Self-regulation influence on game play flow state

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Article history:
Received 22 March 2015
Received in revised form 17 August 2015
Accepted 20 August 2015
Available online xxx

Keywords:
Game play
Flow theory
Self-regulation

Abstract
The authors use the Music Flow digital game with 266 Taiwanese junior high school students to investigate the influence of digital game player self-regulation (SR) on game flow state. Game data were used to probe various aspects of Bandura’s (1986) SR learning model and related effects on game flow state as described in Csikszentmihalyi’s (1990) flow theory to determine if game information can be used to measure SR during different flow states. A tool for recording stage selection, hit rate, and other real time data was created to monitor and measure flow state among players immersed in interactive play. Self-regulation capabilities were measured in terms of skill- and game-level difficulty during different states. Results indicate that SR exerted a significant and positive effect on flow state. Our main conclusions are: (a) flow state was continuously influenced by self-reaction over time; (b) hit rate served as an indicator of self-judgment in terms of challenge, skill and flow state; and (c) flow states in players with distinct self-regulation capabilities were influenced by play stage selection. It is our hope that the method used in this study will help researchers in their efforts to measure and/or analyze player sense of fun in game-based learning environments.

1. Introduction

Researchers are increasingly confirming the ways that digital game-based learning (DGBL) environments help learners develop cognitive operations skills (Papastergiou, 2009). Students in DGBL settings have been described as intrinsically motivated to participate in learning activities at high levels of concentration (Chen, Wigand, & Nilan, 1999; Klimmt, Schmid, & Orthmann, 2009; Vorderer & Bryant, 2006). DGBL environments have also been described as supportive of spontaneous learning and explorative skill development (Ke & Grabowski, 2007; Oliver & Herrington, 2001; Raybourn & Bos, 2005). Kiili (2005) and Lancy (1987) are among researchers who believe that games are most successful at attracting learners when they have clear, pre-established rules that encourage gradual advancement to high levels of complexity, and when they provide immediate feedback that supports a sense of player satisfaction and achievement.

Motivation, pleasure, and player subjectivity are three topics of current interest to game researchers (Papastergiou, 2009). In DGBL contexts, players tend to synthesize, analyze and evaluate multiple modes of information to form strategies such as choosing game stages as part of their efforts to achieve high levels of game competency (Chen & Law, 2015). Due to subjective characteristics such as SR, not all players feel pleasure or achieve effective learning when they play the same games, raising questions regarding how they make adjustments in response to limitations and experiences during game play. DGBL environments give players opportunities to continuously adjust playing processes and to apply SR, self-management, and other skills (Chen & Law, 2015). Our belief that active management is a key factor in maintaining a sense of pleasure and fun is our primary motivation for investigating player flow experiences.

Flow experience, during which players are said to feel “carried away,” emerges from a mix of pleasure and satisfaction (Csikszentmihalyi, 1975). Players in flow states become more engaged in activities (Starbuck & Webster, 1991). A sense of flow is also believed to exert long-term influences on player judgment—an important point in light of Wu, Wang and Tsai’s (2010) observation of player satisfaction as an influential factor in game play. Other influences on flow experience include motivation (Wan & Chiou, 2006), metacognition (Shats & Solomon, 2002), personality (Faiola, Newlon, Pfaff, & Smyslova, 2013) and capability (Hong et al., 2013).

Self-regulation, which Bandura (1986) first suggested as a primary means through which learners comprehend personal
performance, is an important factor determining improvement in DGBL environments (Erhel & Jamet, 2013). According to Bandura (1986, 2001), SR consists of three stages: self-observation, during which learners analyze game environments, set goals, and monitor performance and the effects of specific actions; self-judgment, in which learners evaluate their current performance using personal standards or comparisons with others’ performance; and self-reaction, during which learners assess their satisfaction levels, metacognitively evaluate their errors, and use the information to create new goals and strategies.

Self-regulation is shaped by behavioral and environmental factors (Zimmerman, 2008). Individuals with better SR skills tend to have higher levels of positive flow affect (Barnett, 1991; Csikszentmihalyi, 1990) and more consistent interaction between emotional experience and ability (Zimmerman, 2002). To match expectations, individuals constantly make strategic decisions and search for certain characteristics when choosing and playing games (Costikyan, 2002), and then make ongoing adjustments in response to game difficulty in order to maintain their flow states (Hunicke & Chapman, 2004). When goals cannot be achieved, at some point players are likely to consciously decrease the difficulty level (Bandura, 1991). Whereas good self-regulators tend to expand their knowledge and cognitive competencies, poor self-regulators tend to fall behind (Zimmerman, 1990). Results from a pilot study conducted for this research support the identification of players who are capable of establishing goals and using immediate feedback to achieve short-term flow at different game levels—two factors in game play SR that exert positive effects on game flow. It is our assertion that the higher the level of SR, the greater the potential for player satisfaction.

For this study we analyzed the effects of SR on individuals involved in aggressive games, using an original micro-analytical tool that records game behaviors and flow state self-assessments. Data for investigating player self-judgment and self-reaction include the number of “strings hits” during a music-oriented digital game, plus self-assessments of skills and challenges at different game difficulty levels.

1.1. Self-regulation

Self-regulation is defined as the ability to direct one’s own behaviors, as opposed to being passively affected by external influences. According to Bandura’s (1986) social cognitive theory, personal cognition factors such as motivation and affect are reciprocally determined by behavioral and environmental factors such as the number of successful hits in a game, scores, and rankings (see also Zimmerman and Schunk (2001)). Three interactive stages are usually involved in the self-regulatory process: self-observation, self-judgment, and self-reaction. Individuals use self-judgment to strengthen positively evaluated behaviors and to weaken/eliminate actions that result in negative feelings. Social cognitive theoretical frameworks generally suggest that SR is context-dependent, therefore one’s SR may be high in one situation or domain and low in another (Zimmerman & Schunk, 2001).

Scholars have analyzed different aspects of SR from different perspectives. According to Zimmerman and Schunk (2001), self-regulating learners actively participate in their learning processes metacognitively, motivationally, and behaviorally. Based on their examinations of SR mechanisms in the context of Internet usage, LaRose and Eastin (2004) and LaRose, Lin, and Eastin (2003) established a “deficient Internet SR” construct for studying usage patterns and addiction. Puustinen and Pulkkinen (2001) built on Pintrich and Zimmerman’s work to describe the details of SR as a goal-oriented process. An emphasis on SR has also been noted in discussions of self-generation (Zimmerman & Schunk, 1989), self-control (Shonkoff & Phillips, 2000) and self-management (Stright, Neitzel, Sears, & Hoke-Sinex, 2001).

1.2. Self-regulation and flow

The objective of any game is integrated into the game experience and based on player perceptions (Piaget, 1962). In other words, games not only reflect, but also promote additional player cognitive development. When used in learning environments, properly applied digital games can impact learning effectiveness and learner motivation and concentration (Fabricatore, Nussbaum, & Rosas, 2002) while providing entertainment via game rules, scenarios, and goal achievement (Prensky, 2001). However, although games can induce motivation and promote cognitive development, sense of pleasure and internal satisfaction require successful player encounters with game challenges (Järvinen, 2002). It is important to remember that players are likely to have dissimilar goals that can be affected by game design and interactive structure (Costikyan, 2002). Providing choice within a game has the potential to enhance a player’s perception of autonomy, which has been shown to increase intrinsic motivation (Ryan, Rigby, & Przybylski, 2006). Players regulate their goals, build a sense of achievement, and motivate themselves in the face of different challenges (Costikyan, 2002). The mix of motivation, cognition, strategy, and behavior produces a range of gaming experiences across different players.

During game play, gaming experiences generate feeling experiences via interaction between intrinsic motivation and SR. Feeling experiences (e.g., playful and exploratory characteristics) are associated with the flow experience identified by Csikszentmihalyi (1975). Individuals who become completely focused on situations and activities frequently fail to perceive their own initiatives while engaged in subjective experiences that fill them with joy and reduce or eliminate anxiety. Such flow experiences increase the potential for future engagement in the same activity (Csikszentmihalyi, 1975, 1990; Webster, Trevino, & Ryan, 1993). Individuals with this intrinsic trait tend to generate pleasure from as well as add pleasure to their activities. An emotional flow state emerges when their skills match the challenges of a situation (Csikszentmihalyi, 1975). To achieve such states, activities must have precise goals and explicit feedback mechanisms. Difficulty levels should be higher than current skill levels so that individuals perceive a challenge but avoid feeling overmatched—a balance that is thought to consistently produce positive feelings.

Other factors identified by Csikszentmihalyi (1990) as producing or resulting from flow states include a sense of easy control, a merging of action and awareness, concentration on the task at hand, a loss of self-consciousness, a transformation in time perception, and autotelic experiences. Chen et al. (1999) have established three categories of flow state characteristics: an antecedents stage involving clear goals, unambiguous feedback, and a balance between activity challenge and skill; an experience stage, during which action and awareness merge, distractions are removed from consciousness, and worry of failure is eliminated; and a behavioral stage in which progress reflects internal and optimal experience such as the loss of self-consciousness, a distorted sense of time, and a sense of reward from the activity itself (Table 1).

Since they are based on personal perceptions of skills and challenges, flow experiences are considered subjective, with determinations varying from person to person. Such subjective feelings can produce perceptions of optimal experiences or of anxiety and/or boredom. Individuals must therefore clearly understand their goals and maintain awareness of their progress so as to make immediate adjustments when necessary (Csikszentmihalyi, 1975). When self-perceived challenge and skill level achieves an equilibrium, the potential for entering a flow state increases, thus...
encouraging individuals to engage in more complex activities in the pursuit of greater pleasure (Csikszentmihalyi & Csikszentmihalyi, 1992; Moneta & Csikszentmihalyi, 1996). Boredom results when challenges are too low, while anxiety results when they are too high (Csikszentmihalyi, 1975; 1990). It is important to remember that flow state is never static—as challenges change, so do flow states (Fig. 1).

1.3. Research questions

We addressed five research questions:

1. What are the influences of self-regulation during flow states?
2. Can self-regulation be determined from game data?
3. What is the relationship between game challenge self-judgment and hit rate among players with different self-regulation capabilities?
4. For players with different self-regulation abilities, what is the association between skill self-judgment and hit rate?
5. For players with different self-regulation abilities, what factors influence stage selection during flow states?

2. Method

2.1. Study design and participants

Our primary study goals were to (a) determine the influences of SR on flow state among a group of eighth-grade students playing a stand-alone rhythm game, and (b) clarify the relationship between SR and flow state. Study participants were asked to play Music Flow for 20 min, randomly selecting their own game levels. After each level of play, participants were instructed to respond to questions regarding their flow states that were inserted into the game system. After 20 min they were asked to fill out an SR questionnaire. Music Flow has a feature that records hit rates. Data for the first seven rounds of game play (1 round = 1 min and 45 s of time) were collected and used to measure flow distance (FD), defined as the distance between current emotional state and flow states. ANOVAs and correlation tests were used to analyze the relationship between SR and flow state.

The participant sample consisted of 110 male (41.4%) and 156 female (58.6%) eighth-grade students aged 14 and 15 (M = 14.28, S.D. = .45) attending two randomly selected junior high schools located in Taoyuan and Taichung in north and central Taiwan, respectively. All were confirmed as having basic (e.g., Web browsing) computer skills. Since Music Flow was specifically designed for this research project, the participants had no prior experience playing it.

2.2. The game

Music Flow (hereafter abbreviated as MF) has ten difficulty levels, each with different required keystroke numbers (108–497) and different bar dropping rates (50–83/per minute) (Figs. 2 and 3). Higher difficulty levels, which study participants were allowed to choose for themselves, had more keystroke numbers and faster bar dropping rates.

MF meets the requirements of a simple and intuitive interface with easy navigation so that students can figure out how to play without written instructions or special technical skills. We also tried to inject the three factors identified by Csikszentmihalyi (1990) and Novak, Hoffman, and Yung (1998) as promoting student involvement in a gaming environment: clear goals, immediate feedback, and a balance between challenge and skill. Gaming records included information on player name, gender, age, score, and hit position. We coded each string hit as 1 and each miss as 0 when analyzing SR and flow state (Fig. 4). Performance during the final 30 s of each play round was used as a hit rate benchmark. Hit rate was calculated as

\[
\text{Hit rate} = \frac{\text{number of hit meters}}{\text{All strings}} \times 100\%.
\]

where number of hit meters is the number of string hits during the final 30 s of each play round.

2.3. Flow state scale

We collected 1724 gaming records for 266 students. Average number of play rounds was 74; data from 7 rounds were used to analyze the relationship between SR and flow state. We used

![Flow state scale](image-url)
Pearce, Ainley, and Howard (2005) modified flow state scale to investigate the balance between player skill level and activity challenge level (Moneta & Csikszentmihalyi, 1996) (Fig. 5). Study participants were asked to assess their challenge and skill levels using a Likert-type scale ranging from 1 (“not at all”) to 5 (“very much”). We let the players make their own assessments, based on our observation that the majority needed 3 s or less to verbalize opinions regarding real-time skill and challenge levels, resulting in minimal interruption of the game-playing process.

Our calculations utilized a symmetric flow line in which challenge = skill—that is, \( FD = 0 \) at the flow state points (1,1), (2,2), (3,3), (4,4), (5,5). Maximum anxiety \( FD (+1) \) was identified as (5,1) and maximum boredom \( FD (-1) \) as (1,5). A transformation equation is expressed as

\[
FD = \frac{1}{4} \times (S - C),
\]

where \( S \) denotes skill and \( C \) challenge. Using (2,3) as an example, the FD value is –2.5. Note that the more balanced the skill and challenge, the shorter the flow distance. Anxiety-free players feel a complete balance of challenge and skill.

2.4. Self-regulation questionnaire

Microanalytic assessment tools and protocols such as self-report scales help researchers identify and examine real-time SR-related behaviors. The questionnaire used in this research is based on the SR theory created by Bandura (1986) and further developed by Zimmerman and Schunk (2001) and Zimmerman (2002). The 25 questions were designed to measure students’ SR ability in terms of.

1. Self-observation, with players monitoring their performance and strategy during game play. An example item is “I concentrate on the music during game play.”
2. Self-judgment, with players comparing their goals with actual performance. An example item is “I constantly try to determine whether or not I am achieving my goals during game play.”
3. Self-reaction, with players acknowledging their feelings and providing their own feedback. An example item is “I am satisfied with the performance during game play.”

All responses were recorded along a four-point scale from 1 (“definitely disagree”) to 4 (“definitely agree”). Item analysis was used to assess the quality of individual questions, and a combination of reliability and factor analyses was used to evaluate overall reliability and construct validity. Cronbach’s \( \alpha \) coefficients (.75 – .83) were regarded as acceptable. Summed scores for the three sub-scales represent degree of SR, with higher scores indicating greater self-regulating ability.

However, such questionnaires are limited in their ability to measure causal links between SR processes and performance outcomes (Zimmerman, 2008), and of course are incapable of providing real-time data during game play. Therefore, we also made use of two other methods:

1. Post-event microanalysis, which was created to examine human beliefs and reasoning during actual performance (Agina, Kommers, & Steelhouse, 2011a, b; Cleary, 2011; Kitsantas & Zimmerman, 2002). Agina (2008), Agina and Kommers (2008), and Agina et al. (2011a, b) have used this method to analyze the ways that children think and talk aloud while alone (i.e., without external regulation). To analyze internal regulation, we asked players two questions about casual playing processes at end of each round: (a) what do you think is the challenge level of this game round? and (b) is your ability high enough to solve the challenge of this game round? As Schunk and Swartz (1993a, b) and many others have noted, learning processes are often more important than performance. As part of the SR subprocess, self-judgment focuses on the gap between player behavior and self-
established criteria (Bandura, 1986, 2001). We therefore attempted to continuously record player self-judgments during game play. Another reason for using this method was to test our hypothesis that a relationship exists between playing process and self-judgment ability, especially toward the end of game sessions in this study, the final 30 s of each round of play.

2. Trace logs, which are frequently used to microanalyze gaming processes (Winne & Jamieson-Noel, 2002). Players regularly monitor achievement and gaming tactics as part of SR. MF gives players opportunities to monitor their tactics; we used this feature to gather self-reported data about gaming tactics and achievement estimates. Self-reaction data were used to assess player satisfaction levels that directly affect changes in behavior (Bandura, 1986; 2001). We predicted a relationship between stage choice and self-reaction ability.

3. Data analysis

3.1. Self-regulation ability

The high-to-low order of SR questionnaire scores was self-observation (M = 3.03, SD = .64), self-judgment (M = 2.87, SD = .72), and self-reaction (M = 2.70, SD = .68). The majority of students were found to have strong self-regulating abilities (M > 2.50) (Table 2).

3.2. Flow state

As stated above, we used data from each player’s initial seven rounds to analyze flow state conditions. At the end of the first round, 55 (20.7%), 116 (43.6%) and 95 study participants (35.7%) had scores indicating anxiety, flow state, and boredom, respectively. The data also show that 189 students (71.1%) chose the first (easiest) level to begin play, likely in support of their efforts to become familiar with game rules and processes. Since they chose higher levels as they gained experience, the percentage of participants describing themselves as feeling anxiety increased from...
20.7% to 49.2% (Table 3). According to these data, the majority of players learned the MF melody well enough to not feel any need to return to easier game levels. As players chose more difficult levels, their flow distances increased from .27 to .34 over several play rounds, also indicating greater anxiety (Fig. 6). As shown in Fig. 7, the percentage of study participants reporting a sense of boredom decreased from 35.7% to 8.5% over multiple rounds, also suggesting a positive influence from SR ability over several rounds of play.

Participants were asked to report their flow state every 3 s in order to measure and assess their challenge/skill balances. Since flow state is a dynamic concept, we used a formula to transform flow state scores into flow distance scores. According to our results, none of the three SR dimensions influenced flow state during the first three rounds of play, but a significant effect was noted starting with the fourth round. We also observed that self-reaction exerted significantly negative effects on flow distance starting at round four, with correlation coefficients gradually declining thereafter (fourth round: \( r = -0.16, p < .01 \); fifth: \( r = -0.20, p < .05 \); sixth: \( r = -0.20, p < .01 \); seventh: \( r = -0.31, p < .05 \)). In other words, greater self-reaction capability resulted in shorter flow distance. Correlation data are presented in Tables 4–10.

Our results indicate that self-regulating ability exerted an influence on flow state as players progressed to higher levels. None of the students in the sample had played MF prior to their participation in this study, therefore SR was unlikely to exert any effect at the beginning of play. However, over the full course of the study, SR ability exerted significant effects on flow distance. In other words, the data support the assumption of a significant correlation between player SR and flow distance.

We also tried to determine if different SR levels exerted different influences on flow distance in the sample, using the first factor as an independent variable and the second as a dependent variable. We found that study participants with scores higher than 49 had the strongest self-regulating skills, and those with scores below 39 had the weakest. Results from an independent sample t-test indicate a significant effect between the two groups (\( t = 2.57, p < .05 \)), suggesting a clear difference in the effect of SR on flow distance.

Further, flow distance was significantly higher among those students with high SR scores (M = .32, SD = .23 versus M = .23, SD = .20) (Table 11).

In summary, anxiety levels among the participants increased substantially over the course of game play, a result that can be interpreted in several ways. One is that it indicates increasing participant familiarity with the main Music Game song, therefore participants wanted to play at the same level or at levels considered more challenging in terms of staying on the right beat. In such situations, SR would not affect flow distance at the beginning of play, but as the players became accustomed to the MF interface and game functions, SR exerted an increasingly significant effect on flow distance. Accordingly the results indicate an affirmative answer to the first research question.

### 3.3. Comparison of game data and self-judgment

The students used the feedback provided by MF to make adjustments to their game play actions. They were allowed to choose their own difficulty levels, which we used as a self-measure of success. After each round of play, study participants used their own criteria to assess their performance. This raises questions about a possible correlation between self-judgment and hit rate (especially toward the end of game sessions), and whether or not the participants were capable of making appropriate estimates of their skills and progress. We used overall game scores to address these questions, and found a significant and positive correlation between score and challenge level, but not between score and skill level (Table 12). In other words, the data indicate that scores did not accurately represent challenge and skill evaluations.

Beat sequences were collected for the final 30 s of each play round and recorded as 1 = correct hit and 0 = missed hit. The data were used to calculate and assess skill and challenge level. We assumed that study participants would perceive themselves as more skilled as the number of correct hits increased, and vice versa. Data for 266 students (1724 records) are shown in Table 13.

A significant effect was noted for the correlation coefficient between hit rate and challenge (\( r = -0.41, p < .001 \)), meaning that perceptions of challenge decreased as correct hit rates increased, thereby confirming a correlation between level difficulty and self-judgment. A significant effect was also noted for the correlation coefficient between hit rate and skill (\( r = .11, p < .001 \)). However, the statistical significance is considered low, suggesting that the students were conservative in judging their skills. The correlation between skill self-judgment and hit rate is in agreement with Moneta and Csikszentmihalyi’s (1996) assertion that skill and challenge are the two most important variables influencing flow distance.

Next, we attempted to determine if any relationship exists between self-judgment ability and hit rate. Study participants with self-judgment scores greater than 12.8 were categorized as high self-judgment and those with scores less than 8.8 as low self-judgment; each group was approximately one-third of the entire sample. For the high self-judgment group we noted a significant and slightly negative correlation between hit rate and self-perceived challenge (\( r = -0.33, p < .001 \)), and a significant and slightly positive correlation with self-perceived skill (\( r = 0.09, p < .05 \)). For the low self-judgment group, we also noted a significant and slightly negative correlation between hit rate and self-perceived challenge (\( r = -0.44, p < .001 \)) and a significant and slightly positive correlation with self-perceived skill (\( r = 0.27, p < .001 \)). Combined, the results indicate significant correlations between self-judgment and both skill and challenge, meaning that the hit rate in the MF game could be used as a criterion for measuring the study participants’ self-judging abilities. Accordingly, the answers to the second, third and fourth research questions are also affirmative (Tables 14 and 15).

### 3.4. Comparison of flow distance and self-reaction

As stated in Section 3.2, SR exerted an influence on the study participants’ flow states, which in turn impacted perceptions of pleasure and satisfaction. We asked each student to briefly describe his or her feelings after each round of game play to help us determine the immediate impact of flow state on self-reaction (i.e., game level selection) among students with different SR values. We analyzed 1724 flow distance records to determine level-choosing strategies, using flow distance (anxiety, flow and boredom) as a design variable and choice of level (harder, easier and the same) as a reaction variable. As shown in the Chi-square independent test data

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**Table 3**

<table>
<thead>
<tr>
<th>Game round</th>
<th>Anxiety (S &lt; C)</th>
<th>Flow (S = C)</th>
<th>Boredom (S &gt; C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>55 (20.7%)</td>
<td>116 (43.6%)</td>
<td>95 (35.7%)</td>
</tr>
<tr>
<td>Second</td>
<td>59 (22.2%)</td>
<td>134 (50.4%)</td>
<td>73 (27.4%)</td>
</tr>
<tr>
<td>Third</td>
<td>84 (31.6%)</td>
<td>136 (51.1%)</td>
<td>46 (17.3%)</td>
</tr>
<tr>
<td>Fourth</td>
<td>75 (32.1%)</td>
<td>129 (55.1%)</td>
<td>30 (12.8%)</td>
</tr>
<tr>
<td>Fifth</td>
<td>80 (40.6%)</td>
<td>100 (50.8%)</td>
<td>17 (8.6%)</td>
</tr>
<tr>
<td>Sixth</td>
<td>87 (41.2%)</td>
<td>76 (46.6%)</td>
<td>20 (12.2%)</td>
</tr>
<tr>
<td>Seventh</td>
<td>64 (49.2%)</td>
<td>55 (42.3%)</td>
<td>11 (8.5%)</td>
</tr>
</tbody>
</table>

S = skill, C = challenge.
presented in Table 16, a significant correlation was found between flow state and level choice ($\chi^2 (4) = 99.41, p < .05$; contingency coefficient = .23, $p < .05$).

Next, we looked at the potential impact of self-reaction (in the form of level choice) on flow distance. As shown in Table 17, almost one-third of the study participants (82/254, or 32.3%) selected a more difficult level when they felt bored—in other words, they encouraged flow by making adjustments in terms of dynamic difficulty. Only a small number of students (40/279, or 14.3%) entered flow states when they felt anxious, indicating inability or lack of willingness to move up to the next level of difficulty. According to post hoc comparison results, there was a significant difference in terms of choosing a harder or easier level when the participants felt anxious (Table 18), with less anxious students choosing more...
Individual players have their own ways of modifying games to make them more fun. When first learning a game, players spend their time getting accustomed to game features, assessing game situations, and establishing playing criteria, and make ongoing adjustments in terms of SR, thus increasing their potential to enter flow states. After playing a new game for a period of time, self-regulation gradually starts to influence player feelings. Our data suggest that the study participants who had strong self-reaction capabilities were better at assessing their feelings, thus enhancing their sense of fun and satisfaction (Zimmerman, 2002). Regardless of self-regulation ability, goal regulation is an important factor determining flow state and an ongoing sense of fun. Selecting a different level of play affects a player’s sense of challenge, whether or not there is a close match with skill level. We
Designers may be interested in modifying game learning goals to changes and adjustments to ongoing situations. Accordingly, game appeared to be less capable, perhaps even incapable, of making mechanisms. Concurrently, low self-reaction players in the sample found that high self-reaction players had appropriate adjustment processes. Participants during different flow states.

**Table 16** Results from Chi-square analysis of next game level choice for all participants during different flow states.

<table>
<thead>
<tr>
<th>Flow state</th>
<th>Choice frequency (%)</th>
<th>( \chi^2 )</th>
<th>Contingency coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Harder</td>
<td>Easier</td>
<td>Same</td>
</tr>
<tr>
<td>Anxiety</td>
<td>279 (47.6)</td>
<td>222 (37.9)</td>
<td>85 (14.5)</td>
</tr>
<tr>
<td>Boredom</td>
<td>254 (81.2)</td>
<td>37 (11.8)</td>
<td>22 (7.0)</td>
</tr>
<tr>
<td>Flow</td>
<td>515 (62.4)</td>
<td>225 (27.3)</td>
<td>85 (10.3)</td>
</tr>
</tbody>
</table>

***p < .001.

**Table 17** Next level choice frequencies during different flow states.

<table>
<thead>
<tr>
<th>Flow state</th>
<th>Level choice</th>
<th>Level choice frequency</th>
<th>Frequency of entering flow state</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxiety</td>
<td>Harder</td>
<td>279</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Easier</td>
<td>222</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>Same</td>
<td>85</td>
<td>19</td>
</tr>
<tr>
<td>Boredom</td>
<td>Harder</td>
<td>254</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>Easier</td>
<td>37</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Same</td>
<td>22</td>
<td>7</td>
</tr>
<tr>
<td>Flow</td>
<td>Harder</td>
<td>515</td>
<td>371</td>
</tr>
<tr>
<td></td>
<td>Easier</td>
<td>225</td>
<td>137</td>
</tr>
<tr>
<td></td>
<td>Same</td>
<td>85</td>
<td>73</td>
</tr>
</tbody>
</table>

**Table 18** Confidence intervals for all study participants choosing the next game level (n = 206).

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Comparison group</th>
<th>95% CI</th>
<th>Post hoc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxiety</td>
<td>Harder-Easier</td>
<td>[−.01, .20]</td>
<td>Non-significant</td>
</tr>
<tr>
<td></td>
<td>Harder-Same</td>
<td>[0.26, .41]</td>
<td>Harder &gt; Same</td>
</tr>
<tr>
<td></td>
<td>Easier-Same</td>
<td>[.14, .33]</td>
<td>Easier &gt; Same</td>
</tr>
<tr>
<td>Boredom</td>
<td>Harder-Easier</td>
<td>[0.62, .77]</td>
<td>Harder &gt; Easier</td>
</tr>
<tr>
<td></td>
<td>Harder-Same</td>
<td>[.68, .80]</td>
<td>Harder &gt; Same</td>
</tr>
<tr>
<td></td>
<td>Easier-Same</td>
<td>[−.11, .02]</td>
<td>Non-significant</td>
</tr>
<tr>
<td>Flow</td>
<td>Harder-Easier</td>
<td>[.25, .45]</td>
<td>Harder &gt; Easier</td>
</tr>
<tr>
<td></td>
<td>Harder-Same</td>
<td>[.45, .59]</td>
<td>Harder &gt; Same</td>
</tr>
<tr>
<td></td>
<td>Easier-Same</td>
<td>[−.25, −.09]</td>
<td>Non-significant</td>
</tr>
</tbody>
</table>

Table 19 Results from Chi-square analyses of next game level choice for high self-reaction participants during different flow states.

<table>
<thead>
<tr>
<th>Flow state</th>
<th>Choice frequency (%)</th>
<th>( \chi^2 )</th>
<th>Contingency coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Harder</td>
<td>Easier</td>
<td>Same</td>
</tr>
<tr>
<td>Anxiety</td>
<td>45 (40.7)</td>
<td>44 (38.9)</td>
<td>23 (20.4)</td>
</tr>
<tr>
<td>Boredom</td>
<td>56 (72.7)</td>
<td>13 (16.9)</td>
<td>8 (10.4)</td>
</tr>
<tr>
<td>Flow</td>
<td>82 (50.9)</td>
<td>56 (34.8)</td>
<td>23 (14.3)</td>
</tr>
</tbody>
</table>

**Table 20** Results from Chi-square analyses of next game level choice for low self-reaction participants during different flow states.

<table>
<thead>
<tr>
<th>Flow state</th>
<th>Choice frequency (%)</th>
<th>( \chi^2 )</th>
<th>Contingency coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Harder</td>
<td>Easier</td>
<td>Same</td>
</tr>
<tr>
<td>Anxiety</td>
<td>95 (52.8)</td>
<td>53 (29.4)</td>
<td>32 (17.8)</td>
</tr>
<tr>
<td>Boredom</td>
<td>56 (72.7)</td>
<td>13 (16.9)</td>
<td>8 (10.4)</td>
</tr>
<tr>
<td>Flow</td>
<td>82 (50.9)</td>
<td>56 (34.8)</td>
<td>23 (14.3)</td>
</tr>
</tbody>
</table>

***p < .001.

found that high self-reaction players had appropriate adjustment mechanisms. Concurrently, low self-reaction players in the sample appeared to be less capable, perhaps even incapable, of making changes and adjustments to ongoing situations. Accordingly, game designers may be interested in modifying game learning goals to satisfy the various requirements of players with different SR skills in order to enhance their ongoing sense of fun.

Experiences toward the end of gaming sessions can strongly influence player satisfaction. Our data indicate that the study participants’ self-judgment skills, based on current game play experiences, affects motivation to continue play. As Wu, Wang, and Tsai (2010) note, player satisfaction depends a great deal on how well a game satisfies the needs of individual players. Game factors such as scores, hit rate, levels, and rewards also affect player satisfaction, but not to the same degree as self-performance. In the game used in this study, a good hit rate was clearly the most important factor in terms of player satisfaction, therefore hit rate could be used to assess self-reaction ability.
The most successful games support feelings of "active failure" among players, who make ongoing adjustments to match challenge and skill levels so as to achieve the greatest sense of enjoyment. Relative criteria are easier to establish when players have better SR abilities. By constantly evaluating and analyzing their ongoing situations, players can generate more positive emotions, and therefore make better investments in activities. Our data confirm that at a certain level, a balance of skill and challenge eventually produces a flow state (Massimini & Carli, 1988), thus validating the idea that SR is one of the most important flow state factors.

Acknowledgments
The authors thank the blind reviewers of this paper for their insightful and constructive comments. They are grateful for helpful input on paper organization from Jon Lidemann and the Music Flow digital game designer, Chun-Fu Huang. They are also grateful for funding from the Ministry of Science and Technology, Taiwan, grant number: 99-2511-S-009-009-MY3.

References
Chen, W.-C., Lee, C.-C., Lin, P.-H., & Chen, Y.-L. (2013). The authors thank the blind reviewers of this paper for their constructive comments. They are grateful for helpful input on paper organization from Jon Lidemann and the Music Flow digital game designer, Chun-Fu Huang. They are also grateful for funding from the Ministry of Science and Technology, Taiwan, grant number: 99-2511-S-009-009-MY3.