THE GAME CHALLENGE MODEL

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ABSTRACT

Over the last ten years, computer educational games are increasing as popular instructional tools. This paper defines a machine-processable data structure to represent "challenge" in computer educational games such a structure supports estimates of a player's capability and of the level of challenge, allowing the automatic provision of a suitable activity at an appropriate challenge to the players.

KEYWORDS

Computer Educational Game, Game Challenge Model, Challenge, Game Challenge Structure.

1. INTRODUCTION

A challenge is a task that requires a player's mental or physical effort to complete successfully (Adams 2010). The challenge in a computer educational game supports learners to construct their knowledge (Tan et al. 2007) and to develop their skills (Orvis et al. 2008). Learners are challenged if they face a task that needs skills and knowledge that is beyond their current competence (Van Velsor & McCauley 2004). They usually have to acquire new knowledge and apply it in practice to complete this challenge (Schell 2008; Charsky 2010).

In the context of an adaptive computer educational game, balancing between the player's competences and the game challenge is a part of the process of keeping the player "in the flow channel" (Csikszentmihalyi 1990). A challenge defined by using unstructured text for representing what is a piece of work that a player must complete is a format that cannot be read and processed by a machine, which is necessary for automatic game balancing in computer educational games. A computer educational game must estimate a player's capability, level of challenge, and automatically give a suitable challenge to the players. Currently, there is a lack of a clear machine-processable data structure of challenge that describes the subject matter, the player's capability, and the game context.

This paper defines a data model for representing challenge for adaptive computer educational games based on learning and educational theory.

2. GAME CHALLENGE MODEL

The "Game Challenge Model" is a conceptual data structure that represents the intended learning outcome and game context in a machine readable format. It is proposed for all subject matter domains where gaming and learning takes place. The Game Challenge Model consists of three main components: the objective, the game context, and prerequisite achievement as shown in Figure 1.

2.1 Objective

The "Objective" is a game task that players have to accomplish. It consists of a player's capability and an element of game subject matter.

- **Player's capability**

Player's capability refers to the physical or mental power or skill which the player is to develop as a result of achieving challenge. There are many taxonomies for a learner's capability such as Bloom (Bloom & D.R. Krathwohl 1965; Anderson et al. 2001), Merrill's level of performance (Merrill 1994), and Gagne's hierarchy of learned Capability (Gagne 1985; Gagne 1965).

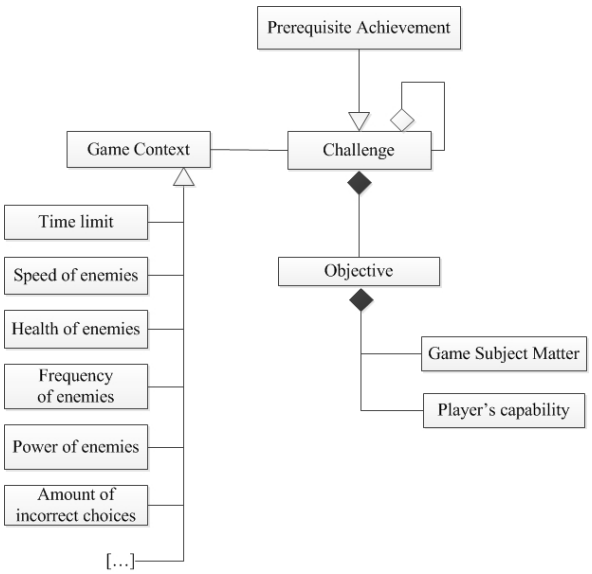

Figure 1: The Game Challenge Model

- **Game Subject Matter**

Game subject matter is the subject matter that is intended that the learner should learn. Merrill (1994) states that subject matter can be classified into four types: facts, procedures, concepts, and principles. Facts are pieces of information that consists of two specifics such as proper name used to call particular objects, parts or events. Concepts are a number of characteristic are used to classify or categories objects, evens, or ideas according to their values on those attributes. Procedures are steps accomplish some goal, solving problem, or produce some product. A principle is a cause-effect relationship between objects or events that can usually be expressed as some sort of an equation.

2.3 Game Context

Game context is the context that makes a game challenge easier or harder such as time limit, speed of enemies, health of enemies, frequency of enemies, frequency of power ups, power of enemies, amount of incorrect choices and so on. For example, in a typing game, the player has to type the same word in a different time limit. In the shorter time limit, player feels the task is more difficult than before. It can be inferred that the game difficulty can be varied by time limit although the player's capability and game subject matter is not changed.

2.4 Prerequisite achievement

Prerequisite achievement is a type of challenge that the player must complete before they can attempt a current challenge. If the player does not meet the prerequisite achievement, the game will be unable to offer the player a current challenge.

3. GAME CHALLENGE STRUCTURE

Each challenge node composes of challenge number, objective and game contexts as show in Figure 2. One challenge might be consist of several small-challenges (Adams 2010). They are assembled into a structure for a particular knowledge domain as represent in Figure 3. The relationship between challenge nodes is an enabling relationship if before players can achieve the top level node, they must first able to achieve the enabler node(s). For example, before players achieve the challenge number C01, they must achieve in the challenge number C02 as shown in Figure 2.

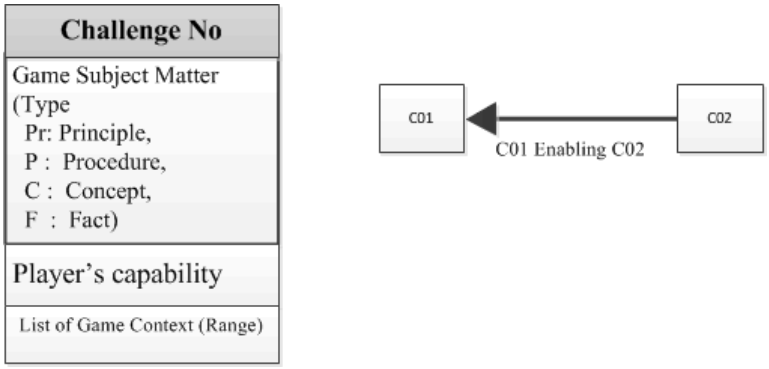

Figure 2 The challenge node and the enabling relationship symbol

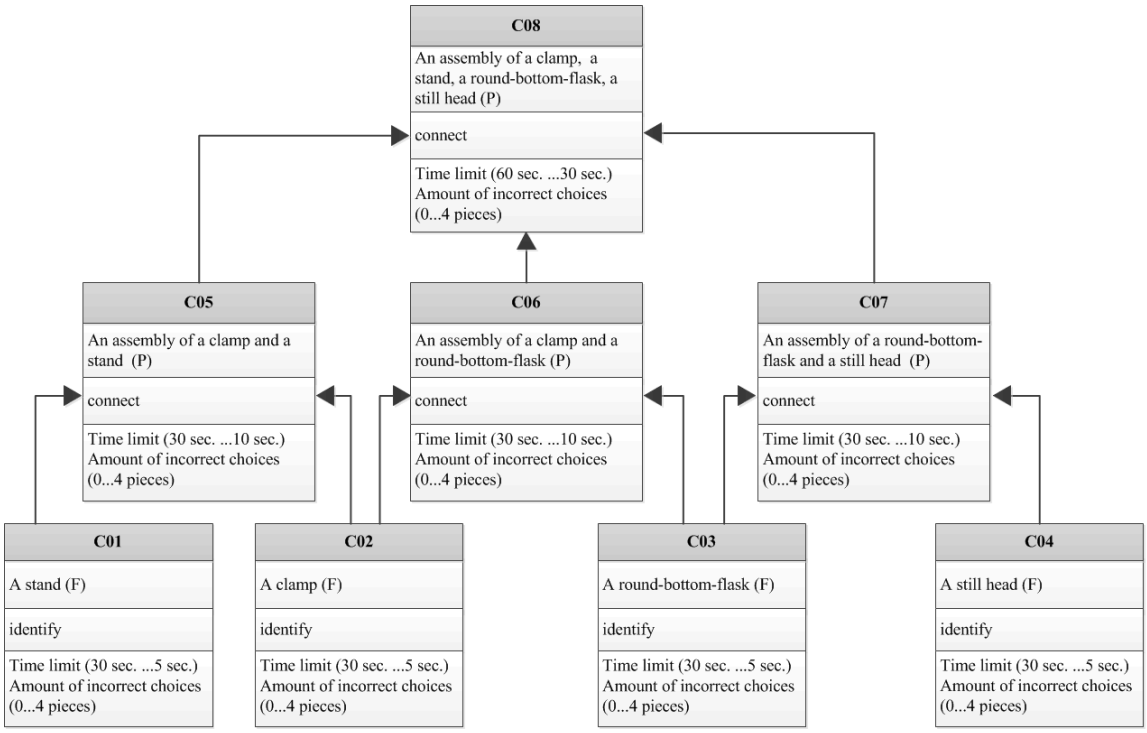

Figure 3 Example of Game Challenge Structure

Figure 3 represents some challenges based on the game challenge model for a puzzle computer game which helps players to learn apparatuses and an assembly of apparatus for a distillation extraction domain. The challenge numbered C01 represents; Objective consists of: the game subject matter that is the fact of a

stand, the player's capability is to identify, and the game contexts have both a time limit and amount of incorrect choices.

The game context might be adjusted for making this challenge more difficult or easier. For example, to make this challenge more difficult, the time allowed for the game might be decrease time limit from 30 to 15 seconds and at the same time increase the amount of incorrect choices from 1 piece to 4 pieces. Moreover, this example also represents the relationship between the challenge nodes. In the enabling relationship, players must be able to achieve the prerequisite challenges (numbered C01 and C02 in Figure 3) before they are given a more difficult challenge (number C05 in Figure 3)

4. CONCLUSION

We have proposed the Game Challenge model to support designing the game challenge of the computer educational game. Unlike traditional a game challenge design that using unstructured text for representing what is a piece of work that a player must complete, our model describes the challenge by identifying the objective, game contexts and prerequisite challenges. It represents the various components and relationships with in the game challenge structure. Therefore, we believe that the game challenge model can support computer educational games estimate a player's capability, level of challenge, and automatically giving a suitable challenge to the players.

REFERENCES

Adams, E., 2010. *Fundamentals of game design*, Thousand Oaks, CA, USA: New Riders Publishing.

Anderson, L.W. et al., 2001. *A taxonomy for learning, teaching, and assessing : a revision of Bloom's Taxonomy of educational objectives* Abridged e. Abridged, ed., New York: Longman.

Bloom, B.S. & Krathwohl, D.R., 1965. *Taxonomy of educational objectives: The classification of educatioonal goals by a committtee of college and university examiners*, New York: Longman.

Charsky, D., 2010. From Edutainment to Serious Games: A Change in the Use of Game Characteristics. *Games and Culture*, 5(2), pp.177–198.

Csikszentmihalyi, M., 1990. *Flow: The Psychology of Optimal Experience*, New York: Harper and Row.

Gagne, R.M., 1965. *The Conditions of Learning*, New York: Holt, Rinehart and Winston.

Gagne, R.M., 1985. *The conditions of learning and theory of instruction*, New York: Holt, Rinehart and Winston.

Merrill, M.D., 1994. The Descriptive Component Display Theory. In *Instructional Design Theory*. New Jersey: Educational Technology Publications, pp. 111–157.

Orvis, K. a., Horn, D.B. & Belanich, J., 2008. The roles of task difficulty and prior videogame experience on performance and motivation in instructional videogames. *Computers in Human Behavior*, 24(5), pp.2415–2433.

Schell, J., 2008. *The art of game design : a book of lenses*, Amsterdam ; Boston: Elsevier/Morgan Kaufmann.

Tan, P.-H., Ling, S.-W. & Ting, C.-Y., 2007. Adaptive digital game-based learning framework. *Proceedings of the 2nd international conference on Digital interactive media in entertainment and arts - DIMEA '07*, (1), p.142.

Van Velsor, E. & McCauley, C.D., 2004. Our view of leadership development. In *The center for creative leadership: Handbook of leadership development*. San Francisco, CA: Jossey-Bass.