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A serious game to promote and facilitate entrepreneurship education for young students

Mario Allegra
Institute for educational technology
Italian National Research Council.
Palermo, Italy

Valentina Dal Grande
Institute for educational technology
Italian National Research Council.
Palermo, Italy

Dario La Guardia
Institute for educational technology
Italian National Research Council.
Palermo, Italy

Manuel Gentile
Institute for educational technology
Italian National Research Council.
Palermo, Italy

Simona Ottaviano
Institute for educational technology
Italian National Research Council.
Palermo, Italy

***Abstract*—The paper describes a serious gamedesigned and implemented within the framework of the European project "Posso … Non Posso … Vado! PNPV Project Rev.2 (I can ... I cannot ... I go!) which aims to introduce and foster an entrepreneurial mindset among young people. The focus of the game is on the management of a touristic company, in a complex market in which players compete with other companies/players. After a brief overview on Entrepreneurship Education, the paper describes the structure of the gamethat allows players to face increasingly complex situations, through learning by doing and learning by failing methodologies. Thenthetools integrated in the game to support teachersin analyzing students' activities are described.**

***Keywords*—Serious games, Game-based learning, Multi-agents systems, Agent-based computational economics, Business games, Entrepreneurship education, Market modeling and simulation**

I. INTRODUCTION

The Communication from the Commission to the European Parliament entitled "Entrepreneurship Action Plan 2020"[1]highlights the role of entrepreneurship education as a key strategy to stimulate economic growth in Europe.Short-term and mid-term entrepreneurship education policies can be a way to overcome the economic crisis that has gripped European economic systems.The role of entrepreneurship education is also stressed in the Annual Growth Survey[2] and in the Agenda for new skills and jobs[3]. According to this agenda it is necessary to promote the full integration of entrepreneurship education at all educational levels and throughout the common curricula of all the Member States.As stated by the report "Entrepreneurship Education at School in Europe: National Strategies, Curricula and Learning Outcomes" [4][5] entrepreneurship education is not yet sufficiently integrated in school education in all the European countries and at the different educational levels, so much work remains to be done in order to move away from entrepreneurship education as a marginal activity reserved for business subjects towards more creative and experiential learning for all. The full implementation of European policies regarding entrepreneurship education requires a transition from the "declaration of intent" contained in national strategies (if any have been adopted), to concrete and effective changes in teaching programs.

From a pedagogical point of view, although a wide range of methodologies exists, we think that to improve the key entrepreneurial in the students is necessary to use an experience-based teaching method, in which the student plays an active role. As demonstrated by several studies [6][7] simulated environments make the learning experiences more useful and effective[8]. Serious games and simulations have had a significant effect on classroom education as well as on training programs[9], increase a learner's motivation, enabling him to embark on engaging and challenging paths through educational material and activities. The use of serious games is often integrated into blended educational models, thus creating an opportunity for teachers to exploit their potential in specific parts of traditional learning paths. In this manner the blended model can increase the experiential aspects of educational paths [10]. For this reason, we have defined and developed a serious game, called PNPVillage,that will be describedin the following paragraphs.

Fig. 1. PNPVillage Student Interface

II. PNPVILLAGE

PNPVillage is a web-based game, developed according to the following general aims:

- to create a simulated environment very close to the real world, allowing students to understand elements of complex situations;
- to encourage competitive dynamics among students;
- to promote self-monitoring and teacher monitoring activities, by means of indexes that summarize market trends and aid/facilitate interpretation;

This serious game tests the skills of students in the management of a tourist resort. The tourism context has been selected because it is close to the students' experience/life; thus, the students are trained in the management of a familiar business.The serious game is integrated in a blended educational path that combines both face to face learning and distance learning, in a formal and informal way. It includes:

- Classroom activity, centered on the teacher's explanations and collective analysis of the results of the last game/simulation phase;
- Laboratory activity, centered on the serious game and aimed at experiential learning and transfer of knowledge and skills;
- Online learning activity, in which students can study the educational content in depth by means of anLMS.

The game engine was integrated with a Learning Management System (LMS) in an attempt to exploit the potential of two different environments [11]. At the design phase it was important to strike a balance between an absorbing game and the educational aims, integrating the educational contents with the activities and objectives of the game [12].

The students are invited to compete in groups to manage their virtual companies efficiently, getting the necessary information in the educational forms of the LMS. Thus a scaffolding approach was adopted where students can enjoy the game as well as studying some topics in depth to improve their educational results and game scores. The help provided by both the educational contents and the face-to-face activities with teachers is intended to ensure the achievement of the educational targets.

All groups operate competitively into a single simulated market. In this way, the result obtained by a single group does not depend just on its own choices but also on those made by all the other groups. This leads groups to compete in an environment very similar to the real world, where the success or failure of a business is determined not only by personal ability and entrepreneurial skills but also by the behavior of its competitors.In order to promote competition and business diversification, the market was segmented into five standard types of customers: VIPs, Professionals, Middle class families, Young families and Popular class families. Each category of customers is characterized by a different propensity to spend and different "needs". These differences are crucial in the process of negotiation and purchase of touristic package by an individual customer.

The following simplifications have been made to reduce the complexity of the game andenhance theeducationalvalueof the game:

- the touristic package has a virtual duration of one week (it is not possible for the customer to buy portions or multiples of one week);
- the customer purchases the package at the beginning of the week and occupies immediately the corresponding accommodation (a reservation mechanism has not been implemented);
- the customer is an individual customer (not considering the number of family members and consequently the "capacity" of the accommodation);
- season differences have not been taken into account (there is no high/low season difference for the consumer).

III. PNPVillage Structure

PNPVillage is divide into 7 levels. At each level, the students will afford new entrepreneurial concepts related to the management of the village through the activation of specific decision-making levers.

The number and complexity of the concepts and their related levers will increase during the game.Decision-making levers can be divided into strategic and operating levers.

The strategic levers represent the management goal in terms of marketing strategy over a long period and are:

- Business Strategy
- Market Segment

Theoperating levers represent operative choose and are:

- Accommodation Units
- Communication
- Price
- Staff for the Accommodation Units
- Food services and related staff
- Corporate Social Responsibility
- Sport and wellness services and related staff.

A Non Player Character (NPC) called Candy,will present the level's goals and teaching materials to the students. Candy will support the student through the entire game with tips and information to overcome the problems that will arise. At every level, new concepts related to decision-making levers, will be deepened through the study of teaching material directly accessible from the game.

Ineach level, players will have to manage the village during 1 virtual year, which has been split in quarters. In such a way, students can analyze the results of their decisions after each quarter, and apply the necessary changes to their management strategy.

The gameprovidesthe studenta set of tools, accessible throughthe user interface(Fig. 1) that canhelp him during the operational decisions. The user interfaceprovidesthe following tools:

- Village Revenue Status (it offers an overview of the economic results).
- Staff Status (it provides an overview on the staffemployed in the village).
- Real Estate (it allows to check the units and services fitted in the village with the related selling expenses and maintenance).
- Market Research (it gives to the student a more detailed view of the market).
- Charts (it displays trends of growth/decline in sales, revenues).
- Reports (it shows the player business results of the level).
- Construction (summary of all the accommodation and services modules that can be inserted into the village).

Moreover, the user interface shows an overviewof the village andan instrument panel (dashboard)that informs theplayer on the evaluablebudget,the maintenance costsof accommodationand its services, the staff costs, the year and the quarterin progress.

The 7levels of the play are presented below. Keep in mindthat at eachnew levelthe student can act back on thedecision-making levers of the previous levels. Below the levels:

- Level 1: the student has to choose the marketing strategy, the market segment, the name and the slogan of the village. Finallythe student will be able to build his own village inserting accommodation units and sea services.
- Level 2: the student can select the most appropriate communication tools for the chosen market segment pursuing an effective advertising policy.
- Level 3: the student can change selling prices of his touristic packages.
- Level 4: the student can recruit/release the reception staff.
- Level 5: the student can create a catering service in the village and recruit/dismiss its staff.
- Level 6: the student is to face the corporate social responsibility issues. He can also decide to create green areas, to eliminate architectural barriers as well as to make his employees follow an up-to-date training.
- Level 7: the student can build sports facilities in the village and recruit/dismiss its staff.

IV. The Market Simulation

One of the main objectives of the game design was to make the market dynamics simulation as realistic as possible and consistent with what happens in everyday life.

From the theoretical point of view, two main approaches for the implementation of a simulated market are compared in the literature:

- the definition of a system regulated by macro-economic laws in which the aim is to model the behavior not of one particular unit, but of all the units combined;
- the definition of a system in which a multitude of actors, each with their own particular behaviors,

interact with and generate the market dynamics. This approach is based on the study of one particular unit rather than all the units combined.

The dualism between the two paradigms(Macro Economics paradigm vs Micro Economics paradigm), has been analyzed in the field of economics since the last century, and even today, it remains at the center of scientific debate.

In the last few decades some researchers have suggested analyzing the market dynamics with the same techniques used for studying complex systems.

A complex system is a system composed of a series of distinct elements that interact with each other; the complex system, as a whole, exhibits one or more properties not clearly derivable from the properties of the individual parts.

The main aim of this approach is to overcome the distinction between the two classical approaches by trying to explain the dynamics of the market at a macro level as emerging properties of a complex system in which individual economics actors operate at the micro level. In this way the theories at both micro and macro levels can find an empirical validation. In this context, according to Flake [13], it is possible to consider the tourist market sector as a complex, adaptive system. A complex system is adaptive if it consists of reactive elements, namely elements capable of varying their own attributes in reaction to changes in surrounding conditions.

The evolution of information technology has led to the emergence of a field of research known as the agent-based system. Multi-agent systems are software systems consisting of independent entities, called agents, each of which is able to interact with the surrounding environment according to a predetermined behavior.

The agent-based systems are now considered to be a useful tool that allows researchers in the economics field to simulate market dynamics and thus validate economic models. In fact, the computational study of economies modeled as evolving systems of autonomous interacting agents has given rise to a research sector known as Agent-based Computational Economics (ACE). ACE is a specialization of economics of the basic complex adaptive systems paradigm [14].

From an economic point of view, this methodology was the theoretical basis for the simulation of the tourism market in the PNPV game. By adopting a multi-agent approach, it is possible to customize the behavior of each agent without having to change the entire system. In this way, the behavior of each agent can be gradually improved and made more complex. Finally, from an educational perspective, the multi-agent approach allows the teacher to gradually make the students aware of the real behaviors of each agent; in this manner the students can analyze the appropriateness of their decisions in the light of these agent models and then recognize the strengths and weaknesses of the strategies adopted. According to Blikstein&Wilensky [15], the simulation is transformed from a purely mathematical tool into an active teaching tool in the hands of students.

According to Allegra [16], different types of agents, autonomous and semi-autonomous, have been defined. The behavior of semi-autonomous agents is customized by the user by means of the game interface. In particular, the identification of the agents and the definition of their behavior were made by experts in economics who guided the development of the simulation; they also supported the tuning phase and the validation of the overall model.

V. Behind the Game: the Succes Indexesand Market Dynamics

In our game, the dynamics of the market are regulated by two main indexes: Market Visibility and Value For Money.

The Market Visibility Index (MVI) measures firm market visibility, in relation to a particular market segment. The level of visibility of a firm is calculated as a function of the investments in communication made by all the firms, for each communication channel. The Value For Money (VfM) is a parameter expressing the quality of the operational choices made by a single firm in relation to the different types of customers. From the customer's point of view, it is the main element for evaluating and comparing the offers of the various firms.

The success is determined by the consistency of the choices made by the villages (i.e. by the group of students) on the various levers that have an impact on these three variables.In fact, the student manages these three variables generally indirectly through the operative levers.The manner in which the various operative levers impact on the three variables also varies from level to level.

The Value for Money is a parameter whose value varies from 0 to 1. The factors that contribute to determining its value are:

- Accommodation Units (AU)
- Beach services (BS)
- Staff (STAFF)
- Food services and related staff (FOOD)
- Corporate policies about Social Responsibility (CPSR)
- Sports and wellness services and related staff (SPORT)

The following table reports the weights with which the different components affect the total VfM; these values are function of the level and take into account the progressive activation of the levers from level to level.

TABLE I. VfM FACTORS BY LEVELS

LEVEL	AU	BS	STAFF	FOOD	CPSR	SPORT
1	70%	10%	20%	0%	0%	0%
2	70%	10%	20%	0%	0%	0%
3	70%	10%	20%	0%	0%	0%
4	50%	10%	40%	0%	0%	0%
5	30%	10%	30%	30%	0%	0%
6	30%	10%	20%	20%	20%	0%
7	30%	10%	20%	20%	20%	20%

The evaluation of the offers made by the villages for a specific type of accommodation, is based precisely on the VfM.

In comparing the offers of several villages of a specific type of accommodation unit, the VfM parameters are multiplied by a factor to simulate the elasticity of demand with respect to price.

For each village the VfM is multiplied by a factor that depends on the ratio of the selling price of the accommodation unit required by the customer with the average prices proposed by the other villages for the same accommodation type.

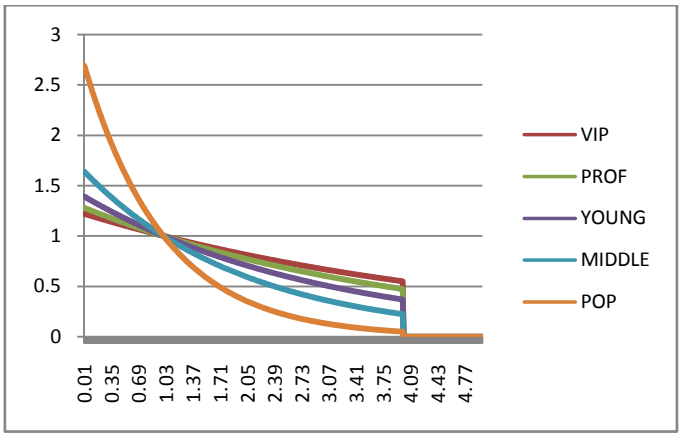

Fig. 2. Multiplication factor for consumer category

Starting from this ratio we have a different multiplication factor for each consumer category, in order to introduce the elasticity of demand with respect to price(actually that some categories are much more sensitive to the price compared to others).

The fig. 2shows the trends of the multiplication factor by the ratio for each consumer category.If the ratio exceeds a factor of 4 the value of this component VfM is cleared to 0.

In the next sections, you will see how each component of the VfM is actually related to operative levers.

A. AU- Accomodation Units

What determines the value of this component is the composition of the village in terms of types of accommodation available. Starting from the accommodation preferences for various categories of customers and considering the composition of the village (it refers to the percentage of units of a certain type in the village compared to the total number of available accommodation units), we obtain a measure of how a village adheres to the characteristics of individual market segments. These measures are then normalized to get a value from 0 to 1.

B. Beach Service

The key parameter that determines the value of this component is the average selling price of the village. Each type of umbrella is characterized by a selling price. The price is initially set by default and cannot be changed.

The average selling price is compared to the average of all villages.

A village with a selling price higher than the average price will be advantaged on VIP and Business categories and penalized on the others.

Of course we will have an opposite behavior for villages with prices lower than the average.

C. Staff

This component of the VfM is determined by various factors such as:

- Salary of the Director, which is compared to the average remuneration of directors of the other villages
- Presence of at least one clerk at the reception with knowledge of two foreign languages
- Presence of at least one clerk at the reception with knowledge of one foreign language
- No. of cleaning staff per Suite, a ratio which is compared with the average of the other villages
- No. of floor waiters per Suite, a ratio which is compared with the average of the other villages
- No. of staff for spring cleaning per suite, a ratio which is compared with the average of the other villages
- No. of staff for spring cleaning per bungalow, a ratio which is compared with the average of the other villages
- No. of animator staff for beach services, a ratio which is compared with the average of the other villages
- No. of lifeguards for beach services, a ratio which is compared with the average of the other villages.

These parameters act differently on different types of customers. In particular the categories VIP and Business are more interested in having qualified personnel (e.g. a director with a high salary) and are interested in cleanliness levels of the suites. While the other categories are concerned with the cleanliness of the bungalows and adequate levels for entertainment and beach services.

D. Food

This component of the VfM is determined by the type and variety of restaurants and food services in the village.

The possible services that a village may include are:

- Food shop
- Market
- Self service
- Restaurant
- Organic food restaurant
- Bar

in three different dimensions (Small,Medium and Large).

Business and VIP categories prefer restaurants and in particular the organic restaurants, while the other categories prefer other types of food.

The value thus obtained is multiplied by a factor that indicates how much the village has a staff adequate - in terms of numbers and professional skills – to the new added services.

In fact, each service needs staff which must be appropriate both in numerical and a professional terms, as indicated in the teaching cards. The relationship between the optimal staff for the village and the current staff indicates how much the group has approached the optimum.

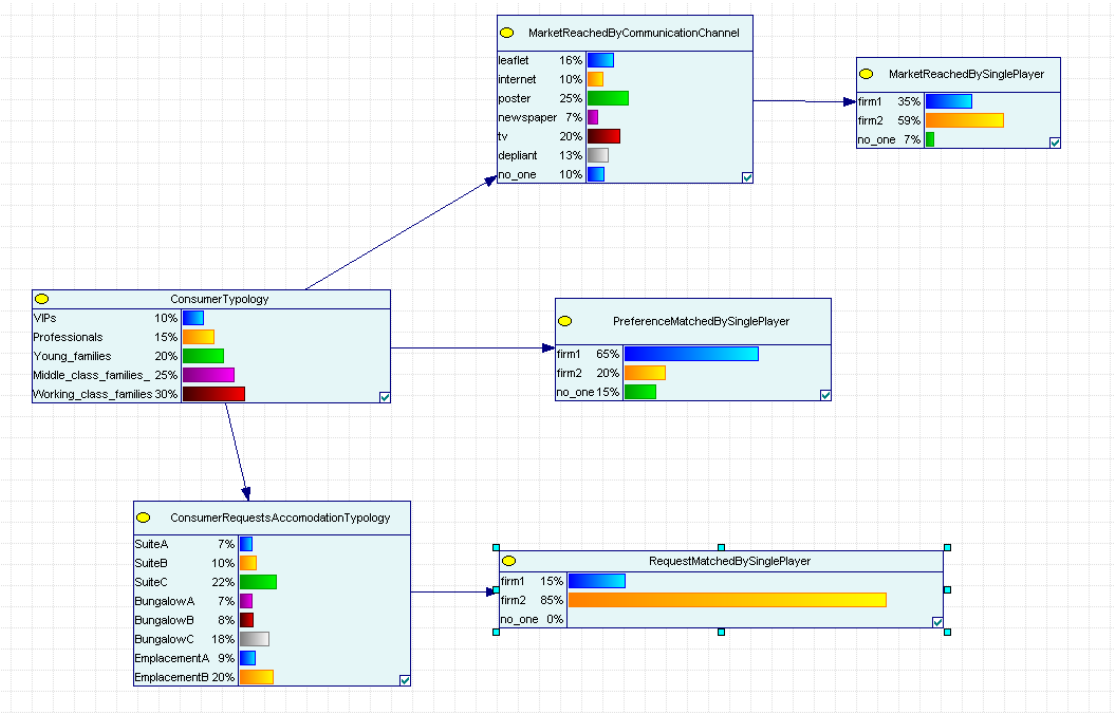

Fig. 3. The Bayesian network of an instance of the game

Adding personal beyond that strictly required does not provide any advantage in this component of VfM while penalizes the village from the point of view of costs.

E. Sport and Wellness

This component of the VfM is determined by the type of sport and wellness facilities available in the village.

The possible services that a village may include are:

- Children swimming pool
- Adult swimming pool
- Tennis court
- Soccer field
- Bowling green
- Beach volley

Each service is characterized by different preference values for each type of customer; the preference values define a "preference vector". For example, tennis and swimming are preferred by categories VIP and Business class. By summing up all the "preference vectors" for all sports available in a village, we obtain a vector specific to the village for those services that determines how the village can satisfy the different types of clients. These values are multiplied by a factor that indicates whether the staff of each village is adequate for all the sport and wellness services offered. In fact, as indicated in the teaching cards, each service needs some professionals. The relationship between the theoretical optimal staff available in the village and the current staff determines how the organization of the village is close to the optimal configuration. Adding staff beyond what is strictly required does not provide any advantage for this component VfM while penalizing the village from the point of view of costs.

Approximately categories Business and VIP prefer tennis and swimming pool while other categories prefer other types of facilities.The value thus obtained is multiplied by a factor that indicates how much the village has a staff adequate - in terms of numbers and professional skills – to the new added services.In fact, each service needs staff which must be appropriate both in numerical and a professional terms, as indicated in the teaching cards. The relationship between the optimal staff for the village and the current staff indicates how much the group has approached the optimum.Adding personal beyond that strictly required does not provide any advantage in this component of VfM while penalizes the village from the point of view of costs.

F. Corporate Social Responsibility

The value of this component is given by the procedures relating to corporate social responsibility activated by the village, such as:

- Staff training
- Recycling
- Renovation of kitchen ventilation systems
- Elimination of architectural barriers
- Adoption of an ethic code

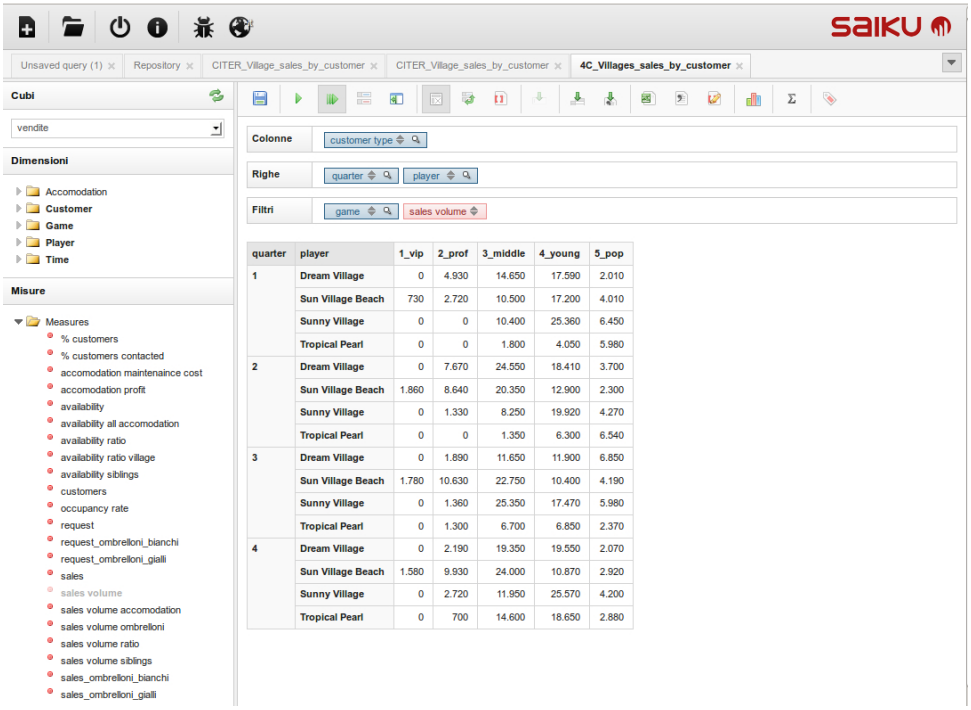

Fig. 4. The Business Intelligence tool interface

In addition, the player can add green areas in the village that will be evaluated quantitatively and compared with the average of the other villages.

VI. TOOLS TO SUPPORT THE TEACHER AS LEARNING FACILITATOR

The design of the game gives an important role to the teacher in analyzing the students' activities. Teachers will help students highlighting strengths and weaknesses of their choice and the effect on the business results.

For these reasons, two instruments has been developed in order to analyze the market trends and choices of the individual groups:

- a Bayesian network, that can provide a probabilistic explanation of markets starting from their structure and the choices made by the individual groups. Using this tool, the teacher can synthesize the "state" of the system in a few numbers and analyze the consistency of strategic and operating decisions made by the students.
- a business intelligence tool, that allows teachers to analyze the results of the simulation at any level of detail, evaluating not only the sales data but also the unmet demands by individual villages.

The Bayesian network is a tool that allows the teacher to get an overview of how the choices made by individual villages could affect the market dynamics.

As an example, from a consideration of the composition of the market, it is possible to verify how this combines with the characteristics of the different types of customer so that these segments can be reached from the different channels of communication. Moreover, by linking this information with the probabilities of channel use, the teacher can find out the market share reached by each village. In fact, a customer will not have a perfect knowledge of the market but can only contact those villages that have invested in the communication channels preferred by that type of customer.

By setting an event in the *ConsumerTypology* node, the teacher can obtain the same information (the market share reached by each village) for a specific customer type (Fig.3).

Conversely, by setting an event in the *PreferenceMatchedBySinglePlayer*node, the teacher can find out the market reached by a single village segmented by customer type.

This information is critical for understanding whether a group has made the right marketing choices in order to reach the target market selected in the strategic decision. The consistency between marketing decisions and the strategic choices made in terms of selected market target, is one of the successful behaviors to be checked by the teacher.

In addition, the teacher has to verify the overall consistency of the village offer in terms of selected market. For this purpose, the teacher can analyze the Value for Money node. The VfM parameter summarizes a series of player choices and provides a quality value of the offer made by a village as a function of the type of customer.

Finally, the third node reveals the probabilistic link between market demand and the preferences of each type of customer, in terms of percentages of the accommodation type required. This information is also linked to the offers of a single village, in terms of accommodation types. Through the probabilistic combination of these two items of information the relationship between demand and offer can be analyzed for each village and/or customer type.

A key element in evaluating the choices made by the individual groups is the possibility of analyzing the results of the simulation. The market defined within the game is a

complex system and, therefore, is characterized by a huge number of data that evolve over time.For this reason, it was decided to support the teacher in this analysis through the design of a tool which could respond flexibly to the teacher's dynamic requirements.

A data warehouse was therefore created to analyze the multidimensional data of the simulation.These data can be accessed using Saiku, an open source web-based tool (fig. 4), which allows the definition of multidimensional queries by means of a simple and intuitive interface.The simulation data can be analyzed by the teacher at any level of detail; through this tool the teacher can analyze the aspects of the simulation that do not translate directly into costs and/or revenues but that are central for assessing the suitability of the choices made by different groups.

Some of the possible situations that the teacher may have to verify are:

- the consistency between the choices of marketing, VfM and types of accommodation structures .
- the level of unmet demand by individual villages in terms of package tours; in fact, a consistent strategy (in terms of marketing, VfM and types of accommodation structures chosen) may not result in concrete results in terms of revenue due to an insufficient investment in accommodation structures
- the level of unmet demand by individual villages in terms of additional services requested by the consumers; in fact, a consistent strategy from a quality and quantity point of view may not produce concrete results in terms of revenue due to a mistake in investing in services or structures.

In fact, the simulation results allow the teacher to evaluate not only the sales data but also the unmet demands by individual villages, thus providing students with an analysis of how to "attack" the potential market.

VII. Conclusions

Entrepreneurship education requires practices that make it possible to unleash the creative and innovative potential of young people, and enable them to work independently.

The serious game described in the paper allows students to progress from a simple scenario to a more complex one with a step by step approach, analyzing the main concepts of company management and taking decisions to improve competitiveness and results. This innovative approach to education can be successfully applied to any given discipline, helping students to develop their competence, knowledge and skills. Teachers assume the role of 'facilitator of learning', guiding students and reflecting with them on the learning process.

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