A Constructivist, Modeling Methodology For The Design Of Educational Card Games

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Abstract

This paper presents a specific modeling methodology for the creation of educational card games. This methodology is based on the creation of the following three models: (a) the model of the subject matter; including all aspects of the learning subject in question, (b) the learners’ model; including learners’ non scientific conceptions about the aforementioned learning subject, and (c) the learning model; consisting of an appropriate learning strategy for the learning of the subject in question through card-game play, taking into account basic social and constructivist views of learning in combination with as well as key structural characteristics of games which can contribute to players’ engagement. Based on the aforementioned methodology, the design of various types of cards is proposed.

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1. Introduction

Constructivist approaches towards learning emphasize that it is important for the learners to actively creating their knowledge instead of being passive receptors of information (Jonassen, 1999). To this end the role of engaging learners in meaningful and enjoyable learning activities is also acknowledged as crucial (Jonassen, 1999; Land and Hannafin, 2000). Games are argued to be an appropriate means to center the learner, making it possible to learn in a meaningful way, to emphasize problem solving, and to approach learning as an active process of understanding (Prensky, 2001). Games can provide students with strong motivation to be actively engaged in their learning (Malone and Lepper, 1987). More specifically, seven factors which include both individual and interpersonal factors

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have been postulated to promote intrinsic motivation. The individual factors are challenge, curiosity, control, fantasy, competition, cooperation and recognition. Many of these factors could be triggered by the use of games (see, e.g., Egenfeldt-Nielsen, 2006; Prensky, 2001). Games also provide a meaningful context for students because the outcome, winning or losing, can be important to them (Ainley, 1990). This motivation to succeed (Anderson and Kamii, 2003) stimulates students to learn the concepts in focus by connecting with previous experiences, both inside and outside the classroom. In addition, games not only provide a source of strong motivation for student engagement in learning, but they can also essentially encourage students’ social, emotional and cognitive development (Kamii & DeVries 1980). Perhaps, the most common educational implication of Piaget’s work is, that play, is important for children’s development (Piaget, 1945/1962). Moreover, research into games and play has demonstrated that players can attain a state of ‘flow’ (Csikszentmihalyi, 1990). Flow is a state of deep absorption in an activity that is intrinsically enjoyable, similar to when artists or athletes are focused on their play or performance. Individuals in this state perceive their performance to be pleasurable and successful, and the activity is perceived as worth doing for its own sake, even if no further goal is reached. In fact, the game-based learning approach brings with it the involvement and the excitement of accomplishment (Rajaravivarma, 2005). Appropriately-designed card games are also mentioned among the appropriate types of educational games for constructivist learning (Kamii & DeVries, 1980). For example, card games meet several -National Council for Teachers of Mathematics- standards, such as number and number of relationships (NCTM 2000-2004). Effective use of card games is reported in the learning of various curriculum subjects such as: Chemistry (Pieroni, Vuano and Ciolino, 2000), Physics (Smith and Muhro, 2009), Language (McGr aw, Yoshimoto and Seneff, 2009), Computer Science (Baker, Navaro & van der Hoek, 2005; Kordaki, 2011), Financial studies (Chandra, Herman, Kim, Lau, Murad, Pascarella, Wu, Preston & White, 2006) as well as Mathematics, (Bright, Harvey, & Wheeler, 1985; Anderson, & Kamii, 2003; Ng, Bin, Pat and Teo, 2007). Despite the above, a methodology for the design of educational card games taking into account modern social and constructivist views of learning has not yet been proposed. Thus, the aim of this work is to provide a concrete and documented methodology for the design of card games taking into account the aforementioned constructivist views of learning. This methodology is described in the next section of this paper. An example of the design of a card game for the learning of basic aspects related to thermal phenomena by fifth grade pupils is also reported.

2. A modeling methodology for constructivist card game design

Modelling methodologies had already been successfully used in the design of educational software (Kordaki & Potari, 1998; Kordaki, 2010). In this paper, a modelling methodology has been formulated for the design of educational card games. This methodology has considered the design of three models, namely: (A) the model of the subject matter. This model consists of the basic concepts of the learning subject in question as well as the basic tasks which are considered as appropriate to be realized by the students in order to grasp these concepts, (B) the learners’ model that includes the students’ non-scientific conceptions regarding the aforementioned learning concepts. These misconceptions could be investigated through specific empirical studies as well as from investigations of the literature, and (C) the learning model consisting of an appropriate learning strategy through card-game play. In the design of the learning model, various aspects of social and constructivist views of learning (Jonassen, 1999; Vygotsky 1974) were taken into account, namely, the essential role of: (a) learners’ motivation through the use of: (i) familiar and interesting learning activities for the students, (ii) appropriate scoring mechanisms for interest and adrenaline, (iii) competition possibilities by playing against a peer, (b) students’ previous knowledge in the construction of new knowledge, (c) classification activities (Bishop, 1988 ) and appropriate questions towards the development of students’ critical thinking skills (Marzano, Brandt, Hughes, Jones, Pressseisen, Rankin, & Suhor, 1988). In fact, classification activities are central in card game-play. In fact, the designer of a card game has to find which are the appropriate classification activities of grouping appropriate cards which could help students understand the learning concepts in question. Here it is worth mentioning that, classification is a universal learning activity (Bishop, 1988) and a core mental skill that can promote critical thinking (Marzano, et al., 1988), (d) visual support in the development of mental conceptions by the students, and (e) scaffolding and appropriate help on learners’ actions in order to progress smoothly in their understanding of the learning concepts in question (Vygotsky, 1974). Furthermore, the following key structural characteristics of games (Bright & Harvey, 1984; Prensky, 2001, pp. 118–119), which can contribute to players’ engagement, have been taken into account: (a) play, (b) rules, (c) goals and objectives, (d) interaction, (e) outcomes, (f) winning, and (g) competition, challenge and
opposition. Based on the above, a concrete 7-step methodology for the design of constructivist card games is described in the following section.

**Step 1: Definition of the subject matter model and of the students’ model:** Based on the modeling methodology described above, the specific concepts in question and the appropriate learning activities as well as the specific student difficulties that should be overcome during card game-play have to be clearly addressed. To this end, the formation of an appropriate concept map can be very helpful.

**Step 2: Definition of the aims of the card game play:** Based on both, the subject matter model and the students’ model, the aims of the game should be explicitly defined.

**Step 3: Definition of appropriate card game-play learning activities:** Here, the design of various appropriate card game-based activities for the learning of the concepts in question while at the same time helping students overcome major difficulties is essential. Examples of such activities are: card-classification activities, asking/answering questions, rejection of non-appropriate cards etc. To this end, the learning activities mentioned in both the subject matter model and the learners’ model should be taken into account. Based on these activities, a number of cards should be designed. In fact, one has to design appropriate categories of cards for the realization of each learning activity. For example, when some experiments are considered as appropriate to be formed during card game-play, one has to design cards illustrating the devices and the materials dedicated for each experiment as well as the basic steps of its progress. As for another example, where the aim of a learning activity is to help players clarify the characteristics of some historical heroes, a number of cards illustrating the basic characteristics, faults and achievements of each hero have to be designed. In order to win, each player should select the appropriate cards of characteristics, faults and achievements of an individual hero during game play.

**Step 4: Definition of specific card game-play activities to help students overcome their difficulties:** Here, the definition of the students’ difficulties or alternative ideas for the learning of the concepts in question is necessary. Then, the design of a number of card-game based activities to help learners overcome their difficulties is crucial. For example, a number of cards –called challenging cards- addressing students’ common mistakes could be designed. Players have to reject such challenging cards during game play. Other forms of challenging cards could be cards illustrating multiple choice questions referred to each concept in question. Each question will be coupled with multiple answers, one of which is correct, while the others are false and include the exact non scientific conceptions that usually express students through their learning of the subject matter.

**Step 5: Definition of the kind of motivation should be provided for the students during card game-play:** Here one can design some motivation cards that could encourage learners to happily engage in card game-play. For example, one can design cards with celebrity athletic figures on the back to motivate students in a sports science department to learn about computer literacy concepts. The design of some cards related to the learners’ interests will be also engaging. These cards should be added to the stack. The design of appropriate joker cards could also provide some motivation for the players. For example, joker cards illustrating Computer scientists could motivate students in a Computing department in their learning about Computing concepts. The design of the scoring mechanism of the game so as to give some bonus points when motivation cards pop up will also be engaging.

**Step 6: Definition of the kind of scaffolding during card game-play:** Here, a number of scaffolding cards have to be designed. These cards should provide some information for the players regarding the concepts included in the subject matter model, for example, text/visual information, solved representative problems, etc.

**Step 7: Definition of the rules of the card game-play:** Here, the goals, the rules, the winning strategy, the interaction among players, the outcomes and the challenges of the card game play have to be considered. Thus, appropriate cards including this information should be constructed.
3. Use of the modeling constructivist methodology: design of an educational card game for the learning of basic aspects of the thermal phenomena

**Step 1: Modeling:** The educational card game presented in this section is designed for the learning of basic concepts related to thermal phenomena by fifth grade pupils. The model of the subject matter consists of the basic concepts related to thermal phenomena, namely: heat, temperature, latent heat, melting and congealment. The learners’ model about these concepts considers that students have difficulties to understand that: (a) heat and temperature are different concepts: students believe that we can measure heat by measuring temperature, (b) each physical substance has its own melting and congealment temperature, (c) the concepts of melting and congealment are related to all substances and not only to water and (d) the heat given to a physical substance changes its state not only its temperature.

**Step 2: Definition of the aims of the card game play:** Based on the aforementioned models the specific aims of this game are to support pupils to understand that: (a) Heat is a form of energy, (b) Heat and temperature are different concepts, (c) Latent heat is implied in melting and congealment, (d) Each physical substance has its own melting and congealment temperature, and (e) The concepts of heat, temperature, latent heat, melting and congealment are related to all physical substances and not only to water.

**Step 3: Definition of appropriate card-game activities:** As emerged from the literature, lab experiments are essential activities to help students learn the concepts pertaining to the aforementioned subject matter and overcome their difficulties. Thus, it was decided to provide students with opportunities: (a) to form experiments from their everyday life for the learning of each of the aforementioned concepts (one experiment for each concept) during card game-play, (b) to make observations and (c), to draw appropriate conclusions. In fact, 5 experiments could be carried out during card game-play by the students. For each experiment, a number of cards (12 cards) have been designed. Each of these cards illustrates one of the devices or the materials needed for the realization of each experiment. There are also cards illustrating some observation and conclusion statements. Students have the task to collect appropriate cards to form a specific experiment, make appropriate observations and draw correct conclusions during card-game play. During their attempts to form these experiments students can express their difficulties about the concepts included in the subject matter model.

**Step 4: Challenging cards:** Here as well, cards illustrating students’ specific difficulties related to the learning concepts were also designed (20 cards; 4 for each concept in question). These cards illustrate wrong textual statements about these concepts. For example: ‘The heat of a body is measured by measuring its temperature’.

**Step 5: Definition of the kind of scaffolding during card game-play:** A number of scaffolding cards have also been designed (6 cards). These cards have textual and figurative parts and refer to essential points of the concepts included in the subject matter model. Scaffolding cards appear on the player’s demand.

**Step 6: Definition of the kind of motivation provided for the students during card game-play:** Firstly, the formation of real life experiments by the students would be interesting. In addition, four joker cards have been designed illustrating some devices (eg. a thermometer) which could be used in the formation of all the aforementioned experiments during the card game-play. Joker cards are presented to the player randomly.

**Step 7: Definitions of the rules of the card game-play:** Here 2 big cards illustrating the rules of the game have been designed as well. The total number of cards included in this game is 92.

**References**


