

## A SERIOUS VIDEO GAME FOR SMART FARMING TECHNOLOGIES

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### ABSTRACT

GATES is a near-to-market (Technology Readiness Level 7) serious game-based training platform that, through the use of a range of gaming technologies (3D scenarios, interactive storytelling, modelling and data), will train professionals and other stakeholders in the value chain in the use of Smart Farming Technology. It is a cross-platform (Desktop/Mobile/Web) available for Android and Windows featuring online and offline synchronized modes. GATES features learning and behavioural triggers for stimulating players' engagement, creativity and collaborative behaviours, while caring for gender and environmental issues related to the use of Smart Farming Technologies. In the current version, the player can choose between five crops (wheat, corn, potato, apples and vineyards) and can select one of multiple field operations, such as irrigation, fertilization, spraying and harvesting. The outcome of this serious game is a set of economic and environmental output of the selection of specific choices by the users. The gaming platform will be marketed as a white-label app, and will function either as a stand-alone or as a complementary tool to traditional training methods, covering a wide range of agricultural settings for the needs of different professionals in the Smart Farming Technologies value chain.

**Keywords:** smart farming, precision agriculture, gamification, H2020

### 1. INTRODUCTION

Smart Farming Technologies (SFT) are related to more efficient application of inputs (seeds, fertilisers, chemicals, water, fuel and labour), increased work speed and comfort and enhanced flexibility on-farm. Europe plays a dominant role in the global production of SFT, with nearly 30% of the global production output of agricultural machinery in 2014 having been produced by companies within the European Union. The European agricultural machinery industry includes 4,500 manufacturers (with over 95% SMEs) employs 250,000 people and in 2015 produced a value of 25 billion Euro (CEMA, 2014). SFT can contribute to the wider goal of meeting the increasing demand for food, feed, and raw materials while ensuring the sustainability of primary production; however, the fast pace of development of these technologies, their complexity and the lack of expertise of end-users have hindered its adoption (JRC, 2014).

The increasing pace of development of SFT over recent years, the costly equipment needed for its implementation and the wide range of existing solutions for addressing the increasing complexity of agricultural systems in a context of climate change, indicates the need for innovative and integrated

training approaches in order to allow end-users to fully tap the benefits of SFT. Traditional training approaches (seminars, self-training material, technical simulators and on-line courses) have proved to be useful for training professionals on the benefits of SFT. On the other hand, they are not always scalable and cost-effective. In addition, the adoption of smart farming has not reached high level numbers, as it was expected due to many reasons that have been addressed by many studies (i.e. Fountas et al., 2015; Barnes et al., 2019).

Gamification is an approach for training professionals and has demonstrated potential to improve many aspects of how businesses provide training to staff and communicate and engage with consumers, boosting knowledge and loyalty among customers, channel partners and other stakeholders. Game-based learning has been demonstrated to be of great efficacy to comprehensively absorb and practice complex concepts and procedures under simulated working conditions, particularly in fields where workers have to learn how to use expensive and/or technologically complex equipment, such as SFT. Game-based learning increases participant's interest while making the training process more enjoyable, memorable and effective based on an engaging experience and a safe environment for failure.

Learning through play is a well-known concept. Educational computer games, underpinned by instructional goals and appropriate application of game mechanics, have considerable potential for training adults through their ability to engage, motivate and influence the behaviour of learners. It is the attributes of games, such as compelling storylines, attainable challenges, rewards, recognition, controlled and a safe environment to fail and try again that make them so powerful for learning (Groff, et al., 2010; Klopfer et al, 2009). Well-designed serious (educational) games make learning fun, challenging and rewarding. In terms of suitability for learning, there are significant parallels between many of the learning theories applied to the design of e-learning courses and the principles of game design.

The objective of this serious game was to develop a serious game-based training platform that, through the use of a range of gaming technologies, will train professionals and other stakeholders in the value chain in the use of Smart Farming Technology. GATES game aimed to develop a serious gaming cross-platform (Desktop/Mobile/Web) available for Android, iOS and Windows featuring online and offline synchronized modes.

## **2. METHODOLOGY**

The development of the serious game followed the minimum viable product or Minimum Viable Game (MVG) approach, where three iterations were created. This general agile methodology that was used for the development of the MVG is a mix of Scrum and classical sequential project management ("waterfall"), which allows for an iterative process with the addition of having a more feasible control of the workload. Scrum is an iterative process, where the ability to respond to requirement volatility and unpredictable changes in an efficient manner is a key principle. An Iteration (or sprint) is a defined time frame, where a product increment is achieved. Advantages of this agile approach are among others, the flexibility in the development process, a high level of engagement and communication between the team members and good transparency of the team's velocity through burn-down charts. The three MVGs were evaluated by end-users (farmers, students, farm machinery professionals) in Spain, Serbia and Greece following a semi-structured questionnaire. For the development of the GATES game, the Unity3D Engine was chosen. Unity3D Engine provides a full - fledged engine for creating games but also an easy way of deploying the created game on several different platforms (web, android, iOS).

## **3. RESULTS**

The GATES training platform is made as a single player game with online capabilities. At the main menu, the player is able to start the game immediately, either creating a user's profile or without registering

so as to be logged in online automatically. On demand, the user is able to register the account and associate a user name and password. By doing that, the player is able to save and resume the game, whenever they want. The “Main Story” game mode is split into stages, with each one of the stages focusing on increasing player’s awareness about the existing SFT and/or benefits deriving from their application. Each stage starts with a mini tutorial informing the player about the stage tasks, while the tutorial character Trektor (Figure 1) informs players during the stage progress about the effects of each of their actions in form of info tips.

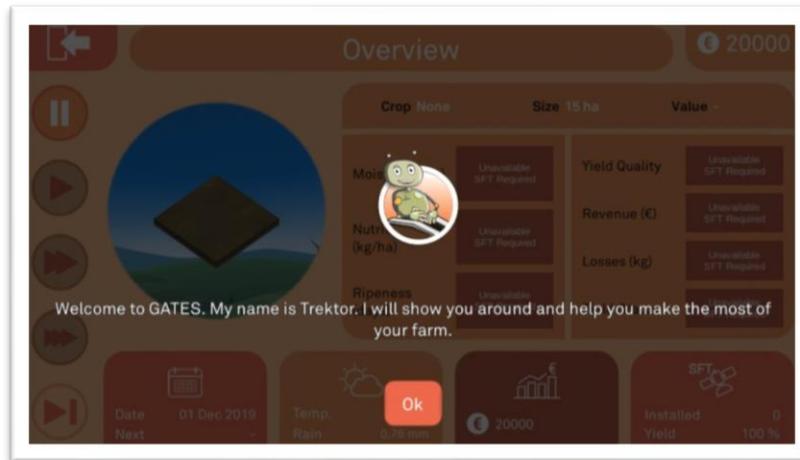


Figure 1. Welcome page with the Trektor instructor

GATES consists of a number of modules that are important to run the game. **The Farming Module** is the core of the GATES serious gaming platform. All the game modes use the farming module as their main playing environment, which contains all the modelling and algorithms needed for the GATES game mechanics. Through it, a representation/simulation of the real world is done, by running the necessary models for defining the negative or positive effects of each type of in-game interaction (e.g. usage of a smart farming service by a farmer), or event (e.g. rain). The Tutorial module is an interactive in-game tutorial which helps players to perform required actions, resulting in better retention. GATES consists of an initial tutorial in which in the first minutes, users will become familiar with the User Interface and will complete their first tasks by purchasing SFT equipment/services (e.g. Variable Rate Seeder) and by applying it in the field (first seeding operation). **The Statistics module** illustrates complex information in a simple manner and allows the game to showcase the authentic effects of SFT in a comprehensive and precise way. This module explains the actions taken by the user by visualizing their effects, allowing players to investigate and analyze their actions and to change their gameplay in order to improve their performance and reach their goals. Finally, the Logger module is used by the GATES platform for improving the game itself and for providing better training results to the users.

In addition, the **Library module** is an in-game educational content, which provides to the players the basic knowledge needed for completing game tasks. The online wiki library provides extensive information on each aspect related with SFT, not only for helping players completing the various game tasks but also for providing an educational tool able to help them in deepening their knowledge on SFTs. The wiki page material is available in the online form, showing documents, presentations, videos, images, diagrams, and links. **The Scenario Creator module** allows users to create custom scenarios defining winning conditions, the SFTs usage, country, area, amount of money, etc (Figure 2). The level of the scenario creator customization ability will vary. Users with the lowest fee will be able to create simple scenarios and to invite friends to play, while users with the highest fee, will be able to create tutorial character info tips, upload 3D models, upload education material, create puzzles and create interactive guides. Moreover, users with the highest fee will have the option to evaluate the invited players’ performances in their created scenarios through the Logger Module. This will help them to find the weaknesses and the strengths of their invited users with respect to the scenario tasks and SFT

displayed. The “Scenario Creator Module” will be available to Premium users according to the game Business Model.



**Figure 2. Story scenarios selection**

Moreover, the **SFT 3D Interactive module** is using GATES 3D engine. This module will simulate the real usage of certain SFTs in the 3D environment and will be used for teaching and preparing players to operate SFT equipment. The players will be able to see and interact with SFT interfaces and they will be able to create interactive guides (using hints and instructions) and puzzle development (Figure 3). For example, puzzles will start with very simple tasks (e.g. turning the machine on and starting it with default settings) with the difficulty to be increased gradually (e.g. player must make finer adjustments over the course of the game, optimizing its usage). Moreover, through this module, a virtual showroom with 3D-Models of various SFT equipment will be developed. Finally, **Social Module** has its own pages on Facebook and LinkedIn Social Networks, which is connected to the game through and Application Programming Interfaces (APIs). Besides regular activities that can be done on such networks they will also be used for triggering competition and engagement behaviors: e.g. when a player will achieve a learning goal and earn the "badge" for the particular SFT, a post will appear on the social networks mentioning her/his progress.

The GATES game environment is user friendly and easy to be played by the end-users with limited training and explanatory time and presents the main information that a person working with agriculture needs (Figure 4). These features are related to soil moisture, maturity level and nutrition needs. The outcome values of the game are yield, quality, field status and revenue. On the bottom of the main screen, can be seen the cultivation calendar, the current weather information from the already installed weather information from previous years, the total revenue, as well as the number of SFTs already installed in the game. In the picture window, the different operations are illustrated, such as soil cultivation, seeding, spraying, irrigation, fertilization or harvesting.



Figure 3. Farm machinery equipment with SFT systems in 3D environment



Figure 4. GATES main overview functions

In the evaluation stage of the project, in total 750 users participated in the three stages of validated learning cycles, but the number of users included in the workshops, presentations and direct contact was much higher. From those who fulfilled the surveys, this is the distribution by type: (Farmers: 253; Students: 297; farm machinery specialists: 204). The satisfaction level was increased from MVG1 to MVG3 and among all modules the 3D interactive module was perceived as the most useful and entertaining to play with.

#### 4. DISCUSSION AND CONCLUSIONS

The main value proposition of GATES is that it provides a serious game-based training platform, making use of different gaming technologies, in order to train professionals across the agricultural value chain on the use of Smart Farming Technology, thus allowing deploying its full economic and environmental potential in European agriculture. As for its main benefits, GATES offers a convenient online way for farmers, agricultural engineering students, machinery manufacturers, AgTech businesses, SFT consultants, farmer cooperatives, etc., to obtain knowledge related to the latest developments in smart farming technologies. Thus, this concept is effectively turning GATES into a repository of information regarding SFTs and a one-stop-shop for interactive learning about their positive impacts

on agricultural production. GATES offers its platform as an appealing and fast interface needed to browse through a variety of SFT solutions and find the most suiting one.

A large number of end-users, who have tested the game commented that language selection is very important, as most farmers are not used in working with English terminology for their farming businesses and they would like to see an instructor/tutor in most scenarios helping them to choose the most appropriate SFTs for their fields. The lean start-up methodology with the three iterative cycles was an extremely important process for the future success of the whole GATES concept, which connected the developers with the testing communities counting several hundreds of users. The feedback collected and the process itself presents valuable points of direction where the final version of the game should lead to.

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