An empirical analysis of 'challenge' as a motivational factor for educational games

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Since one of the most basic and important predictors of student achievement is the amount of time a student spends engaged in learning (or time-on-task; Karweit, 1984; Frederick & Walberg, 1980); and because computer games are hugely successful at motivating users to spend time-on-task (Dondlinger, 2007; Gee, 2003; Mayo, 2007), there has understandably been a great deal of recent interest in harnessing the motivational qualities of computer games in order to create powerful, engaging educational tools (i.e., Gee, 2003; Pivec, 2007; Ruben, 1999). However, to date very little empirical academic research has investigated how, exactly, games achieve these motivational qualities. If we are to create games that produce genuinely educational outcomes, we must understand what exactly it is about games that make them so good at maintaining the player's motivation to continue playing.

Two related factors that have been typically proposed as contributing to player's motivation to continue playing a game are appropriate challenge and flow. Many researchers have proposed that games should present challenges that are matched to the players own skill level, and that playing games is fun only if a sufficient proportion of the games challenges are mastered by the player (i.e., Gee, 2003; Koster, 2005; Vorderer, Hartmann & Klimmt, 2003). Importantly, the concept of appropriate challenge also suggests that players will not be motivated to play a game that they do not find challenging (i.e., a game they have already mastered). Despite the ubiquity of the concept of appropriate game challenge, nowhere has there been a suggestion of what, specifically, constitutes this 'appropriate' level of challenge in a computer game, or how an educational game designer can approach the problem of ensuring that players experience it.

The concept of flow, defined as a state where a person is so involved with the goal driven activity they are doing that nothing else seems to matter, offers similarly little practical guidance for the educational games designer (see Kiili, 2005). In the literature, a flow state is said to occur when the player experiences appropriate challenge in a game (i.e., it is neither too hard and frustrating or too easy and boring). However, there have not yet been any controlled experimental studies that have identified what a flow state, or appropriate challenge actually means in games - whether it constitutes the player achieving a score of 100% on all tasks presented, or whether it is a phase before 100% mastery has been achieved, or, indeed, whether this is entirely subjective and dependent on each players' unique history. This is precisely the level of basic research that needs to be conducted in order for us to better understand the unique motivational qualities of games and to consequently incorporate these qualities in educational programmes.

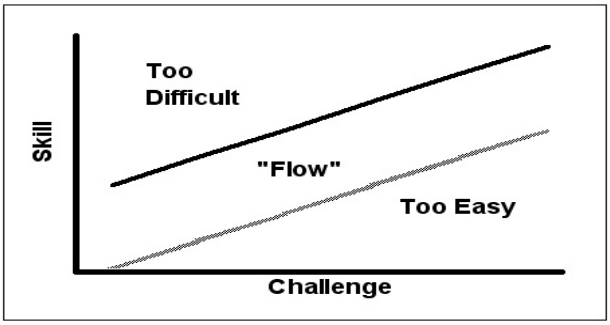

Figure 1. Graphical representation of the concept of flow in computer games. Flow is said to occur when the challenge presented by the game is appropriate to the players skill level.

Understanding the role of game challenge in influencing player motivation is crucial for the potential success of games as educational tools. Specifically, it is possible that the process of teaching, where the learner must have a goal of reaching 100% mastery in that game, removes one of the key motivational features of games. If we find that players, in fact, prefer not to reach mastery at a game, forcing them to do so may lead to a loss of player motivation (i.e., the whole reason why games have been proposed as useful educational tools in the first place).

One crucial problem when examining motivation in games experimentally is that there does not appear to be any existing objective measure of motivation in games. We propose that the methodologies developed by behaviour analysis may prove to be very useful in this respect. Behaviour analysis is an approach to psychology that assumes that all behaviour is determined by an organisms' interaction with its environment (see Hayes, 1993; Skinner, 1953). It is a rigorously quantitative science that is concerned with the measurement, prediction and control of behaviour. Of particular relevance, operant choice procedures (i.e., Herrnstein, 1961) provide an objective and quantitative means for evaluating game players' preference for games or game elements. For example if a participant is first allowed to play two game levels that vary only in terms of one factor (i.e., speed of character movement) before being allowed to re-play one of them, behaviour analysis states that the player will choose to re-play the level that presented them with the most reinforcement. Using such an approach, we can evaluate the motivating properties of games or game elements.

Interestingly, behaviour analysis predicts a situation that is contradictory to that suggested by game designers. Specifically, behaviour analysis suggests that players will prefer games in which a large number of reinforcers are present (i.e. players gain a higher score), while the concept of 'appropriate game challenge' suggests that players will prefer games in which they are competent, but not quite able to achieve the maximum scores.

This paper experimentally examines the role of 'appropriate challenge' in player motivation. We will examine whether there is a particular level of game success that is preferable to participants in general, and whether this can be explained by existing behavioural theories. In order to accomplish this, a basic game was created that required participants to quickly respond to the appearance of game characters by either clicking on that character (a save response), or clicking on a button labeled 'destroy' (a destroy response). Six individual games, which varied in terms of the speed of presentation and number of game characters, were designed based on this basic structure. In each of the six games, participants were required to learn which characters should be saved and which characters should be destroyed, through a process of trial and error - points were awarded for the 'correct' responses. Thus, the quicker a player learned which characters should be saved, the higher the score they would obtain. Participants played all six games in a quasi-randomised order (Stage 1), before being presented with a choice of which game they wished to re-play (Stage 2). The score each participant recorded in each game they played in Stage 1, and the game that they chose to re-play in stage 2 constitute the dependent measures in the study.

Forty-three participants were recruited and presented with the experiment. When given the choice to re-play one of the six games, only a small minority of participants chose the game in which they scored most points in Stage 1. Additionally, only half of all participants chose to re-play games in which they attained scores above 80% correct in Stage 1. These results are surprising, as it was predicted that participants would prefer games in which they achieved higher scores. None of the forty-three participants chose to re-play a game in which

they scored between 72% and 82% in stage 1. This finding is particularly surprising in light of literature of 'appropriate challenge' and 'flow' that suggests how game players enjoy challenges that are just above their current level of ability.

In light of these results, the concept of 'appropriate challenge,' as crucial to the motivation inspired by a game, must be reconsidered. Firstly, for half of the participants in the current study, games in which high scores were achieved actually did constitute engaging experiences, as those games were chosen to be re-played. So, for half of the participants, an 'appropriate level of challenge' appeared to constitute complete mastery of that game. This appears to support a behaviour-analytic understanding of a game as a mechanism for delivering reinforcement. It also suggests that, when designing games, approximately half of the players will prefer if the game does not present a difficult challenge. However, half of all participants also chose games in which they did not achieve a high score. These participants chose to re-play games in which they were not particularly successful – apparently seeking challenge. This result is not predicted with a simple reinforcement analysis.

A number of possible explanations for these results can be advanced, all of which may contribute to the understanding of game challenge. For example, one such explanation is that there may not be any one definable 'appropriate level of game challenge' – this may be different for every participant and may vary with each player's individual previous experience. Some participants may enjoy gaining consistently high scores, while others enjoy the challenge of improving on a previously low score. As such, the concept of appropriate challenge may not be particularly informative or useful. Aiming to provide all participants with an appropriate level of game challenge – a level where they accomplish most but not all challenges on their first attempt - will apparently alienate rather a lot of potential players.

The current paper represents a first objective, empirical step into examining the factors that motivate players to keep playing computer games. Findings suggest that the concept of appropriate challenge as a determinant of motivation in computer games may not be particularly informative or useful. Rather, it may prove more useful to adopt the existing methods of behaviour analysis in understanding and harnessing the motivational qualities of games for educational purposes.

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