Gamification and Serious Games Based Learning for Early Childhood in Rural Areas

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Abstract. Early childhood education has a high impact on the success of higher education. Besides, it allows a sustainable social and economic development of the country. It enables a relevant upbringing and education of future generations by providing the necessary skills and competencies. This is especially regarding African developing countries and rural areas in particular. Therefore, it is necessary to support the development of the early childhood education in terms of apprehending the knowledge and improving the children's skills. Actually, recent pedagogical and neuroscience researches show that the best way to teach children is through playing, getting their attention, their engagement, receiving feedback and consolidating their skills. In fact, playing represents a natural and privileged method for children's learning. Correspondingly, our approach integrates all aspects mentioned above to develop a playful and creative learning. The proposed approach is a play-based learning using the Montessori pedagogical principal as a core of the method that is implanted in several types of serious games. This paper proposes a Montessori's Method based on serious games solution. We developed several serious games according to an agile method. Future works will focus on deploying and validating this solution in a real context, precisely in rural preschools near Marrakech. Our aim is to evaluate the user's experience and assess the children's acceptance and usefulness of our system.

Keywords: Preschool learning · Serious games · Gamification
Montessori · The play power · Early childhood education

1 Introduction

Education is an essential right that must be accessible to all people without any discrimination and it has an essential effect on promoting gender equality and empowering women. It is one of the basic pillars of economic and national development [1, 2]. Poor education practices are among the main factors affecting the social and cultural development of the society. Education is crucial to give people capabilities such as literacy, confidence, and attitudes [3]. Furthermore, education is crucial to foster tolerance between people and it contributes to forming more peaceful societies.

However, it remains a challenge in some parts of the world, particularly in developing countries that have a significant number of dropping out of school. This is due to several reasons, such as poverty, tuition fees, or associated costs (uniforms, supplies) as well as the lack of security. All those causes might create barriers pushing some parents to keep their children away from school. An example of the inequality in the matter of education is the lack of opportunities affording education for girls in rural areas. As a solution, it is essential for gathering all efforts to find innovative approaches to deliver an accessible education allowing a gapless learning. So we should assess individuals' needs and elaborate strategies defining targeted objectives of the educational system that meet their specific expectations. The usage of the emergent digital technologies offers promising solutions and efficient approaches to achieve good education goals.

Besides, the family is the first source of learning and supportive relationships to children, especially the parents who are considered as the first and the most important teachers and who have the biggest part of the education responsibility [7]. For the good upbringing of their children, the parents have to set up intellectual and emotional life bases, to give suitable and valuable attitudes in order to ensure an active participation for a good preschool departure [8, 9]. Children are curious from the moment they are born and they want to learn about their world and understand it. Learning starts at birth, and the first six years are for discovering and exploring. So, a strong beginning in the early years provides them with the best and fairest chance to reach their fullest potential [10]. Children's early learning is the main factor for school success and helps their brains develop well.

Playing is the natural way for children to improve their future skills from the moment they are born [4, 5]. When they play, they use plenty of their senses to capture and acquire diverse information and extend their knowledge about their environment. Moreover, through the fun playthings, children will develop new skills and their ability to talk, think, act, feel and learn about themselves. Otherwise, playing provides children with the opportunity to boost their attention span, learn to get along with others, cultivate their creativity and address their social, emotional and cognitive needs. It also develops children's main academic skills (language, mathematics, etc.) that are the base for later learning, without forgetting that it is an innate human behavior, which goes with us along our lives. It also has a vital role in the healthy development of the children enabling them an open and ludic way of developing, learning, and socializing [11–13]. In fact, whether it is a toddler, teenager, or even a retired person, playing is a fantastic way of learning and development [14]. Allowing children to choose their activities and establish their own ways of doing things, give them the feeling of controlling their learning and the opportunity to make new challenges. Furthermore, providing an adapted solution gives children the opportunity to reach their goals which increase their confidence and motivations.

The rapid widespread of Information and communications technologies (ICT) reached and involved in children's daily life provides learners with better learning opportunities. It has also changed teaching methods and makes access to high-quality educational content easier, such as textbooks, videos, and distance education with a lower price. ICT have paved the way for personalized learning, adapted to the pace of each learner. Serious games, IoT, Virtual reality, cloud computing and many

other emerging technologies offer the possibility to develop innovative learning solutions like the mobile and pervasive learning systems. Those new technologies can be considered as promising ways to perform the objectives and needs cited above and used to improve the existing educational methods in order to reduce the gap between technologies, gamification, and learning approaches.

This paper presents a methodological approach that underlines serious games and the cognitive of playing based on new technologies in order to offer a research-based solution that makes playtime more stimulating and educational for children.

2 The Benefits of Early Childhood Education

The preschool prepares young children for the elementary education and it's considered as an instructive period in the formation of concepts and constant ideas [35]. The preschool is an important step in life that ensures children, from birth to age six, the best possible departure in life. It helps the children starting strong and being prepared for lifelong learning and success. The inequalities begin in the first six years and on the other side the early childhood education promotes the better intellectual development of individuals. So, the role of pre-school education is vital in preventing school failure. In fact, a child is not a vase that needs to be filled in, but a source that we leave unleashing, based on good education practices.

The preschool must be a linguistic gateway allowing the children to develop their mother tongue strengthening their emotional and social development, promoting the early acquisition of behaviors and attitudes, while imbuing the new languages. Also, it allows children to live in the community preparing for the social relationships which make them aware that there are rules to respect and constraints to accept.

Most of the time, the child is asked to do activities that are neither a decision nor a personal motivation on his part but just imposed by the teacher whatever the activity is. Therefore, the child does not pay close attention and is not really engaged. Also, the child has often the difficulty to consolidate what he learned because he does not have the possibility to repeat the same activity when it's necessary. While making mistakes during his activities, the signal of error that the child could detect is insufficient, that is because the teacher doesn't have the possibility to give individual and immediate feedback to each child. Thereby, we should reconsider the preschool's teaching methods in order to fit the real needs of the children improving their motivation and confidence.

3 Pillars of Learning: When Neuroscience Explore the Enigma of Education

Neuroscience synergizes with other disciplines, have broadened our understanding of the brain in a way that is highly relevant to educational practices [37]. Cognitive science has identified at least four key factors as pillars of learning processes and pedagogical strategies [15]. Actually, good learning involves attention, active engagement, feedback and consolidation (see Fig. 1).
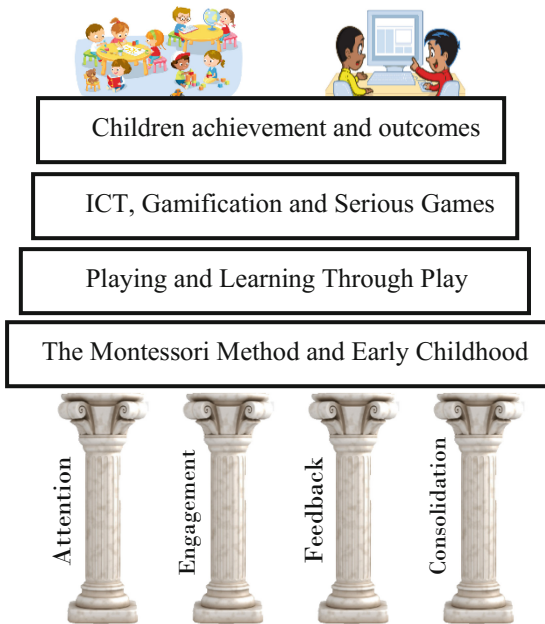
Fig. 1. Foundations of the proposed approach

Indeed, mobilizing children's *attention* is a priority goal. The teacher must create attractive materials that do not distract the child from his primary task. Therefore, given the sensitivity of their brain to social cues, the educational counseling attitude is essential: he must focus the child's attention through visual and verbal contact.

Moreover, the active *engagement* role underscores how important it is for the child to be maximally attentive, active, and predictive, and in this respect, to maximize curiosity in order to have a total engagement. Thus, a care must be taken in order to introduce to the child learning situations that are neither easy nor difficult, adequate to his context. As a matter of fact, preserving commitment means that the teacher must avoid giving a long lecture, but involve the children, test them frequently, guide them while allowing them to discover certain aspects by themselves, and reward systematically their curiosity rather than discourage it.

Withal, the importance of the *feedback* underlines the educational status of the error. The educational accompanist should realize that from the point of view of cognitive neuroscience, far from being a fault or a weakness, the error is normal, inevitable even, and in any case indispensable for learning. Better an active child who is wrong and learns from his mistakes, than a passive child.

Further, the *consolidation* considered as the knowledge automation. Automation is the act of passing from conscious treatment with an effort, to an automated unconscious treatment.

Correspondingly, the child learns by his emotional intelligence [16, 17], then develops a link with his mistress, which makes him learn more words and operations.

As soon as it grew, he should be initiated at the intelligence logic, which must be implemented by single organizations and visual methods.

4   Learning Through Play

Outdoor Games and playing are very important for every child, considered as a legitimate right of the child; it represents a crucial aspect of the physical, intellectual and social child development. It's fundamental to their well-being.

While playing, the children develop their skills on several aspects: reflection, problem solving, expression, moves, cooperation, and exercise of moral conscience [19, 20, 24]. That's how their development unconsciously improves [21]. When tackling the brain development, scientists have proved that many of the fundamental tasks children must achieve can be most effectively learned through play. They also confirm that play is essential to healthy and even exceptional to the brain development [22, 23].

Moreover, all kinds of play and games can be specified by means of different components. The first component is the rule or gameplay, which creates the pattern defined through the game rules that connect the player and the game. The second is the challenge, which determines the bonuses to reward the good actions or the obstruction and barriers that avoid the player reaching the game goal easily. Challenges are used to create the different difficulty levels of the game in order to encourage enjoyment and motivate the player to spend more time with the game. The third component is the interaction which represents the way the player communicates with the game. Interaction refers to any action that is done by to start some activity, it can be visual, listening, physical (typing, mouse, touchpad, button pressing), dialogue exchange, etc. And the last component is the objective which is defined as something that one's efforts or actions are intended to attain or accomplish.

Nowadays, the children have the ability to manipulate brilliantly different technological devices (computers, console games, smartphones, etc.) which play a significant formative role in their personal development [18]. Moreover, the usage of technologies contributes to reducing the distance and offering access to pedagogical resources, especially when it comes to the rural areas. Furthermore, that enables access to other ways to learn and offers innovative methods to develop our skills. So, it will be fascinating to conceive ludic and funny products and services based on the new technologies and the concept of the four learning pillars by making the child in the center of the educational act. Wrapping up the learning activities by games is what makes learning through playing more fun and consequently more motivating for students.

5   Gamification in Learning and Serious Games

Gamification is generally considered as the application of game elements in conventional contexts aiming to change and enhance individuals' behaviors and attitudes. Gamification techniques are benefiting from advances in ICT. Applications of

gamification span a wide range including healthcare, marketing, management and recruitment, as well as learning and teaching. The relation between gamification and education is on the rise and learning activities are an important context that can be subject to gamification.

A serious game is a computer application that combines with consistency, both serious aspects such as learning, or communication intent, with playful springs from the video game like collaboration, competition and strategy [25, 26]. Actually, their main use aims to improve users' skills, engagements and performances [27, 33].

Relevant serious games applications, have recently been developed in different domains, including education, training, well-being, advertisement, cultural heritage, interpersonal communication, and healthcare [28]. Advances in gaming technologies allow the real-time interactive visualization and simulation of realistic virtual heritage scenarios, such as reconstructions of ancient sites and virtual museums [29]. Many research contributions are directed towards taking advantage of the success of video games and using them to benefit the educational domain, such as [30].

Also, there are a few research and project using serious games in the context of preschool to develop the children's abilities and academic skills in mathematics and languages [31, 32].

6 Proposed Approach: Gamification and Serious Games Based Learning for Early Childhood

As it was mentioned above, one of the motivating challenges is to elaborate pertinent solutions addressing the problem of the growth of the number of dropping out of school in early childhood especially. In this context, we have initialized a project aiming to develop innovative solutions to deliver an accessible early childhood education. Our goal is to eliminate the inequality in the matter of education and create real opportunities for children, in particular young girls, in rural areas to have access to education.

The pedagogical method we adopted within our project is based on Montessori approach [6, 36, 38]. It stated that the purpose of the early childhood education wasn't to fill the child by predetermined studies, but rather, to cultivate her own desire to learn. This approach proposes to organize the main learning activities around children playing activities. It distinguishes five categories of activities and skills to develop (see Fig. 2). Also, it assumes that during learning activities, the individual should be autonomous and be mainly motivated by its natural curiosity and its love of knowledge. Two fundamental principles of this approach are, first, allows each child to learn by doing according to its own choice and rhythm without no obligation, and secondly, to help him to refine its natural learning tools when it's needed.

All the serious games that we have developed within our project are aligned to the Montessori approach and with respect to the pillars of learning reflecting the educational cognitive science point of view (see Fig. 1). Indeed, errors are considered as phases of the game and do not prevent children's to continue. Also, immediate feedback ensures the checking of the quality of what we have learned, that is a very important factor for effective learning. We aim to deliver and to introduce some games and apps with purpose (serious games), allowing a gamification integration, to manage

behaviors or learning, such, mathematics improving and science skills, languages progression (see Fig. 2).
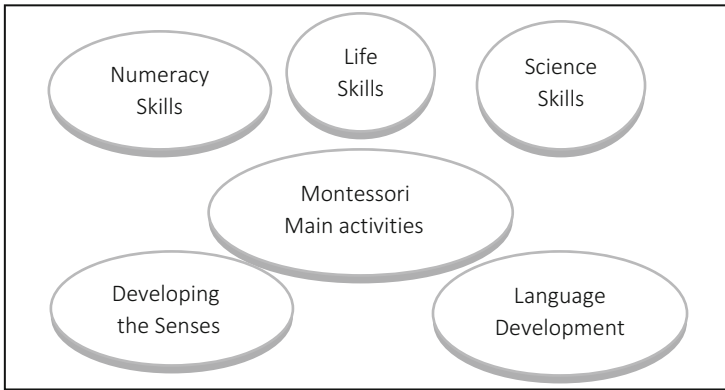

Fig. 2. The montessori approach main activities and skills

7 Realization and Deployment

All the serious games we have developed could be used within group of children in the context of an online learning or a blended learning that combines them with traditional classroom methods. They are accessible using a mobile device like a smartphone or a desktop (see Fig. 3).
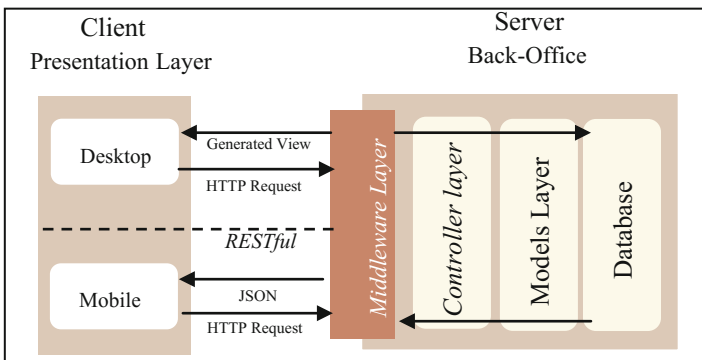

Fig. 3. System architecture

Montessori Method's materials, physical or digital (serious games), would enrich the universe surrounds children to enhance and promote a playfully and creative learning. An adult can supervise and assess the children's learning activities reminding

them with benevolence the dangers, prohibitions, respect and without too much intervention or leadership.

Presently, we have implemented more than twelve serious games spread between different Montessori Approach main activities and skills (see Fig. 3). While continuing agile development of other games, we project to deploy, as quickly as possible, and conduct tests of our approach in a real context in rural preschools near Marrakech. Our aim is to get feedback as earlier as possible relative to user experience and assess the children's acceptance and usefulness of our system. The goal is to evaluate each step in the chain of the learning process including its technical aspects according to an agile method.

Below, we present some examples of serious games that we have already developed (Tables 1, 2 and 3).

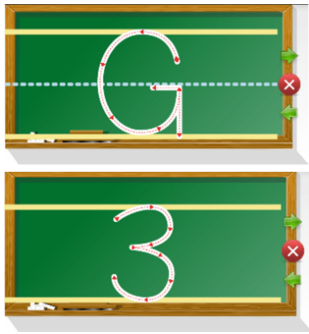**Table 1.** Some serious games developed concerning the language and the numeracy skills development

Activities and skills : Language development	**Activities and skills** : Numeracy skills
Game goal and Guidelines: This game help kids recognizing a letter, numbers shapes, associate them with phonic sounds, and put their alphabet knowledge to use in fun exercises. It has the same pedagogical goal and it is aligned with the entitled games "The phonetic alphabet" and "Identifying alphabets" in [38].	**Game goal and Guidelines:** This game is about numbers and how to use them and apply some basic mathematical operations with quantities (using fruits). This game has the same pedagogical goal and it is aligned with the entitled game "Addition using numerals" in [38]

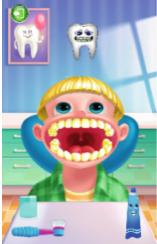**Table 2.** Some serious games developed concerning the senses and the life skills improvement

Activities and skills : Developing the senses	**Activities and skills** : Life skills
Game goal and Guidelines: This game teaches the kid the colors, their spelling and their phonetic sound. This game has the same pedagogical goal and it is aligned with the entitled game "Discovering colors" in [38]	**Game goal and Guidelines:** This game shows the child the importance of brushing teeth. This game has the same pedagogical goal and it is aligned with the entitled game "Cleaning teeth" in [38]

Table 3. Some serious games developed concerning the science skills development

Activities and skills : Science skills	**Activities and skills** : Science skills
Game goal and Guidelines: This game teaches the child the continents, the countries and their location by making his first experience of geography as concrete & as fun as possible. This game has the same pedagogical goal and it is aligned with the entitled game "Introducing a globe and map " in [38]	**Game goal and Guidelines:** This activity serves double purposes. While the child is making and constructing a puzzle of a flower, he is learning about the parts of a flower and their names. This game has the same pedagogical goal and it is aligned with the entitled game "Make a flower puzzle " in [38]

8   Conclusion and Perspectives

Playing is the main children's source of pleasure whether on its emotional, social, physical, language or cognitive development. Covering up learning activities with games is what makes learning through playing more fun and consequently more motivating for students. Through play, the child would feel more confident, autonomous and have more pleasure to acquire new academic skills (mathematics, language, etc.) and social aptitudes (confidence, communication, etc.). While playing and doing fun actions, he would be more motivated and curious to discover the world around him while adopting a positive attitude towards action.

Gamification is generally considered as the application of game elements in conventional contexts aiming to enhance individuals' behaviors and to improve their skills. A serious game is a computer application that combines with consistency, both serious aspects such as learning, or communication intent, with fun and ludic video game's features.

Nowadays, African countries present a significant number of dropping out of school, in particular in preschool. This is due to several reasons, such as poverty, growth tuition fees as well as the lack of security. Learning starts at birth, and the first six years are for discovering and exploring. Indeed, a strong beginning in the early years provides individuals with the best and fairest chance to reach their fullest potential. Therefore, it would be essential for gathering all efforts to find innovative solutions to deliver an accessible education allowing a gapless learning.

A part of our actual research studies deals with the above problems and challenges. In this paper, we have presented our propositions and contributions to assure the development of the children's early learning, in particular in rural areas. In fact, access to preschool is the main factor for individuals' school success and thus social and economic development of the countries. For early childhood, we propose a Montessori's Method based serious games solution. We developed several serious games according to an agile method. We project to deploy this solution in a real context, precisely in rural preschools near Marrakech. Our aim is to evaluate the user's experience and assess the children's acceptance and usefulness of our system.

It's a beginning of a long way and a rewarding challenge. Many questions remain open and there are many motivating perspectives to address. For example, one of them is how to enable the teachers to track and analyze students' activities and progress during the educational games session. Another challenge that we try to face is about the youth unemployment problem in Northern Africa. To treat the scourge of youth unemployment, we project to capitalize on the outcomes of the actual project to develop a pervasive collaborative system to enhance Northern African youth entrepreneurship through gamification [34].

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