Educational Communications and Technology Yearbook

Will W. K. Ma
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Shaping the Future of Education, Communication and Technology

Selected Papers from the HKAECT 2019 International Conference

Springer

Educational Communications and Technology Yearbook

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The Hong Kong Association for Educational Communications and Technology (HKAECT) was established in 1989. Its first conference was organized in 1990, addressing "The Role of Educational Communications and Technology in Year 2000," with speakers coming from the United States, China, and Taiwan to discuss the outlook on educational communication and technology. Throughout these years, the HKAECT has held a number of international conferences, symposiums, workshops, and talks with various themes to provide a platform to enable rich exchanges for academicians, practitioners, and professionals in the fields of communication and education to discourse about the shaping and changing issues on education, communication, and technology. This Yearbook series collect presentations from the annual international conferences held by the HKAECT. Chapters would come from the annual global call for submission, and be selected based on blind review from international review board. Subject areas include but not limited to communication, new media, news media, broadcast journalism, democracy and the media, entertainment and education, learning analytics, AI in education, game-based learning, ubiquitous learning, MOOCs, open education, instructional design, social context and learning environment, social media, risk and ethics in new media, etc.

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Hong Kong, China, 17–19 June 2019

Conference Proceedings

Springer

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Preface

The HKAECT 2019 International Conference on "Shaping the Future of Education, Communication and Technology" is co-organized by the Hong Kong Association for Educational, Communications and Technology (HKAECT) and Chu Hai College of Higher Education. It is scheduled for 17–19 June 2019 at Chu Hai College of Higher Education, Hong Kong SAR, China.

Technology has significant impact on education and communication. On the one hand, the whole learning process can be digitized, captured, and analyzed that the data informs academicians and practitioners for a continuous improvement in curriculum development, teaching philosophy, pedagogy, learner characteristics, student engagement, assessment, and feedback. On the other hand, to a broader perspective, technology changes the way we communicate, in the form of interpersonal communication, small group communication, mass media and journalism, new media, and social media. HKAECT 2019 International Conference provides a forum for exchanges of theory and practices on technology in education and communication. This platform provides a linkage between local and international academicians and practitioners and among institutions, society, and the world. HKAECT 2019 International Conference aims to enhance the contribution of applied research and scholarship, support the development and application of new conceptual frameworks, improve the quality of contemporary practices, and encourage the continuous revisit of theories.

The Conference has appealed through open calls for paper submissions. The encouraging response to the calls has reflected the timeliness of the Conference. In this edited volume of conference proceedings, selected high-quality manuscripts are broadly categorized around four main themes: (a) curriculum development, pedagogy, and instructional design (five chapters), (b) teaching and learning experiences with technology (four chapters), (c) online learning and open education resources (five chapters), and (d) communication and media (four chapters).

We are extremely pleased that the Conference has successfully invited renowned scholars and learned authors to share their inspirational insights with the audience from a wide range of perspectives in shaping the future of education, communication, and technology. On behalf of the Conference Organizing Committee, we take this opportunity to express our deepest gratitude to Dr. Trey Martindale of Mississippi State University, Professor Shih-chang Hsin of National Tsing Hua University, and Dr. Luwei Rose Luqiu of Hong Kong Baptist University for their consent to be our keynote speakers. Our heartfelt appreciations also go to all chapter contributors and reviewers. Their excellent works and contributions make this monograph a success in facilitating rich and resourceful exchanges among academicians, practitioners, and professionals.

We thank the Centre for Crossmedia Culture Studies, Chu Hai College of Higher Education, and the Hong Kong Pei Hua Education Foundation for their incessant support and sponsorship, without which the Conference could not have been realized.

Hong Kong, China
June 2019

Will W. K. Ma
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HKAECT

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Part I
Curriculum Development, Pedagogy and Instructional Designs

Chapter 1
Understanding the Effect of Gamification of Learning Using Flow Theory

Chi-Keung Chan, Ho-Man Leung, and Man-Wai Kung

Abstract This research aims to use flow theory to explain the relationship between gamification and learning outcomes. Two experimental studies were conducted with 80 participants for each study. Study 1 examined the relationships among type of players, state of flow and learning. Study 2 investigates the relationships among number of players, state of flow and learning. For study 1, the relations of the type of players with flow and learning outcomes were insignificant. Furthermore, there was no significant relationship between flow and learning outcomes. In study 2, participants who played video games in the multiplayer mode had significantly higher levels of flow and better learning outcomes. Furthermore, state of flow fully mediated the relationship between number of players and learning outcomes. The authors explained these findings by using the concept of group flow.

Keywords Gamification · Flow · Group flow · Learning · Type of players · Number of players

1.1 Introduction

Many students show their interests in video games but not in their studies, and they always feel that traditional classes are boring. In recent years, an increasing number of research have examined how gamification of learning can enhance students' learning motivation and engagement. Gamification of learning is a concept introduced by Domínguez et al. (2013); they suggested that the principle of gamification of learning is to motivate students to learn by using video games or other gaming elements. A previous study showed that gamification of learning had positive effect on academic results (DomíNguez et al. 2013).

Most students have more positive attitude towards the game-based learning than traditional learning approach. Both male and female students showed better

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testing performance after game-based learning than students who did not attempt game-based learning (Yien et al. 2011). Students were more effective and productive in the visual game setting than the traditional learning condition. Also, people always feel satisfied with the learning environment even though they failed in the game.

Why do people get better performance with game-based learning? The theory of flow can be used to explain how gamification can improve learning. It is because most of the game designs emphasize a balance between challenges and skills of the players (learners), and so playing video games is one of the easiest ways to reach the "state of flow" (McGonigal 2011). During the flow experience, learners concentrate at the present moment which helps them to focus on the learning activities without being distracted by the external environment or other factors (Admiraal et al. 2011). The benefits of flow experience are not limited to individual learning; a previous study found that students in multiplayer mode perform significantly better than those in solo-player mode, suggesting a possible benefit of social/group flow (Arellano et al. 2016).

Since there are very few studies investigating the process of gamification of learning, it is important to investigate the direct and mediating roles of flow. Furthermore, there is a lack of investigation in understanding the existence of social/group flow; this study also examines potential differences between solo-player and multiplayer game modes on engagement and learning.

1.1.1 Gamification of Learning

Gamification is a process that can address the reality problem by using game logic and game mechanics (Deterding et al. 2011). In other words, gamification can be defined as using game play elements for non-game applications such as academic learning. There are cognitive and educational benefits of gamification of learning. Neuroscience research have shown that playing games can increase the release of the chemicals norepinephrine, epinephrine and dopamine in our brains which helps us to be more open-minded and acceptable in learning (Guiterrez 2012; Rackwitz 2012). Game-based learning can not only strengthen students' creativity and innovation (Brown and Vaughan 2009) but also stimulate their intrinsic motivation (Viola 2011). Students had higher motivation in game-based learning than traditional learning approaches (McGonigal 2011). Furthermore, students are more engaged to learning with high efficiency under game-based learning. The major difference is traditional learning approaches engage students by extrinsic motivation, whereas game-based learning engages students with their intrinsic motivation.

1.1.2 Flow Theory

Flow theory is a concept introduced by Mihaly Csikszentmihalyi in 1975. Flow is an optimal experience in which people reached the state of full absorption and concentration. To reach this optimal experience, it requires a balance between one's perceived challenges and level of skills. If a task is too difficult and one does not have the levels of skills to take on this challenge, people then feel anxious. If a task is too easy and requires lower levels of skills, people may feel bored. Hence, both suitable levels of skills and challenges are necessary for achieving the state of flow.

Besides the balance between skills and challenges, there are other components for reaching flow experience – high attention on the present moment, a clear goal, autotelic experience, combination between action and awareness, self-consciousness, high self-control, slow temporal experience and immediate feedback and rewarding are also important elements for the state of flow (Jackson and Csikszentmihalyi 1999). Compared with other activities, gaming is the easiest to match with the above components of flow. The basic structures of games support flow experience because the game challenges can be adjusted to one's level of skills (Csikszentmihalyi 1975).

Previous studies have consistently shown the positive effects of flow experience on student learning. Rossin et al. (2009) held a 2-week online course for MBA students in a midwestern American university. The flow experiences of students were measured by the Flow State Scale. The findings of this study showed that autotelic experience in flow had a significant positive effect on learning performance. It was found that the immediate feedback and rewarding during the learning was the key dimension of flow, which positively affected the learning outcomes. Additionally, the three characteristics of flow, goal clarity, immediate feedback as well as balance between skills and challenges, were positively associated with learning outcomes (Rossin et al. 2009). Another study which was conducted in Amsterdam also showed that college students with more flow had better learning outcomes than students who did not have flow experience. Students were also more focused and more engaged in the learning process with flow experience (Admiraal et al. 2011). These two studies demonstrated that students can fully focus on the learning process and performed better when flow experience occurs. Thus, it is important to match the characteristics of flow and the content of learning. Therefore, people who had flow experience had better learning experience and outcomes.

From the findings of these studies, this study attempts to validate whether flow experience can explain the psychological mechanism in gamification of learning.

1.1.3 Group Flow

"Flow" usually describes individual experience, and "group flow" describes the collective flow experience of a group. Individual flow is based on using individuals as units, while group flow is based on teams. The main concept of group flow is a team of people can attain a collective state of flow. Although the founder of flow theory – Mihaly Csikszentmihalyi – did not study much about group flow, Keith Sawyer has been conducting research to understand the concept of group flow. A study (Sawyer 2014) recruited 300 professionals from three different companies, which included a petrochemical company, a government agency and a strategy consulting firm. The researchers found that when a team of people is under group flow, they could achieve the optimal performance. Another research relevant to gaming showed that players in multiplayer game mode had significantly faster heart rates and higher level of engagement than players in solo-player game mode (Arellano et al. 2016).

According to Sawyer (2014), there are ten required conditions to achieve group flow: (1) having clear and attainable team goals, (2) close listening to team members, (3) reaching full concentration, (4) balancing autonomy and controllability, (5) accepting team diversity, (6) engaging equal participation, (7) improving team familiarity, (8) enhancing team communication, (9) having a moving-forward intention and (10) taking team challenges. Another purpose of this study is to investigate whether learners in multiplayer mode can have higher levels of flow experience and better learning outcomes than learners in solo-player mode.

1.1.4 Type of Players

This study also aims to examine whether the type of players is related to the levels of flow and the learning outcomes. The BrainHex model (Nacke et al. 2011) is a player satisfaction model which is based on results from neurobiological studies. Nacke et al. (2011) conducted a survey with 50,000 players using the BrainHex model as a personality type to collect and compare demographic data of different types of players. The BrainHex model categorized players into seven different types by neurobiological findings. These seven types of players are achiever, conqueror, daredevil, mastermind, seeker, socializer and survivor. The seven types of players are motivated by different motivators. This present study only selected two types (conqueror and mastermind) for our first experimental study. Game players with mastermind type enjoy solving questions and devising different strategies. Their ultimate goal of playing games is to identify the most efficient decisions to win. Whenever players with mastermind type face difficult situations in a game, the neural system in their brains ensures that making good decisions is rewarding. Players with conqueror type do not want to win easily, but they want to fight against strong enemies. From neurophysiology, when people with conqueror face difficult situations in a game, the human's body produced norepinephrine and epinephrine to increase arousal and excitement in their brains. These arousal and excitement motivated them to fight against stronger enemies.

1.1.5 The Present Study, Conceptual Framework and Hypotheses

From the previous literature, it is argued that playing video game is one of the easiest ways to achieve the state of flow. The literature review also supported a significant relationship between the state of flow and gamification of learning. Therefore, the main focus of this present study is to investigate the effect of flow on gamification of learning. In other words, flow theory is used to explain the relationship between video gaming and learning.

Furthermore, two others factors are considered in the present research to capture the differential effects of flow on game-based learning – the type of players (mastermind versus conqueror) and number of players (solo-player mode versus multiplayer mode). This research contains two experimental studies. Study 1 focuses on examining the relationship between flow, learning outcomes and type of players. Study 2 focuses on investigating the relationship between flow, learning results and number of players. Figure 1.1 presents the conceptual model for the present study (including study 1 and study 2).

From the above conceptual framework, this study attempts to address three research questions. Firstly, does the level of flow experienced in video-game learning relate to better learning outcomes? It is hypothesized that more flow experience in video-game learning is significantly related to better learning outcomes. Secondly, which type of players (mastermind or conqueror) is easier to achieve a higher state of flow and better learning outcomes? It is anticipated that conqueror is easier to achieve a higher state of flow and better learning outcomes. Thirdly, does the number of players (solo or multiple) affect the state of flow and learning outcomes? The last hypothesis is learners with multiplayer game mode can achieve a higher state of flow and better learning outcomes than solo-player game mode.

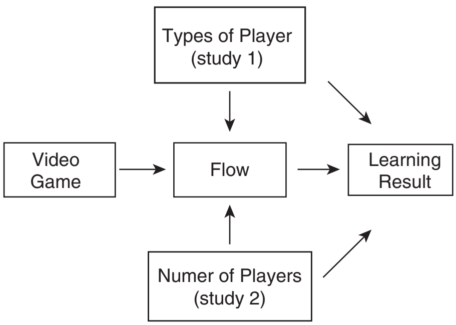

Fig. 1.1 Conceptual framework for the present study

1.2 Method

1.2.1 Participants

Eighty participants were recruited for study 1, and another group of 80 participants was recruited for study 2. Convenient sampling was adopted in both studies to recruit undergraduate students at a self-financing university in Hong Kong. For study 1, the participants were assigned to play the game as mastermind or conqueror according to the BrainHex model. The number of participants as mastermind or conqueror was even. For study 2, all participants played the game in both conditions – solo-player mode and multiplayer mode – and again the playing order between the modes was randomly generated to minimize order effect.

1.2.2 Measures

This research adopted the flow questionnaire (Csikszentmihalyi 1978) which required participants to describe their perceived flow experience subjectively. There are two sections in the flow questionnaire. Section 1 requires participants to describe their flow experiences, and section 2 requires them to endorse a number of yes/no questions to validate their self-described flow experience (Csikszentmihalyi 1975). The flow questionnaire assumes that flow requires a balance between skills and challenges of the activities, which fitted the purpose of video-game learning task used in the present study. The flow questionnaire in this study had very good reliability ($\alpha = .857$).

In both studies, the video game "Learn and Play Japanese Gojūon" was chosen because the game design matched with the theory of flow, including the immediate feedback as well as a balance between skills and challenges in learning Japanese gojūon. In this game, players needed to link up with gojūon. If a player could successfully link up the same gojūon, they would get different scores based on their speed of linking up. After completing the task, the player received a gift in the game as a reward. If the player (participant) got all of the correct answers, the best possible score would be 1000. If the player got all of the answers incorrect, the lowest score would be 0. Therefore, the range of the score in this game is from 0 to 1000. The multiplayer game mode was generated for two players to play simultaneously. Figure 1.2a, b capture two screenshots of the "Learn and Play Japanese Gojūon" game – one for solo-player game mode and one for multiplayer game mode.

In study 1, there were three measurements in the experiment. The first one was the type of players (mastermind or conqueror) which was measured by the BrainHex survey (Nacke et al. 2011). The second one was the flow experience of participants during the game, which was measured by the flow questionnaire (Csikszentmihalyi and Larson 2014), and the last one was the learning outcomes measured by the total scores of the game (Learn and Play Japanese Gojūon). In study 2, the measures of

Fig. 1.2 (**a** and **b**) Screenshots for multiplayer game mode and solo-player game mode in the "Learn and Play Japanese Gojūon"

flow experience and the learning outcomes were the same as study 1. The number of players (solo or multiple) in the games was added to study 2.

1.2.3 Procedures

Prior to each experiment, informed consent was obtained from the participants to ensure their understanding about the content of the corresponding experiment. In study 1, after signing the consent form, the players completed a screening survey for determining their type of players (mastermind or conqueror). Afterwards, they played the "Learn and Play Japanese Gojūon". After playing the game for 15 minutes, the participants completed the flow questionnaire. In study 2, after signing the consent form, half of the participants were randomly assigned to play the video game in multiplayer mode first, while the other half played in solo-player mode first. In the multiplayer mode, two players played the game simultaneously. After playing the game for 15 minutes, the participants completed the flow questionnaire. Then, they switched to the other game mode and played for another 15 minutes. After completing the game, the participants needed to complete the flow questionnaire again. The flow questionnaire was mixed with some other irrelevant items to prevent testing effect.

Although participants might feel tense and stressful when playing the video game, especially in the multiplayer mode, there was no major or long-term emotional and psychological harm to participants. Furthermore, all data were kept confidentially and will be deleted after the completion of the study to protect the participants' privacy. This study got the ethical review approval at the self-financing university the authors collected data from.

1.3 Results

Study 1 There was a total of 80 participants, including 48 females and 32 males. Their ages were from 19 to 23 (*M* = 20.60 and *SD* = 1.01). Their range of the score in the game, which referred to the learning outcomes, was 0 to 1000 (*M* = 540.00, *SD* = 275.41), and the range of the score in the state of flow, which was measured by the flow questionnaire, was 27 to 63 (*M* = 40.48 and *SD* = 8.43). The descriptive statistics for both types of players are shown in Table 1.1. Results of independent-sample t-tests did not show any significant difference on learning outcomes and state of flow between conqueror and mastermind.

Correlation tests were conducted to examine the bivariate relationships among the type of players, state of flow and learning outcomes. No significant correlation was found between the type of players and the flow experience ($r = .005$, $p = .484$), between the type of players and the learning outcomes ($r = -.058$, $p = .303$) and between the flow experience and the learning outcomes ($r = .166$, $p = .071$).

A series of linear regression analyses were also conducted to test the mediation effect of flow experience on the relationship between type of players and learning outcomes. First, learning outcomes were regressed on the type of players. However, the overall regression model was insignificant ($F(1,79) = .268$, $p = .606$), with a R^2 of .003. A linear regression was also conducted by using the flow experience to predict the learning outcomes. The overall regression model was also insignificant ($F(1,79) = .002$, $p = .968$), with a R^2 of .027. A multiple linear regression was conducted by using type of players and state of flow to predict the learning outcomes. The overall regression model was insignificant ($F(1,79) = 1.230$, $p = .298$), with a R^2 of .031. In sum, none of the hypotheses was supported by the results in study 1.

Study 2 There was a total of 80 participants, 37 females and 43 male participants. Their age range was from 19 to 22 (*M* = 20.45 and *SD* = .727). Participants' learning outcomes were measured by the scores of the game in solo-player and multiplayer modes. The range of the scores in solo-player mode was 200 to 1000 (*M* = 536.25, *SD* = 191.76) and that in multiplayer mode was 0 to 1000 (*M* = 612.50, *SD* = 277.59). Participants' scores in the flow experience of solo-player and multiplayer modes were measured by the total score of the flow questionnaire. The range of the score in solo-player mode was 15 to 70 (*M* = 42.59 and *SD* = 14.983) and that in multiplayer mode was 17 to 73 (*M* = 50.55 and *SD* = 23.834). The descriptive statistics of study 2 are shown in Table 1.2. Results of the two independent-sample t-tests

Table 1.1 Descriptive statistics of learning outcomes and state of flow by type of players in study 1

Measure	*M*	*SD*	*N*
Learning outcomes of conqueror	524.39	272.75	40
Learning outcomes of mastermind	556.41	280.78	40
State of flow of conqueror	40.51	7.63	40
State of flow of mastermind	40.44	9.29	40

Table 1.2 Descriptive statistics of learning outcomes and state of flow by number of players mode in study 2 ($N = 80$)

Measure	M	SD
Learning outcomes in solo-player mode	536.25	191.76
Learning outcomes in multiplayer mode	612.50	277.59
Flow in solo-player mode	42.59	14.98
Flow in multiplayer mode	50.55	23.83

showed that multiplayer mode had a significantly higher level of flow ($t = 2.021$, $p = .045$) and better learning outcomes ($t = 2.530$, $p = .012$) than solo-player mode.

Correlation analyses were conducted to examine the relationships among number of players, state of flow and learning outcomes. The findings showed that number of players had weak positive relationships with state of flow ($r = .197$, $p = .042$) and learning outcomes ($r = .159$, $p = .045$). State of flow had moderate positive relationship with learning outcomes ($r = .676$, $p < .001$).

Furthermore, two separate correlation analyses were conducted. The results showed no significant correlation between the flow experience and learning outcomes for solo-player mode ($r = .137$, $p = .114$). A significant correlation was found between the flow experience and learning outcomes for multiplayer mode ($r = .898$, $p < .001$).

A series of linear regression analyses were conducted to test the mediation effect of flow experience on the relationship between number of players and learning outcomes. First, a simple linear regression was conducted by regressing the learning outcomes onto the number of players mode. The overall regression model was significant ($F(1,159) = 4.086$, $p = .045$), with a R^2 of .025. The estimated parameter showed that multiplayer mode had higher learning outcomes than solo-player mode ($\beta = .159$, $t = 2.021$, $p = .045$). Another simple linear regression was conducted by using the number of players to predict state of flow. The overall regression model was significant ($F(1,159) = 6.400$, $p = .012$), with a R^2 of .039. The estimated parameter showed that multiplayer mode had a higher state of flow than solo-player mode ($\beta = .197$, $t = 2.530$, $p = .012$).

Finally, a multiple regression was conducted by using the number of players and state of flow to predict the learning outcomes. The overall regression model was significant ($F(1,159) = 66.411$, $p < .001$), with a R^2 of . 451. The findings showed that state of flow significantly predicted learning outcomes ($\beta = .671$, $t = 11.203$, $p < .001$). After adding state of flow into the model, the relationship between number of players and learning outcome became insignificant ($\beta = .026$, $t = 0.440$, $p = .661$). Hence, state of flow was a full mediator to account for the relationship between number of players and learning outcomes. Supplementary analyses showed that state of flow significantly predicted learning outcomes in multiplayer mode ($\beta = .898$, $t = 17.982$, $p < .001$) but not in solo-player mode ($\beta = .137$, $t = 1.217$, $p = .227$).

1.4 Discussion

This research applies the concept of flow to understand the mechanism for gamification of learning. Study 1 had two research questions. Firstly, does flow experience in video-game learning relate to better learning outcomes? The results showed no significant relationship between the flow experience and learning outcomes. Furthermore, the flow experience in the video-game learning could not significantly predict learning outcomes. These findings were inconsistent with the proposed hypothesis.

The second research question was which type of players (mastermind or conqueror) is easier to achieve a higher state of flow and better learning outcomes? The results did not show any significant relationship between type of players and the flow experience. Furthermore, both type of players and the flow experience did not predict learning outcomes. In short, these findings did not support the first two hypotheses.

For study 2, the focus is on the relationship between number of players, flow experience and learning outcomes. The third research question is whether number of players (solo-player mode or multiplayer mode) affects the state of flow and learning outcomes. It is anticipated that multiplayer mode can achieve higher levels of flow and better learning outcomes. The results were consistent to this anticipation. The participants who played in multiplayer game mode achieved higher levels state of flow and better learning outcomes. In addition, state of flow was only a significant predictor of learning outcomes in multiplayer mode. Most importantly, flow experience was a significant full mediator on the relationship between number of players and learning outcomes. In other words, flow experience can fully explain the differences on learning outcomes by number of players.

These findings can be explained by the concept of group flow. According to Sawyer's (2014) study of group flow, some requirements of group flow could be used to explain why participants had higher levels of flow experience and better learning outcomes in multiplayer game mode. First, the skills of players were quite similar because all participants did not formally learn Japanese. The participants were allowed to communicate during the game during the experiment. Through communication, they could understand each other and worked together to find ways to solve problems and to achieve a clear common goal (getting more points in the game). With the support from a teammate with similar skills in the multiplayer mode, they can raise their skills and take on bigger challenges. These findings have a significant implication in designing classes and course with game-based learning to support collaborative deep learning as a group.

Future studies should further explore the roles of flow experience in gamification of learning. In study 1, no significant relationship was found between flow experience and learning outcomes. However, it might be due to the limitation of this study that there was no accurate measure of the former experience in Japanese prior to the experiment. Although researchers already asked the participants whether they have had any learning experience in Japanese, the informal exposure (e.g. travelling to

Japan) to Japanese of the participants should be more accurately controlled. Future studies can measure the flow experience by using more biologically valid measures, such as the physiological changes in the body (e.g. heart rates) during gaming.

Not just the individual flow, it is worthy for conducting more future research on group flow because this concept may be a major breakthrough in the flow theory. According to the present study, there was significant difference on the state of flow between solo-player mode and multiplayer mode. Nevertheless, it is difficult to verify whether the group flow actually existed and what factors affect the group flow due to the limited existing literature and tools for measuring group flow. In addition, it is critical to further study group flow because it is more applicable and important to the real-life learning context (e.g. school project, team work, athletic team), especially when nowadays learners are so individualized and egocentric due to the competitive educational environment (test-driven and performance accountability).

Indeed, studying group flow can significantly improve the performance and work efficiency of team performance. These are some guiding directions for future research. By identifying the predictors of the group flow, future studies can make a significant contribution to the group flow model and design valid and reliable tools for measuring group flow. Most importantly, further studying flow and group flow in gamification of learning can provide insights for curriculum and instructional design to tailor the educational needs and the learning experience of all learners as an individual and as a team.

References

Admiraal, W., Huizenga, J., Akkerman, S., & Ten Dam, G. (2011). The concept of flow in collaborative game-based learning. *Computers in Human Behavior, 27*(3), 1185–1194.

Arellano, D. G., Tokarchuk, L., & Gunes, H. (2016, June). Measuring affective, physiological and behavioural differences in solo, competitive and collaborative games. In *International conference on intelligent technologies for interactive entertainment* (pp. 184–193). Cham: Springer.

Brown, S. L., & Vaughan, C. C. (2009). *Play: How it shapes the brain, opens the imagination, and invigorates the soul*. New York: Avery.

Csikszentmihalyi, M. (1975). Play and intrinsic rewards. *Journal of Humanistic Psychology, 15*(3), 41–63.

Csikszentmihalyi, M. (1978). Intrinsic rewards and emergent motivation. In M. R. Lepper & D. Greene (Eds.), *The hidden costs of reward: New perspectives on the psychology of human motivation* (pp. 205–216). Morristown: Erlbaum.

Csikszentmihalyi, M., & Larson, R. (2014). Validity and reliability of the experience-sampling method. In *Csikszentmihalyi Mihaly's Flow and the foundations of positive psychology* (pp. 35–54). Dordrecht: Springer.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining gamification. In *Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments* (pp. 9–15). New York: ACM.

DomíNguez, A., Saenz -De-Navarrete, J., De-Marcos, L., FernáNdez-Sanz, L., PagéS, C., & MartíNez -HerráIz, J. J. (2013). Gamifying learning experiences: Practical implications and outcomes. *Computers & Education, 63*, 380–392.