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Abstract. In higher education, many academic support programs intend to enhance the student success. Some of them particularly focus on first generation students. This is the case of an innovative serious game entitled "Success" which aims at fostering awareness about contributing factors of success. The game proposes to embody a coach and guide a virtual student during his/her first semester. In this fictional universe, the virtual students are subject to daily events, invitations, professional/associative/cultural activities and school responsibilities. The coach's mission consists in helping them to self-organize and achieve what is expected to succeed including a healthy way of life. To that end, the coach must give them some advice and suggest to balance academic work and privacy. Our contribution focuses on the design process to create interactive and educational scenarios embedded in this serious game. It presents a model to describe different profiles of virtual students and indicators related to what can be considered as a healthy way of life. The model we propose allows to create a library of virtual students that the players can guide on the way of success.

Keywords: Serious game, first-generation students, academic success

1 Context

Since 2000 with the Lisbon Strategy, European Union and countries of the European Union pay a particular attention to study options at the end of secondary school level and student success in higher education. Innovation is at the heart of "the most competitive and dynamic knowledge-based economy, capable of sustainable economic growth with more and better jobs and greater social cohesion". European countries are developing a strategy called the "Europe 2020

strategy" which contains three axis. One of them aims at reducing the dropout rate and the academic failure. In 2020, in the context of economic recovery linked to the COVID-19 pandemic, a new digital strategy plan for Europe 2020-2030 set out an action plan for digital education (2021-2027). It aims at "improving the quality and quantity of education with regard to digital technologies, supporting the digitization of teaching methods and pedagogies and providing the necessary infrastructure for inclusive and resilient distance learning" [1].

In higher education, many academic support programs intend to enhance the student success. Some of them particularly focus on first generation students (i.e. enrolled for the first time in higher education). Globally, research studies showed that a smooth transition from secondary school to university increases the probability of success in terms of performance and achievement [17] [24]. Cook et Leckey showed that student study habits persist all over the first semester of their university life while there is a large gap between secondary school and university [11]. In France, according to the French government, only 44 per cent of the students who obtained the Baccalaurat in 2016 (similar to A-Level diploma or High School diploma) and were enrolled in the first year at the University - obtained their degree (Licence) in three or four years [2]. This success rate changes according to the student's socio-demographic profile and academic background. It is important to note that in 2020, the context of the COVID-19 pandemic has had an additional impact on the graduation at the end of secondary school. As a consequence, the success rate in France was higher than in previous years.

The engineering schools in France have the particularity of selecting the best high school students in STEM (Science, Technology, Engineering and mathematics) discipline. In these schools, the secondary-generation students used to mentor first-generation students. This is one way they have explored to create a bridge between secondary education and higher education. These one-to-one mentoring experiences assist first-generation students to overcome inadequate preparation for higher education. Most of the time, this mentoring program is associated with field trips to increase the efficiency. However, the fact is that around 15 percent of first-generation students give up their studies in French engineering schools. Hence, the question is what are the reasons that force brilliant students to give up their studies? The issue is that academic success depends on many contributing factors like motivation, engagement, self-esteem, learning strategies etc. Engineering schools analyzed the reasons that lead to dropout. It reveals that contributing factors are linked to organizational difficulties. Even the most brilliant student can encounter difficulties to manage their new way of life. French universities and engineering schools propose detection process and academic support programs to help young students to acquire autonomy and maturity.

Their goal is to prevent academic failure and reduce the dropout rate of first-generation students. The way they choose to move forward on this problem is to use gamification through serious games. Gamification itself means using design approaches as well as elements in the game to be implemented in a non-context game [13]. As an illustration, Browning et al [8] used an active outdoor game

based on water balloons to make students aware of the complexity for historians to recover the History. A game with purposes apart from entertainment context is called serious game [19][29]. Since a decade, there has been a growing interest in the implementation of games as educational tools. Many areas as education, health, wellbeing and government [10] have been concerned. Serious games are designed to develop or reinforce skills, expand concepts, or assist learners in learning skills or make them aware of something. Serious games are expected to contribute to deeper and more active learning, through which players learn from their own experiences [23][4]. They are essential tools for delivering a message, teaching non-theoretical knowledge, or gaining skills through interactivity. This determines the parallel interests in both engaging features of games as an entertainment medium and their use for learning purpose.

So, a digital serious game entitled "Success" has been designed to raise awareness about challenges of academic success and encourage first-generation students to adjust their new lifestyle to the higher education expectations. "Success" is a computational application developed with the Php/Javascript programming language combined with a Mysql database. It provides real-life like situations to place students in front of their new daily dilemma.

The game proposes to embody a coach and guide different profiles of first-generation students during their first six weeks at the University (see Fig. 1). The coach's mission consists in making suggestion to the virtual student in order to help him/her to organize her/his academic work and globally observe good daily living habits. The virtual student is a non-player character which is controlled by an artificial intelligence. During a game session, the virtual student is subject to daily life events that cannot be foreseen such as sickness, legal obligations or loss of their credit card, academic duties, and solicitations such as an invitation to a party or invitation to his/her cousin's wedding. The player is supposed to guide the virtual student and gives him/her advice through a virtual mobile phone. He/she also can suggest to schedule academic duties, sport activities, housework etc to their personal agenda once it has been synchronized with the academic one (see Fig. 2).
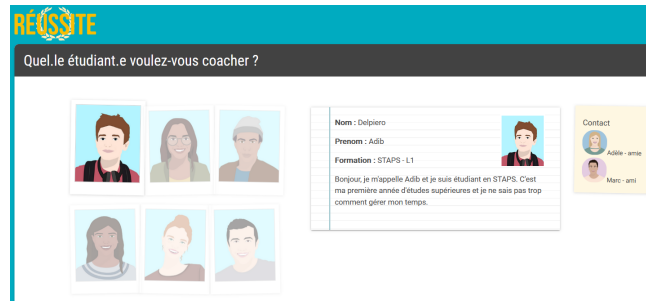

Fig. 1. A library of virtual students can be coached

The virtual student results depend on their personal investment in studies, their background and the way of life they explore. As in real-life, the virtual student can decide to approve or refuse the suggestions.

At the end of each virtual week, a summary of student's choices is displayed to the player. Between two virtual weeks, a short video presents a practical local information like driving schools, supermarket locations, health center, academic library, tutor program etc. At the end of a game session, a summary of virtual student's results and coach guidance performance is displayed.
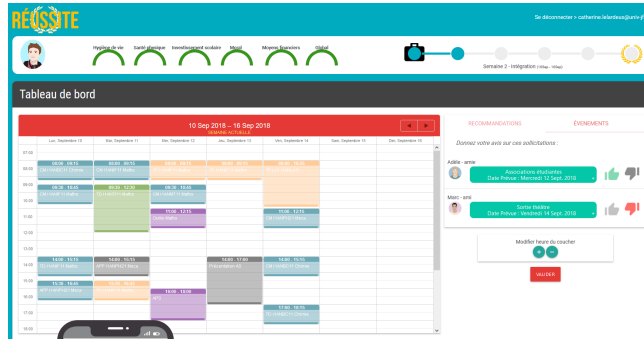

Fig. 2. The virtual environment presents a default academic schedule that should be completed with personal events/tasks

2   Purpose

This article presents the methodology used to create interactive and pedagogical scenarios embedded into the game. As there is a potential risk of stigmatizing certain student profiles and perpetuating stereotypes, it has been essential to elaborate a model to design a virtual first-generation student taking into account the ethical issues. The first point is to define a generic model to describe the virtual students. This means that the model should be used to create a library of typical virtual students. The second point is to identify criteria to depict what are the "success" in terms of the monitoring measures into the game. The research questions are: What are the characteristics can be used to define a first-generation student? What are the student characteristics/events/behaviors that impact the success? What are the ones to take into account in the game? What are the ones that can be used to control an interactive scenario and be able to give automatic educational feedback to the player?

3   State of the Art

Serious digital games [3][26][29] and in particular Learning games are devices that combine technologies and know-how from the video game industry with

educational scenarios. They are designed for training or awareness purposes and offer monitoring and feedback tools that allow users to be guided throughout the experience and to obtain a summary of their performance at the end of a game. There is a wide variety of serious games for education and training. The ONISEP, National Information Office for Education and Professions in France, the University of Firenze in Italy, Aspire International, Euroguidance center in the United Kingdom, FASE (Formacin y Asesores en Seleccin y Empleo) in Zaragoza, Spain, AEVA (Associao Para A Educao E Valorizao Da Regio De Aveiro), association for education and evaluation-valorization of the Region of Aveiro, Portugal with the support of ERASMUS+ have combined their expertise to reference and build a database of serious games for education related to guidance and career guidance in Europe. Their project called Games2Guide aims at increasing social inclusion and develop general skills and learning about employment and jobs market. They focus on guidance professionals, pupils and students/trainees.

The vocational guidance consists of a facilitating process that helps the student choosing a professional career through self-skills and knowledge of the jobs in real professional life. This practice has two approaches: statistical (in which the advisor makes the career direction of guiding) and clinical (in which the advisor is a facilitator even if the advisee makes the final decision). There are two main categories of serious games focused on vocational and professional guidance. The first one offers a discovery of professions. They are sometimes associated with time-limited competitions. This is the case of GemGame (Guidance and Entrepreneurship - Mind-sets through Games) which proposes to experience 10 professions and discover skills used in different jobs. The second category provides an evaluation of skills through simulations. In France, ONISEP, National Information Office for Education and Professions, published in 2016 a guide of serious games focusing on jobs discovery.

The aim is to draw up a profile according to one's skills and thus to facilitate professional guidance. This is the case of SkillPass. Caron [9] used the TAM model [12] adapted for serious game [18] and studied three dimensions of the utility of Skillpass: the self-utility, the global utility and the utility related to skills development. He completed his study with the utilisability and the order which fosters the teacher to use the serious game with their students, for example being member of a teaching community, belonging to a School that creates a main stream.

Morais et Notargiacomo [21] developed a serious game dedicated to professional advisors to perform their activities in career guidance. The application includes a decision tree algorithm based on 18REST that is a short version of RIASEC test Holland[15]. 18REST is a short 18-item inventory to describe students' position on John Holland's RIASEC interest types. They used artificial intelligence to enable the identification of the player's professional tendency, offering another subsidy to compose the professional career selection process.

4   Outcomes

The aim of our research consists in providing a generic model to describe a lot of virtual students that should be embedded into interactive scenarios. To that end, a group of experts have been set up to define the virtual student-candidates.

A review of literature shows that there is in-group bias that can impact the choices in the design process. Molenberghs et Louis [20] identified intergroup biases that can exist between a wide variety of different groups such as people from different races, nations, ethnicities, political or religious beliefs, opposing sport teams or even arbitrary groups. In their review, they provide a neuroscientific overview of functional Magnetic Resonance Imaging (fMRI) studies that have revealed how group dynamics impact on various cognitive and emotional systems at different levels of information processing. They describe how people can perceive the faces, words and actions of ingroup and outgroup members in a biased way. In a design process, in-group bias can impact the way to design characters or virtual students' profile and more globally scenarios for a game. To reduce the in-group bias, we have involved in the design process different profiles of experts such as teachers, researchers, pedagogical engineers, experts in guidance and psychologists from different culture, different age, sex and religion. This group is composed of professionals from Higher Education and Universities (universities with more than 20,000 students, universities with less than 5,000 students and engineering schools). We based our study on traditional theories of student success [27, 5]. The academic student success is measured by three important indicators: grade point average (GPA), attained number of credits (ECTS) and intention to persist. Globally, it can be approached in a qualitative dimension such as motivation, engagement, emotions, self-esteem, affective profile, intelligence, learning strategies etc[14, 22, 6] or quantitative dimension such as gender, age etc. Leach and Zepke [28] emphasis non-institutional factors that influences student engagement. The background contextual differences, money, culture and power have been identified as contributing factors that impact the academic success.

Van Rooj et al [25] led a study in Netherland where 33 per cent of first-year university students do not continue to the second year of the program they initially started. They showed that motivational and behavioral variables did not influence GPA and credits directly but through academic adjustment. Furthermore, only satisfaction with the degree program predicted intention to persist. They showed that academic adjustment was influenced by intrinsic motivation, self-regulated study behavior and degree program satisfaction, which together explained 72 per cent of the variance in adjustment.

As it is really complex to approach the academic success in a qualitative dimension, we focused on the quantitative dimension to create a model to design a set of virtual first-generation students.

In 2010, a sociographic study was conducted by Vermandele et al (Vermandele et al., 2010) on the distribution of first generation students entering university in French-speaking Belgium. Later Lafontaine et al [16] showed the joint impact of gender and parents' level of education on achievement at university.

Their research focused on the socio-demographic factors and previous school paths that contribute to passing the first year at university. The analysis of empirical data collected in French-language Belgium revealed that female students outperform male students, irrespective of previous school paths. Beyond the gender-based achievement gap, interaction effects between gender and parent' level of education also emerge. The socio-demographic variables studied were gender, parental degree level, scholarship status, and several variables describing previous schooling (educational delay, type of education, and options taken at the end of secondary school).

The academic variables measured by the Ministry of Higher Education Research and Innovation in France are: gender, baccalaureate series (literary, economic and scientific for general baccalaureates), honors obtained (very good, good, fairly good, fair 1st group and fair 2nd group) and social origin (very advantaged, advantaged, fairly advantaged, disadvantaged and no response).

As far as our work is concerned, the variables selected to create the library of virtual students are divided into two types: the static variable and the dynamic variables. The static variables are attributes that cannot be changed neither through player's interaction nor over the virtual time. They are listed below: - gender - type of baccalaureate obtained (general, technological, professional) - Mention obtained at the baccalaureate (fair, good, very good) - social background (very advantaged, advantaged, fairly disadvantaged, disadvantaged) - educational delay (one year behind, more than one year behind) - type of studies pursued in Higher Education

The dynamic variables depict the student lifestyle. They can change over the time either through student's decisions or unpredictable life events. Five dynamic variables have been identified: 'Healthy Lifestyle', 'Physical Fitness', 'School Engagement', 'Mood', 'Finance'. They are represented by gauges on the graphical interface to make the player understand the impact of the virtual student's choices. The gauge 'Healthy Lifestyle' focuses on the importance of food, sleeping, cleanliness of body and living space. The gauge 'Physical Fitness' focuses on sport, physical activities and sickness. The gauge 'School Engagement' highlights the importance of personal work, assiduity etc.

The model we designed to build the profiles of virtual students is based on both static variables and dynamic variables. It has been used to build 6 interactive scenarios. Academic events, private events and unexpected events have been pre-positioned at each game stage. They impact the dynamic variables in a positive or negative way. For example, when the virtual student gets a student job, the gauges 'Mood' and 'Finance' increase.

An exploratory experimentation have been conducted with a short panel of students. 22 first-generation students were involved (19 males and 3 females). The game was experimented in a real classroom. The experiment took place right after a strict containment during the pandemic and right before the end of the academic year. We checked the usability of the system using a standardized questionnaire System Usability Scale (SUS) developed by Brooke [7]. The reliability of the SUS questionnaire has been proven even on small samples. In our

study, the size of the sample is large enough to be significant. The SUS score indicates a correct usability (53.33). A score between 50-70 indicates that the system is marginally acceptable. This result may highlight the player's difficulty to understand the impact of their suggestions on the virtual student choices as the virtual student is a non-player-character. Another result shows that 95 per cent of students felt that they were coaching a student. This means that their role was very well identified. An advantage of positioning the player in the role of the coach is to create a natural distance from his/her student posture. The inconvenient of this choice is that the coach is not responsible for the academic success since the virtual student can agree with or not with the coach's advice. This first experiment highlighted a real engagement and motivation to play the game. Students enjoyed particularly the gaming approach. The debriefing stage reveals that before playing, they were not really familiar with the contributing factors of academic success nor with the danger that represents a late adjustment of their way of life to the higher education expectations.

5   Conclusion

Our contribution addresses the design of a digital serious game entitled "Success" dedicated to the first generation students (i.e. enrolled for the first time in Higher Education). It seeks to highlight the importance to adjust their new lifestyle to the higher education expectations. This game intends to raise awareness about contributing factors of success and particularly self-organization. It proposes to embody a coach and guide a virtual student during his/her first semester in higher education. The virtual student (controlled by a non-player character) is subject to events (musical party, streaming movie party, sickness etc.), invitations (family, friends, etc.) and must deal with his/her school schedule, a possible professional/associative activity and his privacy. A model of 'virtual student' has been defined. It combines static variables (gender, type of baccalaureate obtained, mention obtained at the baccalaureate, social background, educational delay and type of studies pursued in Higher Education) and dynamic variables which are represented by the following gauges: 'Healthy Lifestyle', 'Physical Fitness', 'School Engagement', 'Mood', 'Finance'. Based on this model, a library of 6 virtual students has been designed.

"Success" was experimented with 22 first-generation students and their teacher. The SUS score indicates a correct usability. The student's role was very well identified (95 per cent felt that they play the role of a coach). Future work will focus on improving usability and checking acceptability both for students and teachers. Another research study will focus on the student's awareness related to the factors of academic success. To that end, new experiments will be planned with a larger student panel.

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