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An Analysis of Scrabble from the Viewpoint of Gamified Learning

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Extended Abstract

In the past, games were treated as entertainment medium which targeted mainly. However, they have continuously gained spacious attention and became more accessible to most generations. Besides, techniques and principles in games are brought into non-game contexts, which is called 'gamification.' Gamification has been applied to various fields, e.g., work, education, marketing, health, and business to improve user's engagement successfully. This approach makes the actual purpose of the main action less direct but becomes more interesting in a user perspective.

Language is a basis of a communication system between human, and one of the fundamental parts of social development. In the globalization era when linguistic is the source of opportunities, it is undeniable that has become increasingly significant. Besides, learning language potentially improves the human brain functionality by various means. The living of people is subjected to change as the technology develops. The advanced technology was introduced and became irreplaceable infrastructure in most organizations, including education. Previously, the development of knowledge can be carried out only at an institution or by a textbook. Later, an introduction of smart devices and the advancement of consistent connectivity brought the distant study to be doable at one's convenience.

Game theory is the study of cooperation and conflict between decision makers in a competitive circumstance. It has been applied to various contexts in economics, political science, psychology, logic, biology and computer science. In computer science, minimax is known as the prior algorithm used in decision making for maximizing the minimum gain, while minimizing the maximum loss. In the past decades, AI research has been swiftly developed as the world champion caliber of Go and Chess were outplayed by them. The success was due to an advancement of the algorithm as well as significant increases in computational power, which benefits from high-end terminals with improved network infrastructure.

Many efforts have been devoted to studying game theory so that it is successfully developed to figure out how to identify the sophisticated decision and strategy. However, how attractive and balance is the game is another challenging question, and little is known about them. Flow is known as the zone where one is fully concentrating on a specific activity, which is in the balance between

difficulty and skill. During that state, the performance and the creativity are increased, while decision making becomes automatic. All people may experience flow in various activities, e.g., sports, games, studying, working, and even daily routines.

The actual attractiveness may depend on various determinants, e.g., game mechanics, duration of the game, game complexity, the proficiency and preference of a player. However, there is a conjecture that from the perspective of a neutral observer, an identical game with unpredictable outcome tends to be more interesting. Game refinement theory, proposed by Iida *et al.* is active research which focuses on quantifying game entertainment and its sophistication, based on the conjecture. Two mathematical models, known as board game model and game progress model are constructed, then a link between physics-in-mind and Newtonian physics and is established. Apparently, the measure describes the rate of change in information progress during the game. Prior researchers suggest that the well-refined zone of the game refinement measure conforms to the range 0.07 to 0.08, which we call 'sophisticated zone' regardless of the game classification. While insufficient value leads to tedious or boredom, an excessive amount may lead to frustration or anxiety.

However, game progress model does not directly fit with a game with a non-uniformed scoring rate. Instead, swing model is obtained by deriving from it. Swing turnover is considered when a state transition in mind is changed during the game progress among two states: advantage and disadvantage. For an exciting game, it would have an appropriate measure of swing, as it describes the frequency of the occurrence of swing turnover. In this study, the artificial intelligent player is developed for data simulation, which is necessary for quantifying its attractiveness and educational benefit of SCRABBLE, which are brought to our consideration due to its unique characteristics.

SCRABBLE is a multiplayer word anagram game, which up-to-four players competitively score points by placing tiles on a 15 by 15 board. Each tile bears an English alphabet and its respective mark. A formed word is required to be a valid word in a standard dictionary and adjacent either horizontally or vertically to preceding words. Many competitive SCRABBLE tournaments were held in the United States and Canada, attracting professional players worldwide to join. Besides competitive purpose, SCRABBLE is playable as a friendly game, which can strengthen the bond among family or faculty members. Playing SCRABBLE is a less direct way to improve vocabulary size as well as speed up the mental arithmetic skill. If learning English vocabulary is considered as the main action, then SCRABBLE is one of the possible gamified direction. Despite the fact that most have only a singularity, SCRABBLE has dual properties of board game and scoring game, entertaining and educative. Game refinement theory indicates that SCRABBLE is an enjoyable game, in which sufficient vocabulary knowledge is required to enjoy the game. Although it is made comfortable for native speakers, the excessive branching factor may frustrate non-native speakers, which results in unbalanced player distribution between them.

Besides, different results from two models reflect the game refinement theory that an inconsistency between legacy models is discovered. Therefore, we claimed that the real intuition on a player does not only depend on the game sophistication, but also the resistance from a player, which we define as 'mass-in-mind.' The 'mass-in-mind' or a shift of perceived challenge is introduced. Its mathematical model is constructed based on the hardness of the decision process in the board game, which all possible instances are reduced to only one single solution. The idea has been extended to other types of games, e.g., scoring game, then later leads to the establishment of game refinement model considering mass, which successfully strengthens the link between two original models. The study shows that the sophisticated zone of game refinement considering mass is from 0.00245 to 0.00320.

Despite the fact that entertaining aspect is the principal factor in designing a game, but it is possible to discuss other elements in the case of SCRABBLE. In this study, the educational benefit is being reviewed by a general fact in English and learning coefficient, which is proposed based on the growth of learning. Possible enhancements, which focuses on entertaining and educative experience are suggested and discussed theoretically to improve SCRABBLE. Either board size reduction or the dictionary size shrinks the excessive branching factor efficiently. The study shows that 13 by 13 board size is continuously an entertaining game regardless of the player strength while reducing the dictionary size to 4%   6% of the standard size adequately fit the foreigners' taste. The methodology we proposed is expected to be applicative to descendant works as well.