨ **Accessibiity Resource**<br>¨ **All Age Groups**<br>¨ Web-based<br>¨ Adaptable<br>¨ Different File Types<br>¨ Downloadable<br>¨ Multilingual |
| | | **Cloud Based Hosting**<br><br>Hosting for the INCLUDEME Platform | ¨ **Infastructure**<br>¨ **Web-based**<br>¨ Service<br>¨ Scalable |
| 5 | **SWU** | **None Offered** – Training and Study Organisation | |
| 6 | **PAC** | **None Offered** – Training and Study Organisation | |
| 7 | **AAP** | **None Offered** – Training and Study Organisation | |

*Table 1. Technology Repository*

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ADVANCED TECHNOLOGY SYSTEMS

# 3 DISCUSSION

Chapter 2 has shown that we already have a comprehensive repository of software technology within the consortium that can be re-used, adapted, and further developed to suit the requirements of the INCLUDEME platform. This chapter serves to gather the resources together into their respective categories – Accessibility, Serious Games, Collaborative Authoring Tools, and Infrastructure to discuss their opportunities, best practices and limitations within the framework laid out in the DoA. It is necessary to further identify those areas of the platform where the technology repository falls short in terms of providing components for development. By realising the shortfalls at this stage, effective planning can be put in place to create and source these elements and integrate them with our existing assets.
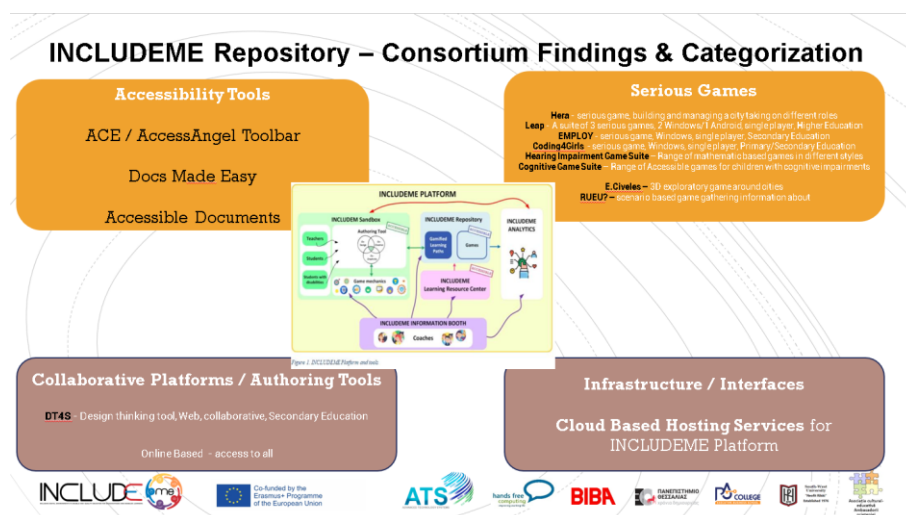


*Figure 39. INCLUDEME Categorization of Components*

## 3.1 Accessibility Tools

Accessibility is at the forefront of INCLUDEME, for the platform itself, the games, the authoring tool, and access to and navigation of accessible documents and information.

Accessibility for our users means the ability to manipulate the interfaces of the portal to suit their individual needs. On many websites and online platforms, we find that the text may be too small, the wrong colour, difficult to read elements on the page, wrong language or the interface is too busy with images and flashing content.

With the introduction of the **ACE/ AccessAngel** Toolbar the ability to change these aspects and more, is there any time it is needed. The suite of features available add an extra layer of accessibility to aid everyone, especially those with Dyslexia, Autism, ADHD, Visual Impairment and Physical Disabilities.

Being a web-based tool, **AccessAngel** is versatile in that it can be integrated platform wide, across all interfaces and within the sandbox authoring tool.

Commercial assistive technology products providing Speech Recognition, Colour schemes and Magnification are extremely popular but also come at a high price. **AccessAngel** provides those options too to allow the creation of documents, messages, and text online with accurate dictation and Magnification of the screen elements up to 50 times with crisp imagery.

This is not to say that the toolbar does not need further updates and features. It will evolve throughout the duration of the project to give even more accessibility coverage with added themes for visual impairment, simplify page settings and audio recording.

Having the accessibility toolbar integrated into the platform is not enough though to make INCLUDEME truly accessible to everyone. Yes, it gives a customisable experience, but it will not make the interface code itself accessibility compliant. That is to say, being compatible with external assistive software such as screen readers and eye gaze, providing alternative text tags for images and consistent keyboard navigation. For this, the interfaces of the INCLUDEME environment need to be programmed following the Web Content Accessibility Guidelines (WCAG 2.1) to achieve at least AA standard.

Giving the means to access information in your way is one thing but INCLUDEME strives to go that step further in not only giving a range of pre created accessible documents to download but by providing the tools and knowledge to give user the ability to create your own accessible documents themselves. **Docs Made Easy** is an intuitive tool that is a downloadable and installable add in for Microsoft Word. It allows the user to make their document accessible by changing text, font, spacing, titles, headers and checking accessibility standards. It is a valuable addition to create accessible Word documents quickly, however, it needs further development throughout the project lifecycle to include better functions for headers and titles, alt image creation and access to Word's accessibility checker. Furthermore, the ability to work across all Office applications would be beneficial within Office 365. For this to be possible Docs Made Easy would need to be created as an online resource.

With the tools already at our disposal, we have a fantastic foundation for making INCLUDEME accessible as per the DoA.

## 3.2    Serious Games

As we have seen from Chapter 2, the number of Serious Games available to the project is extensive. The range of subject areas, age groups and skill set to be learnt from these games further sits within the objectives of the project.

On the surface of it this is more than satisfactory but there are other factors to consider here. INCLUDEME is an online portal, but the majority of games documented are created within Unity and such require installation on a separate PC.  This proves a developmental issue in whether our programmers can effectively link these applications to INCLUDEME in order to track and analyse performance and usage. For example, the process of creating a gamified learning path within the authoring tool and picking and choosing from a range of gaming software to suit the learning objectives is ideal. However, if these applications are then required to have separate download and installation, then the trail of analytics and pedagogical value is lost at this point. It would be preferable if it was possible to load these applications within an iframe within the platform and keep playable data in house. Or another possibility would be to modify the source

code of these external games in order to introduce a common analytics engine that would communicate with the INCLUDEME platform. Although extensive modification would be needed to the games, this concept is technically feasible as the source code for the games is available from the consortium partners as well as the original developers. Further research is needed on this area however and consideration taken on the costs and man hours needed to undertake these modifications.

On the other hand, it could be argued that INCLUDEME serves as a pool of resources, so having downloadable games at your disposal covering the main aspects of education and skill acquirement, is a positive thing, and the fact usage is untraceable in the main portal is not a priority. These games and applications can just be added into the collaborative lesson, played separately to then move on to the next step of learning.

A developmental decision needs to be made on the functionality we want to provide in terms of downloadable content.

In light of that we note that a suite of online games for children with cognitive and physical impairments is shared by HFC which can directly interact with the project portal and give educational learning to a younger audience. During the development stage of the project a larger amount of these games can be developed to cover a wider subject range but there remains a gap in the resources available for each age group. Further online games will need to be developed to cover the wider age and learning range of our users, giving more choice for the gamified learning paths and authoring tool.

A requirement of the project is that the gaming content is adaptable to the teacher and student needs by way of the learning content offered. In many respects this is currently given in applications such as Hera Project and Coding4Girls – the option for different scenarios is tremendous. On the flip side, the other gaming options to us are fixed in their subject and learning matter and cannot necessary be changed to adapt to different learning styles and lesson plans. While these games serve a purpose, the idea of being able to input bespoke learning content into games is desirable and would provide a greater scope for learning objectives and the lifecycle of the finished product. It would therefore be desirable to develop a base structure of perhaps 3 to 4 online games, which allow the input of user content directly into the games themselves. For example, there could be a quiz game structure, a maze structure, or a racing car game structure in which different questions could be asked to proceed past a checkpoint or move onto the next level.

The accessible features and functionality of the serious games is also an important consideration. ACE / AccessAngel will not be able to provide assistance within the games, so accessibility features must be built in. There are similarities in the types of features required for accessible content, such as font sizing options, colours, and text to speech but gaming accessibility includes other factors such as being able to change the speed and difficulty, customising the amount of background and images, practice mode and tutorials as well as range of different control methods (mouse, keyboard and switches) to name a few.

By following the gaming accessibility guidelines, the relevant features can be put in place during game development, but it is pleasing to note that there are several gaming accessibility features implemented within the serious games already in this repository booklet, especially throughout the online games for children with cognitive impairments.

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## 3.3    Collaborative / Authoring Tool

INCLUDEME serves to be a collaborative and co-creative environment in which teachers and students can share ideas and create gamified learning paths.

We are privileged to be able to include and adapt the online DT4S platform for integration to form the basis of the authoring tool and collaborative sandbox area. As we previously discovered, DT4S offers the ability to create learning paths and courses and assign them to students, who in turn can work online together to brainstorm ideas, ask for help and review information. There is a large range of features available to both teacher and student which promote co design, co creation, social interaction, and reward.

By building on the current development of DT4S there is scope to connect the INCLUDEME repository (Gamified Learning Paths and Games) and Analytics to form the basis of the INCLUDEME Sandbox and Authoring Tool.

## 3.4    Infrastructure / Interfaces / Analytics

The hosting of INCLUDEME will be administered by a cloud-based server provided by ATS. There will be sufficient bandwidth and storage to cope with the usage demand across the continent.

We do not currently have any existing system for the front-end interfaces and feedback analytics at present. Aside from the authoring tool and gaming interfaces, there is a requirement to develop the main bridging interface of the project which will hold the INCLUDEME Information Booth and Learning Resource Center areas as well as the analytics dashboards.

Although there are no re-usable assets at this stage for these elements there is a sufficient skill base amongst the consortium partners to professionally develop these UI's, configure the analytics and connect the back end all together.

The technology repository show that we have a solid basis for steadily developing a prototype of the INCLUDEME platform. We expect to have the first pilotable protype by month 12 and then a pilotable protype by month 18. This will allow for extensive testing and a feedback period during the pilot phase. The results of the pilots and consortium feedback will shape the final design of the platform to reach development month 24.

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# 4 CONCLUSIONS

The main goal of this document was to provide a repository of existing technology resources that the INCLUDEME consortium can re-use, adjust and extend. These resources were to be mapped with best practice examples to the different components of the INCLUDEME platform in order identify gaps between what we have and what we need to further develop.
All partners have contributed to this repository of existing software and hardware and assets have been classified and stored within Chapter 2 of this document.

We already have a lot of resources available, which serve as a basis for INCLUDEME. Accessibility tools and accessible documents can be provided as well as a pool of serious games and platforms covering varying age groups and subject areas, all using different technology which can be recycled, adapted, and extended towards our needs. An available authoring tool / collaborative platform allows the creation of lesson plans, a design thinking methodology, social co – creation and reports on the students' progress. An available server infrastructure will be used for prototyping, automated builds, and testing, as well as for hosting the overall architecture and running of INCLUDEME.

However, there are challenges that exist. Even though we have an excellent starting point, consideration is needed around the connectivity of the serious games to the inner workings of the platform. The fact that many of our resources are standalone downloadable applications gives rise to whether we can host them as online running applications or provide a mix of software on and offline. There are some elements that require more work than others - therefore, the provided games need to be adjusted to the appropriate content and functionality for accessible gaming. Some requirements listed in the DoA do not exist yet and have no cover within this repository such as analytics and front-end UIs, so development time and skill sets need to be factored into the wider context of the gamified learning system.
This deliverable is used as input for WP4.

## APPENDIX:

### Table of Abbreviations

| | |
|---|---|
| **AAP** | "Friendship Ambassadors" Association |
| **ACE** | Accessible Content Everywhere |
| **ADHD** | Attention Deficit Hyperactivity Disorder |
| **ATS** | Advanced Technology Systems |
| **BIBA** | Bremer Institut für Produktion und Logistik GmbH |
| **C4G** | Coding for Girls |
| **DTG** | Direct Target Groups |
| **DOA** | Description of action |
| **DT4S** | Design Thinking for Sustainability Education |
| **HERA** | Higher Education Re-Engineering through Active Learning for Growth |
| **HFC** | Hands Free Computing Ltd |
| **INCLUDEME** | Inclusive Digital Environments to Enable High-Quality Education for Disadvantaged and Disabled Learners |
| **IOT** | Internet of Things |
| **LEAP** | Lean And Agile Practices Linking Engineering Higher Education to Industry |
| **LMS** | Learning management system |
| **PAC** | P.A. College |
| **SWU** | South-West University |
| **UTH** | University of Thessaly |
| **WCAG** | Web content accessibility guidelines |

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