

Modelling the Learner's Values with Computer-based Educational Game

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Abstract— Over the last decade, computer-based educational games have become more and more prevalent. With the increasing applications of these games in education, an increasing number of studies investigate the use of these games for extracting useful information about the learners while playing the games. In fact, computer-based educational games are not only considered as interactive didactic support that is able to increase the learner's motivation and engagement, but also as the means to provide ample opportunities for learner's interaction with the computer, which can be used to create reliable learner models. This paper introduces a computer-based educational game and proposes several scenarios for extracting a specific learner characteristic while playing this game, which is the learner's values.

Keywords— Computer-based Educational Games, Learner Model, Learner's Values, Adaptation, Learner Modelling

I. INTRODUCTION

In recent years, there has been a growing interest in computer games that support learning and teaching [1, 2, 3]. This is due to the belief of games can offer various learning benefits to learners. Indeed, the use of educational games can attract learners' attention and increase their motivation and engagement that can then lead to stimulate learning [1, 2]. In addition, educational games provide visual, tactile and intellectual stimulation; increase and stimulate creativity; provide genuine collaboration between players; and, improve self-confidence and facilitate self-help and social skills through collaborative working [1].

A number of tools have been developed to explicitly measure the learner's values, such as the Schwartz Value Survey [4, 5], Human Values Scale [6] and the Portrait Values Questionnaire [5]. The uses of these measuring tools can provide direct and precise estimation of learner's values, but this would endanger learners' motivation in case the survey interrupts their study.

One of the ways to get reliable results is to extract the learner's values from the game-play actions took by learners implicitly with computer-based educational games that

provide ample opportunities of learner interactions with the computer. As a preliminary step for developing computer educational games to evaluate learner's values, a role-playing game called the "Choice-Game" was designed and adapted to extract the learner's values throughout learner's interactions within the game. The implementation of a set of scenarios was based on the 4-step methodology: (1) we analysed the set of values based on related works; (2) we analysed the relations between the set of values (for example, priority between values or opposite values); (3) we analysed the relationship between the learner's values and the games genres in order to select the most appropriate game genre for modelling the learner's values; and, (4) we designed two scenarios for each learner value. The scenarios allow us to observe a set of values when the player makes choice in the game-play. The same scenarios allow us to observe another set of values in conflict with the first set of values when the player makes the opposite choice.

The rest of this paper is organized as follows: Section 2 starts with the presentation of a definition of the two main concepts, Learner Model and Learner Values. Section 3 presents a literature review related to the methods that are used to model a learner while playing computer-based educational games. Section 4 introduces the new computer-based educational game and proposes several scenarios for modelling the learner's values while playing this game. Finally, Section 6 concludes the paper with a summary and future works.

II. LEARNER MODEL & LEARNER VALUES

A. Learner Model

A Learner Model (LM) is a key component of any adaptive e-learning system as it maintains information about learners in order to provide them adaptive and personalized learning services according to their current learning needs as well as situations [1, 2, 7]. Bull [8] defines the learner model "is a model of the knowledge, difficulties and misconceptions of

the individual. As a learner who learns the target material, the data in the LM about their understanding is updated to reflect their current beliefs”.

Learner model may be constructed from learner data and traces gathered by learning systems or serious games [1, 2, 9]. Learning systems and instructors would be capable of knowing their learners’ strengths and weakness through the learner models [1]. Based on that, the pedagogical approach can be adapted to each specific learner or learner group [7].

Learner model is a higher level and presents the abstract view of the learner. In addition, it is able to deduce more extra information about the learner [9]. Moreover, LM should contain important information about the learner such as: domain knowledge, learning performance, interests, preference, goal, tasks, background, personal traits (learning style, aptitude...), environment (context of work) and other useful features [10]. Bull et al. [11] also add various information types that could be stored in the LM, including cognitive style, eagerness, helpfulness, interaction preferences, opinions of peers, and user actions.

In particular, learner’s values play a core role in an educational context [12, 13, 14]. In fact, the set of values have an important influence in learner’s behaviour [5, 13], personality traits [5, 16, 19], motivation [5, 16], beliefs [5, 18], goals, reasoning [5, 15], and strategies [5, 17]. Moreover, values has an important role in the process of constructing the learner implicit knowledge [20].

B. Learner Values

Values may be defined as "criteria that people use to select and justify actions and to assess people (including the self) and events" [5]. Rokeach [21] has defined values as "enduring. . . beliefs that a specific mode of behavior or end state of existence is preferred to (its) opposite . . . a standard that guides and determines action, attitudes toward objects and situations, ideology, presentation of self to others, evaluations, judgments, justifications, comparisons of self with others, and attempts to influence others" (p. 25).

Values are viewed as core aspects of the person and can be expected to be widely constant over time [4, 13, 15]. Moreover, personal values play a crucial role where they represent motivation that urges people to make decisions in their own way [5]. When the learner determines his/her values, he/she could discover what really fits his/her needs and goals [5, 22].

Various taxonomies of values have been suggested, but the framework proposed by Schwartz is arguably the most prevailing in psychology [4, 5]. The Schwartz value theory has been successfully used in the analysis of learner’s values [22, 23, 24, 25]. The theory proposes 10 basic values that are largely conventional across cultures. These 10 values are self-direction, stimulation, hedonism, achievement, power, security, tradition, conformity, benevolence, and universalism. Each of them can be characterized by describing its focal motivational purpose. Table 1 represents Schwartz value taxonomy, which shows the 10 values’ definitions and motivational values.

TABLE I. SCHWARTZ VALUE THEORY

Learner’s Values	Definition of their goals	Motivational values
Self-direction	Independent thought and action	Freedom, self-respect, independent, choosing own goals, creativity, curious
Stimulation	Excitement, novelty, challenges in life	An exciting life, a varied life, daring
Hedonism	Pleasure or sensual gratification for oneself	Pleasure, enjoying life
Achievement	Personal success by demonstrating competence according to social standards	Successful, capable, intelligent, ambitious, influential
Power	Social status and prestige, control or dominance over people and resources	Social power, authority, social recognition, wealth, preserving my public image
Security	Safety, harmony, and stability of society, of relationships, and of self	Healthy, national security, social order, reciprocation of favors, family security, clean, sense of belonging
Tradition	Respect, commitment, and acceptance of the customs and ideas that one’s culture or religion provides	Devout, humble, moderate, detachment, respect for tradition, accepting portion in life
Conformity	Restraint of action, inclinations, and impulses likely to upset or harm others and violate social expectations or norms	Politeness, honoring parents, self-discipline, obedient
Benevolence	Preserving and enhancing the welfare of those with whom one is in frequent personal contact (the "in-group")	Helpful, honest, forgiving, true friendship, meaning in life, loyal, mature love, responsible, spiritual life
Universalism	Understanding, appreciation, tolerance, and protection for the welfare of all people and for nature	Social justice, wisdom, protecting the environment, a world of beauty, equality, unity with nature, a world at peace, broadminded, inner harmony

Schwartz [4] proposes a circular structure of dynamic relations among the values. This circular structure illustrates the relations of conflicts and compatibilities among values. This structure can be summarized in two orthogonal dimensions [4]:

- **Self-enhancement vs. Self-transcendence:** On this dimension, power and achievement values conflict with universalism and benevolence values. Both of the former emphasize the pursuit of self-interests and relative success, while both of the latter emphasize concern for the welfare and interests of others.

Hedonism shares elements of both openness to change and self-enhancement [5].

- **Openness to Change vs. Conservation:** On this dimension, self-direction and stimulation values conflict with security, conformity and tradition values. This dimension captures the conflict between values that involve independent action, thought, feeling, and willingness for a new experience, and values that emphasize self-restriction, preservation of the past, order, and refusal of change [5].

Different instruments have been proposed and used in the literature to measure the values.

- The Schwartz Value Survey (SVS) is an instrument developed to measure values based on the Schwartz theory [4, 5]. The survey consists of two lists of value items. The first list includes 30 items guiding principles in life (e.g. purpose in life). The second list includes 26 or 27 items that define possible ways of acting to achieve the end states from the first list. The 57 value items as life-guiding principles on a 9-point rating scale ranging from -1 (opposed to my principles), 0 (not important), 3 (important), to 7 (of supreme importance).
- Human Values Scale: an instrument used for measuring the values is Human Values Scale (HVS). The HVS developed by [6] for high school students. The scale contains 42 items in six subscales which are Friendship, Honesty, Tolerance, Peaceful, Respect, and Responsibility. It is a five-point Likert scale (A: Never, B: Rarely, C: Sometimes, D: Frequently, E: Always) and could be administered individually or in groups. The items were scored as A: 1, B: 2, C: 3, D: 4, E: 5.
- The Portrait Values Questionnaire (PVQ) [5] is an alternative to the SVS created in order to measure the 10 basic values. The PVQ contains 40 short verbal portraits describing a person's goals, aspirations, or wishes that point to the importance of value. For each portrait, Respondents indicate on a 6-point scale how much the described person is like them.

III. LEARNERS MODELLING USING EDUCATIONAL GAMES

The process of creating learner model, so-called learner modelling, requires numerous if not continuous observations of interactions between the learner and the computer [1]. Learner interactions with the computer are rather restricted in traditional e-learning systems (limited to clicks, time that the learner invested in visiting a page, etc.) [2].

The lack of a variety of interactions between the learner and the traditional e-learning systems affects the certainty of the interpretations that could result in a misconception and therefore affect the accuracy of learner modelling process [1, 2]. In this context, educational games are not only considered as interactive didactic support that is able to increase the learner's motivation and engagement, but also as the means to provide ample opportunities for learner's interactions with the computer, which can be used to create reliable learner models

[1]. Khenissi et al. [1] proposed a taxonomy of learner modelling while using these games as Figure 1 shows.

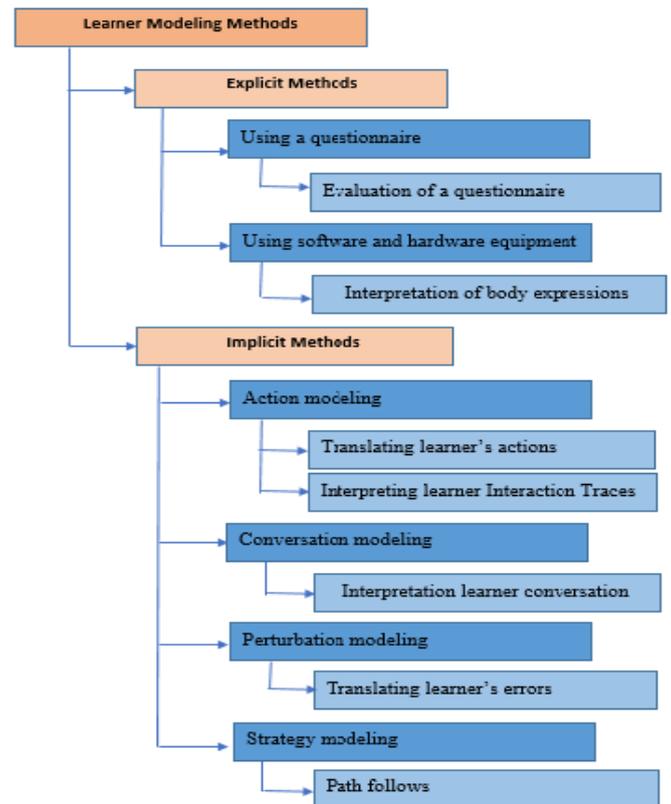


Fig. 1 Learner Modelling Taxonomy [1].

Khenissi et al. find that learner modelling with educational games can be done explicitly or implicitly. The explicit way can be accomplished with a questionnaire that gives direct and precise answers but could endanger the high level motivation provided by the games due to filling out a questionnaire requires learners stopping from game playing. Alternatively, the use of hardware and software equipment provides an explicit way to model the learners while playing the games. This method can provide additional information for modelling the learner. However, it obviously requires additional cost and causes intrusively feelings. Furthermore, observations collected using these equipment can be interpreted in different ways and this can endanger the reliability of the learner models.

On the other hand, the learner modelling with educational games can also be done implicitly by recording actions of the learners take while they are playing the games (i.e., Action Modelling). The actions took by the learners during the game play can be interpreted and translated into descriptive information useful for modelling the learners.

Conversation Modelling is another implicit way to extract information about the learners. It essentially models the communications between the learner and the non-player character. It records the learner's choices during these conversations and questions answered during game dialogues. It also records conversations with fellow players.

Moreover, Perturbation Modelling is also used to extract information about the learners in an unobtrusive way. It interprets information of what the learner has learnt and what misconceptions that the learner has learnt. It also records learners' errors, failure and success.

Finally, Strategy Modelling is also used to implicitly elicit information about the learners. It concerns long-term learner behavior during the use of an educational game as composed of a series of learner actions. Learner strategy can be monitored by following learner's learning paths inside the game.

IV. MODELLING THE LEARNER'S VALUES USING A COMPUTER EDUCATIONAL GAME

The "Choice-Game" is a role-playing game (RPG) aims to motivate learners to find the right answers to the questions about Unity software and to find the treasure at the end of the game. The game casts the player in the role of the young boy who is trying to search for the treasure on the island. In this game, the player follows a set of direction and discovers the checkpoints that help the boy to find the treasure. For each checkpoint, he/she must correctly answer to a question in order to move to the next step. Figure 2 shows the main interface of the Choice-Game.

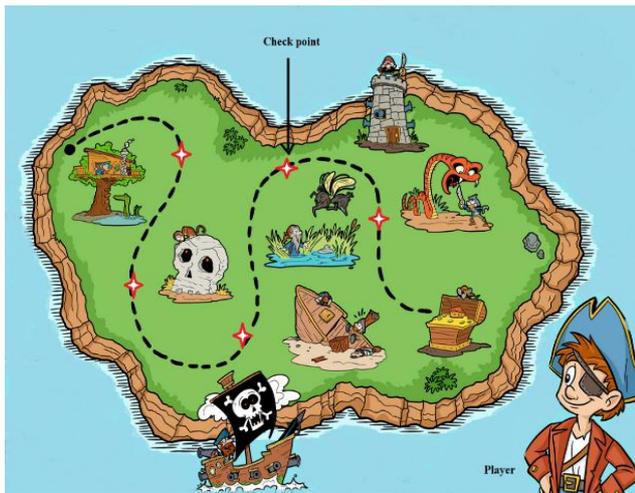


Fig.2 the Choice-Game Interface

The game will put the player in sensitive situations with multiple options for him/her to choose for passing them and then collect the traces about the learner's values. The learner's values will be modelled based on different scenarios.

Before going on to describe the game scenarios, we will present in table 2 the specified collected game traces, the description of it, the methods for collecting these traces, and the game scenarios that helped for collecting these traces.

TABLE II. THE COLLECTED GAME TRACES

Specified traces	Traces description	Methods for collecting	Interpretation of
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		traces	traces through the game scenarios
Generous	Shows if the player help others or not	Interpreting interaction	Scenario1, Scenario3, Scenario7
Risk	Indicate if the player prefers taking the risk or not.	Path follow	Scenario2, Scenario5
Social relationships	Shows the relationship of the player to others and how to deal with their customs and traditions. Shows if the player is open to change or not.	Interpreting conversation	Scenario3, Scenario4
Confidence	Shows the degree of self-confidence within the player.	Interpreting conversation and action	Scenario2
Activities	Shows if the player Respect the others and the rules through their activities or no.	Interpreting of action	Scenario6, Scenario8

As mentioned in table 2, the player traces are a generous, risk, social relationships, confidence, and activities. Here, each trace has two variables. For instance, Generous (Unhelpful/Helpful), Risk (Take risk/ Not take a risk), Social relationships (Open/ Close), Confidence (High/ Low), and Activities (Respect others and rules/ Not respect others and rules).

Now, we will present the applied game scenarios to collect the identified traces.

Scenario 1: The player's character (i.e., the boy) starts his adventure in an island. After he moves toward inside the island, he finds a person who needs help as Figure 3 shows. Here, if the player chooses to give the person a hand implies that he/she is considered as has the universalism and the benevolence values because people's benevolence value focus on solving the problem of others and provides an opportunity to protect and help them. They are like welfare for him/her [5, 23]. If the player chooses to not help, then it may imply that he/she should be considered having the power, the achievement and the hedonism values [5, 18]. In such case, he/she will continue his/her way along. Choosing the second decision make the player hears a horrible sound of a dangerous animal. Here, the player has a chance to rethink his/her decision and may exchanging help with the person who needs help. In this case, the player passes to the second situation with his/her new mate if he/she gives the person help of course and fail if he/she chooses to continue being alone because he/she will be eaten by the animal and restarts the game level.



Fig.3 Screenshot of the first game scenario in the Choice-Game

Scenario 2: After walking for a while, the player and his/her mate will find a crossroads: one is safe and the other is risky. The mate here will try to convince the player to choose the safe way and to join his/her mission of saving his missing sister as Figure 4 shows. If the player chooses to accept his suggestion and request to take the safe road, it implies that the player has the benevolence, the security, the tradition, the conformity, and the universalism values. People who have security value do not prefer to take the risk [2, 5]. Having order and stability in their environment is important for them [18]. If the player refuses to take the suggestion and join the mate in his mission, it implies that the player has the power, the self-direction, and the stimulation value.



Fig.4 Screenshot of the second game scenario in the Choice-Game

Scenario 3: If the player chooses the risky way, he/she will find a river with crocodiles in front of him/her. The player has to kill them to pass. Then he/she finds himself/herself in a mummies group. Here, a suggested question for the player is "Do you want to wear clothes like them or not?" If the player accepts, it implies that he/she is open to change. So he/she is considered to have the stimulation, the hedonism, and the self-direction values [5]. On the other hand, the choice made by the player implies that he/she has the tradition, the conformity, and the security values. If the player chooses the safe way and he/she goes with the mate. He/she will find the same situation in the end but without encountering with the river and the crocodiles.

Scenario 4: After walking for a while, the player will find a king. The game will ask the player whether he/she wants to kill the king to be in power or not. If he/she chooses to kill the king, then he/she has the power and the achievement values.

The player's power and achievement values need to be very successful and in power [5]. Besides, he/she is likely to prove his/her power through their actions with others [5]. Else if the player refuses to kill the king, then he/she has the universalism and the benevolence values [5, 23]. After that, another question will be proposed for the player for modelling his/her hedonism value. The question is "Do you like to drink alcohol or not?" The game has this question in order to know if the player has the value of hedonism likes alcohol consumption [23]. In fact, alcohol is often consumed for fun and pleasure [23]. So, if the player chooses to accept, it implies that he/she has the hedonism and the stimulation values. On the other hand, the opposite answer means that he/she has the security, the tradition, and the conformity values [5, 23].

Scenario 5: In this scenario, we put two checkpoints at the same level but the ways to reach them are different. In the first one (checkpoint 1), the access road contains many difficulties. While the access road to the other checkpoint (checkpoint 2) is easy. Here, if the player chooses the hard way, then he/she has the stimulation, the hedonism, and the power values. In fact, people who have these three values love the challenges. They always search for opportunities to exploration, interaction, excitement [5, 23]. Besides, they prefer to take the risk and try their chances [2, 13]. On the other hand, if he/she chooses the easy way, this means that he/she has the security, the tradition, and the conformity values [2, 5, 23].

Scenario 6: The game allows the player to catch the fishes. A banner is put with the words "prevents catching fishes of this type" and a picture of the fish type. If the player does not catch this fish type and respect what the banner says, then he/she has the conformity value because people who owns this value, usually adheres to the rules [5, 23, 24]. Else, if he/she catches this type of fishes and he/she doesn't respect the words on the banner, then it implies that he/she has the self-direction value.

Scenario 7: the player in this scenario will find two things: a checkpoint and a little gazelle which is trying to cross the river to get happily united with mother gazelle, she could not do that on its own and needs helps. Here, the player is free to decide whether to offer little help or to simply continue his/her adventure by passing the checkpoint. So, if the player chooses to pass the checkpoint, it implies that he/she has the power and the achievement values. People who have these values usually try to solve their problems to progress in their life. They need to be very successful [5, 18]. But if he/she chooses to help the gazelle, it may imply that he/she has the benevolence and the universalism values. People's benevolence value focuses on solving the problem of others who seek for their helps [5].

Scenario 8: In this scenario, the player will drive a car and he/she will see a traffic sign "stop". If the player stops, this means that he/she has the conformity value since he/she pursues rules even when no one is controlling him/her [23][24]. Else, if he/she doesn't stop, this means that he/she has the self-direction value.

V. CONCLUSION

The research reported in this paper is a preliminary step for developing a computer-based educational game which allows to extract the learner's values and model the learner. In particular, this paper introduced a computer-based educational game called the "Choice-Game" and designed eight scenarios for modelling the learner's values from players' game-play.

Information about learner's values can be used in adaptive e-learning systems for providing learners with individualized materials and personalized recommendations that positively affect the learners' learning process. Furthermore, learner's values have an important influence in learner's behaviour, learner's personality traits, learner's beliefs, learner's goals, and learner's reasoning and strategies.

This study has a limitation that is the use of the only eight scenarios cannot help to collect enough data about the learner. Therefore, the game cannot really reach the research goal. To achieve our goal, we should consider something like we do in Item Response Theory as well as any valid and reliable questionnaire, the game should have more scenarios and each of them may be related to one of the three values we want to identify. According to the players' choices, the game should be able to find out their values via convergence. The other limit is the proposed scenarios have not been validated.

As for future works, we will design and implement at least three game scenarios for each learner's value to achieve our goal. Moreover, future works will empirically validate the proposed scenarios. In particular, we will invite participants to play the "Choice-Game" and to model their values implicitly while playing this game. After that, we will invite the participants to answer a valid measuring tool of learner's value such as the Schwartz Value Survey (SVS). Results obtained from the measuring tool will be compared to the results obtained from the computer educational game. This will allow to check the validity and the effectiveness of our approach of modelling the learners' set of values.

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