Adaptability of Learning Games Based on Learner Profiles in the Context of Autonomous Training

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Abstract. Learning games are widely used as teaching resources, because of their capacity to help learners' increase their knowledge in conditions of autonomous learning, especially in domains for which training is expensive. However, to get the best productivity of these learning games, they should be adapted to the learners' profile. To propose content in an application that satisfies the uniqueness of each learner is difficult. We therefore want to provide learners with learning games that meet their profiles and improve the proposal by tacking their new skills into account, so that they are always in the presence of games adapted to their needs. The idea of this paper is to propose a model, that provides a training plan based on learning games, adapted to the learners' profile. The ALGP (Adaptive Learning Games Provider) model defines the learning profiles of individuals, then characterizes learning games to make a mapping between the profiles and characteristics of the games. But, to meet the needs of learners throughout the lessons, monitoring data are added, to dynamically adapt the content according to their progress. An evaluation of the model through learner follow-up in two separate classes, a first class assisted by the ALGP model and a second class with the traditional system without assistance of the model were carried out, and the results obtained show that the learners in the assisted class, are more motivated and more involved than in the non-assisted class, which increases their productivity.

Keywords: Learning games · Adaptive learning · Classification · Learner profile

1 Introduction

The quality of training has always been a central concern to the academic world. Recent research on Learning Games (LGs) have proven their effectiveness, for training. It is important to note that their success factors are numerous and have been widely demonstrated in several scientific publications [1]. The development of technology and design platforms have contributed to the spread of LGs in the marketplace. Thus, thousands of LGs are now available for learning basic to academic skills [2]. However, the major problem that presents itself, is to provide appropriate LGs to learners, so that their attractiveness remain maximal [3]. In practice the problem to be solved is to adapt

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the selection of games provided in a training course considering the learner's learning specificities. This problem cannot be solved by adaptation one game, by changing its content according to the learner's profile. In fact, adapting to the game level, would be expensive and is limited in the use of new games that can be useful. The aim of this paper is to propose a model of adaptability that is not only associated with the game and the perception of the player. The ALGP (Adaptive Learning Games Provider) model first studies the learner's learning profile and player profiles, then a classification of available games is realized using metadata indexing [4, 5]. In addition, the analysis of the learner's acquired experience and level of knowledge to make a matching with the prerequisites of the training. All these are analyzed to provide the game adapted to each learner to the nearest of his profile. Finally, the cycle is repeated for another analysis. To evaluate the model, an experiment was realized in two first-grade computer science classes on a group of 28 learning games, and the results obtained provide information on the effectiveness of the ALGP model, compared to an autonomous training based on learning games without assistance.

This paper is structured as follows:

The state of the art presents previous work related to the topic. We then present the ALGP model. The third part of this paper presents the experimentation that was set up to evaluate the model. Finally, we discuss the results and perspectives to our work.

2 Purpose of the Work

To satisfy the growing training demand, a large variety of free online resources, such as training LGs, are now available. However, the use of LGs in a free learning process without considering the profiles of learners, does not generate real motivation. Thus, the objective of this paper is to propose a model that will provide a list of LGs, that are adapted to the learner's profile, and that will consider the new knowledge they acquire, in order to maintain their motivation, and hence increase their knowledge acquisition.

3 Related Work

In previous work, much research has been led to provide models that improve learners' understanding of educational content. A classification of learners on how they learn is often determined to offer the same type of content per learner segment. However, this requires prior knowledge of the different learner profiles before providing them with training content.

The difficulty, in using the LGs, lies in the correlation between the concepts of the game and the training objectives. The transfer of knowledge of the chosen game activity to defined teaching cases is not always obvious and it is up to the teacher to find the subject to be taught. An alternative proposed is the modification of existing games to adapt them to the realities of teaching, with *Type of dead* for example, we have a historic zombie game attacking the player who must hurry to exterminate them, the modification to make on the weapons to use, which are the letters of the keyboard in order to improve the mastery of the keyboard in the learner. These types of game

modifications are common to provide a learning environment to which the learner can be accustomed, such as *Prog & Play* and *Zombie Division*. But these modifications, even if they are interesting, bring the knowledge deficiencies that can traditionally be found in his games. An obvious solution is to create games directly based on the training objectives, so in some jobs there are games specially created for specific types of training. In [6], we find a game created to stimulate cow rearing among agricultural students, the skill is directly derived from the learning notions of the field, with practical cases. But as tools used for training, the acquisition of knowledge diffused by LGs depends strongly on the learner's profile, i.e. the learner's preferred means of acquiring, retaining and processing information [7], in specific how he perceives and understands what is being taught [8]. The learning profile considers the individual's ability to adapt to his or her learning environment, to transpose what he learns into real-world activities and to use his new and old knowledge to propose new solutions to problems [9]. But since it is above all a question of the play, it is necessary to consider not only the learner's profile in terms of comprehension but also the learner's profile as a player. Thus, to propose games that adapt to the learner's profile in an assisted training, work has proposed game designs that change in the aspects of the scenario according to the interaction with the learner. In [10], an adaptation of learning is defined according to the learner's profile, but we always remain in the same game with the same types of action and the same playability. Obviously, it is difficult for a game to cover all aspects of training, and if it were possible it would be difficult to develop, so in assisted learning, several games will be used. We want to have a training adaptability model with the learner's profile that will not depend on the learning game but where any game can be inserted. For the ALGP model, we start by analyzing the student's learning profile with an analysis of the student's player profile and then match it with the classification that would be made of the games.

4 Adaptive Model Design

4.1 Learning Profile

There are many learning profile theories and definitions because it's difficult to delimit. So, in *Learning Styles And Pedagogy In Post-16 Learning*, *Coffield* has determined 71 different learning profiles with 60 profiles that have their own measurement tools [11]. Among these, Felder-Silverman's learning model is widely used in game-based learning as opposed to other learning profile models. This model classifies the profiles into five dimensions of ten opposing elements, two by two, in the relationship of personalities by showing from the outset the nonconformity of learner type. The most important aspect of this model is the correspondence that it made between the learning profile and the learning concept.

- Sensitive/intuitive: this dimension calls for perception.
- Visual/verbal: this dimension uses training elements.
- Induction/deduction: this dimension deals with the organization of things.
- Active/reflective: this is a bit of a sensitive and intuitive sequence, here we talk about processes.

– Sequential/global: this dimension characterizes the learner's faculties in terms of learning approach, it is the understanding of things. Sequential is best in step-by-step learning where training is presented from the simplest to the most complicated [9].

So, in characterizing learners, the *Felder-Silverman learning style model* (FSLSM) give good tools to classify the learner in learning based on LGs.

4.2 Playing Profile

The other aspect to be considered when using LGs, is the learner's player profile because, in addition to the way of learning, the learner's preferences in terms of game types, content and scenario are important if we want to create motivation and increase their knowledge.

Early work on defining personality models focused on aspects of motivation, such as achievement, social and immersion [12]. However, most of the work on the player profile is done on specific types of games, the games in their different specificities are analyzed to bring out a few determinants to rely on to define player profiles. What is needed is a global representation of the player profile that can fit into the mold of most LGs. The most recent model that considers this is the *BrainHex* classification [13], which divides players into seven categories:

– The Achiever is objective oriented, motivated by long-term rewards and likes to act.
– The Conqueror is driven by challenges, tends to start games with the difficult or expert level and is captured by the desire to win everything.
– The Daredevil likes risk and prefers to play games where victory is not obvious.
– The Mastermind likes reflection, calculation, strategies, and solving enigmas.
– The Seeker is always looking for discovery and will prefer games where there are frequent changes of scenery.
– The Socializer likes interactions with other players and, prefers games where we go to meet other players either as a team or as an opponent.
– The Survivor likes fear and enjoys games where there is a lot of negative experience.

This classification in addition to not being dependent on a particular of game, is based on a neurological study with a questionnaire widely (+60 000 times) used to illustrate the approach [14] and conduct other types of classification.

Now that we have defined the classifications for the two aspects of learners' profile (learning and playing), it is also necessary to define a way of classifying LGs to match this profile.

4.3 Game Classification

The classification of LGs is important in proposing specific training content for learners' profiles. Most LGs indexing methods are based on metadata representation. But this metadata, although effective for describing content, is not sufficient to classify LGs appropriately. Indeed, to attain our objective, the type of classification to adopt must imply the playability, the level of required implication, the technicality of the

game… in this sense the Gameplay, Purpose, Scope (G/P/S) model [15] proposes to classify LGs, but which can be extended by add the specific characteristics of LGs. It is on this model that we will build to classify LGs based on indexing by metadata standards.

The classification models will start from a prior description of the games by the LOM (Learning Object Metadata) [5, 16] standard which includes 9 categories of 68 elements, however, not all fields need to be described representing a LG. Then an extension of the G/P/S model is made to provide a classification that can match the learning profile (Fig. 1).

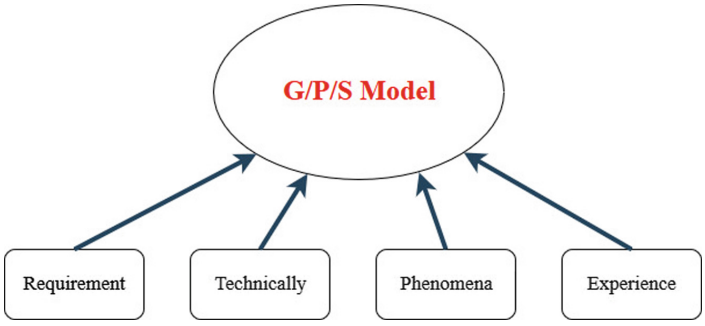

Fig. 1. G/P/S model extended

The extensions we add to the G/P/S model allow us to get as close as possible to the learning profile.

- The requirement will be able to, an entry questionnaire to define the type of games of the learner's beginning.
- The phenomena already give a glimpse of the actions that may intervene in the game.
- The experience goes as you learn to help you tell when to change games and which game to play next.
- The technicality will make it possible to define the concepts of handling of the game.

These new combinations will also enrich the concepts of this model, for example the gameplay will be more evocative with the consideration of the technicality and the phenomena defined in the game. It is these grids of representations that will be used by the game adaptability model according to the learner profile, to offer pedagogical content that is always like the type of learner, however, LGs adapted to the learning profile cannot be proposed without the consideration of the user experience.

There are many works on the adaptability of LGs, but they are oriented towards methods so that a single game which could be adapted according to player's behavior during the execution of the game. Thus, the learner's techniques are analyzed to extract data to be interpreted to add new actions as the game progresses, move to a specific step, lead the player differently [10].

4.4 Adaptive Learning Games Model

Indeed, in the process of learning, learners go from a state X to state Y. This new state means acquiring new knowledge and new techniques, understanding the phenomenon of the LGs they are playing. So, we will have to update their profile to offer another game that fits and redefine their learning characteristics. For example, if we are facing intuitive learners making them repeatedly play the same game may result in a drop in the motivation because they will already have apprehended this game and therefore will get tired of playing. What we propose in this paper is to provide, from a list of LGs analyzed, the game that would be closest to the learners' aspirations at that specific moment, considering their change of state.

- As input, a survey is carried out to define an initial learner profile.
- An indexing of the LGs based on the metadata makes it possible to describe them to have a general knowledge of the LGs.
- A classification is made to categorize the games that will constitute the catalog list.
- We take the objectives to achieve defined in the proposed training.
- An analysis of the objectives is carried out with the learner's knowledge and skills in order not to offer them what they already know.

A matching between the learner profile, the training objectives defined by the teacher and the LGs are done through a scoring system assigned to the game profiles and characteristics using the *BrainHex* model platform http://survey.ihobo.com/BrainHex/ [13]. Next, LGs that stand out are proposed to the learner (Fig. 2).

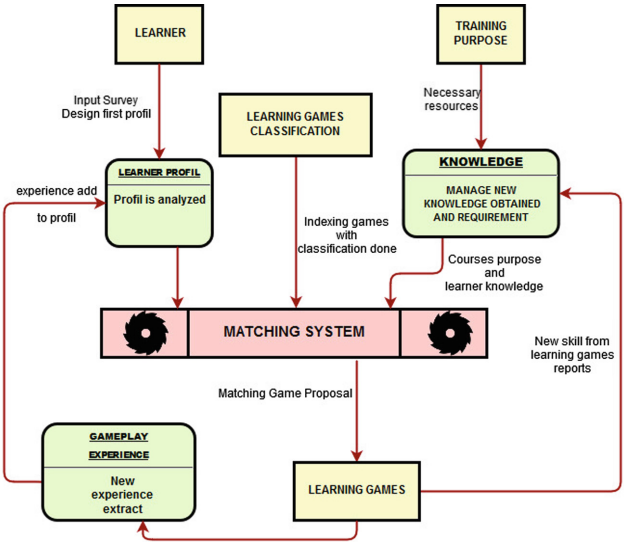

Fig. 2. Adaptive Learning Games Proposal model cycle

After playing, the learner's playing experience is extracted to be used as data in the composition of the learner's profile. In addition, the lessons transmitted in the learning game played increase the knowledge and give new skills to the learner, this is used with the objectives of the training to serve a content that will deal with the lessons coming just after this newly acquired knowledge and that will serve as a prerequisite. Each time the process is repeated to enrich the model and serve new LG in the learner's training.

5 Experimentation

The experimentation of the model was carried out on two classes of twenty-five first grade students in computer science, from the Virtual University of Côte d'Ivoire in self-learning. The LG catalogue includes 28 LGs in the areas of math, English language and

Table 1. Learning games catalogue for experiments.

Learning games	Fields
Maxtrax	Math
Luminosity: chalkboard challenge	Math
Cisco binary game	Math
Zombie division	Math
Prog & play	Math, computer
A.I wars: the insect mind	Math
Lure of labyrinth	Math
Demolition division	Math
Algebot	Math
English taxi	English
Duolingo	English
English training: have fun improving your skills	English
Cash cab	English
Opening a sales call	English
CeeBot3 educational programming software	Computer
Cisco aspire	Computer
Algo-bot	Computer
Game to teach sql	Computer
Vocabulary.co.il	English
Power words	English
Lord of the files	English
Grammar ninja	English
Hit typing	Computer
Programming learning game	Computer
Wireless explorer	Computer
Iscen	Computer
Computer quiz	Computer
Typing of dead	Computer

computer science with programming and network teaching. The experiments took place in two stages (Table 1).

The students were divided into two classes homogeneously according to their learning profiles, in the first class named "free class" the game catalog was provided without assistance, the games were classified by teaching subjects, so it was up to them to choose themselves the ones they want to play to get the knowledge required by the training. On the other hand, the second class called "assisted class" was assisted by the model to suggest the LG that should played, according to the learner's profile and their learning objectives.

The experiment took place over six weeks, and a satisfaction survey was conducted to collect the learners' motivation [17, 18] level each week. At the end, a questionnaire was produced to determine the level of learners' involvement in these training sessions.

6 Results and Discussions

The surveys were carried out on the following criteria; motivation, knowledge acquired, and level of engagement observed. It is by a qualitative measurement of the factors that we proceeded. A percentage is generated to serve as a result at the motivation level and scores are assigned for the other factors (Figs. 3 and 4).

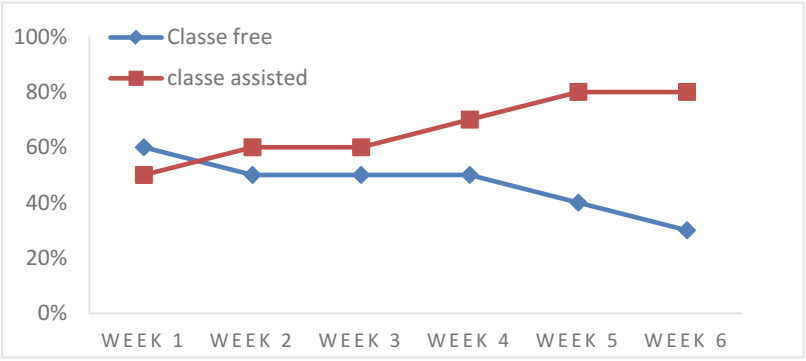

Fig. 3. Motivation evolution graph in %, generated from the evaluation score

The observation that we make on these results is striking, about motivation, after the excitement of the first week the level of the free class decreases constantly while that of the assisted class increases. This is due to the fact that, the games offered are adapted to the learning profiles of each student. As the proposals are based on the preferences of the learners, motivation continues to grow. For acquired knowledge, the level follows the same logic as that of motivation, in fact the level of knowledge obtained from a game is linked to the level of motivation [19].

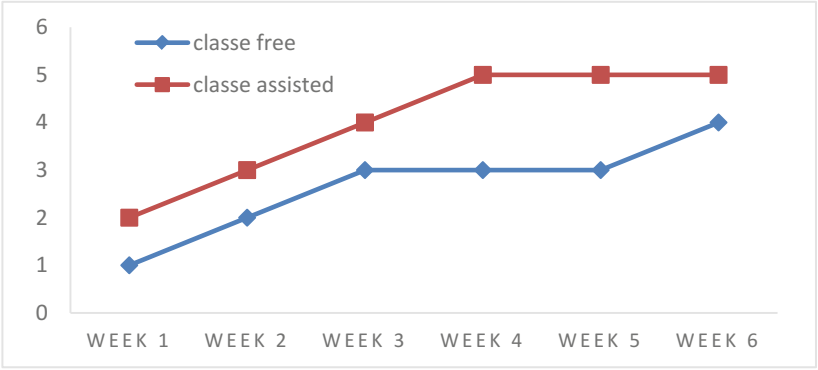

Fig. 4. Knowledge level score graph

7 Conclusion

The use of LGs to support learner training is widespread, especially in the case of self-directed learning. The success of learners in training based on LGs depends a lot on their level of involvement, their motivation to learn, and the experience that results to generate better knowledge of the concepts addressed. For this a model of game adaptability is proposed, and this model presents real advantages compared to training without assistance. Nevertheless, it would be more interesting, not to limit oneself to an adaptation of the LGs to the level of each learner without considering the group, and in addition, it would be beneficial, to also consider the learner's evolution in his way of understanding the notions of training.

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