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探討遊戲化設計與線上學習意圖之關聯性：心流狀態之中介效應

Explore the relationship between gamification and learners' intention to learn in an online environment: the mediation effect of flow states

林俞均

Yu-Chun Lin

指導教授：吳玲玲 博士

Advisor: Ling-Ling Wu, Ph.D.

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探討遊戲化設計與線上學習意圖之關聯性：

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本論文係林俞均君（學號 R09725038）在國立臺灣大學資訊管理學系、所完成之碩士學位論文，於民國 113 年 7 月 29 日承下列考試委員審查通過及口試及格，特此證明

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所　　長：

中文摘要

為了解線上學習遊戲化與學習意圖之間關係，以及學習中產生心流是否影響學習效果進行本研究。學習生態在疫情衝擊之下出現重大改變，為使學習者更專注在學習內容之上，遊戲化概念蔚為風氣。但遊戲化的加入也可能導致學習者將心思放在遊戲而非學習內容。我們預期透過遊戲輔以學習內容的方式，使學習者在不考慮學習成績的壓力之下享受學習的樂趣，並且在遊戲當中因為沉浸與愉快的體驗更使得學習者在學習意圖以及學習成果上有更好的表現。研究透過實驗法收集 234 名學生的學習資料，分析其於實驗中感受到的心流程度以及活動後的學習意圖。結果表明學生在遊戲情境之下確實能感受到心流，而遊戲中的競賽元素則不會導致學習者有心流程度的差異。學習意圖與學習成果並沒有因為遊戲的加入呈現顯著的上升，其中又以無競賽的學習組別受到的分心程度最高。遊戲組別的學習者感受到心流可以提升學習意圖，而競賽對於學習意圖的效果並不會因為心流的產生而有顯著的改變。希望透過本研究的發現給予教學者一些教學設計的靈感與應用方向。

關鍵字：遊戲化、競賽、心流、學習意圖、學習成效

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Abstract

This study was conducted to understand the relationship between gamification of learning and learners' intention to learn in an online environment, and whether the generation of flow in learning affects learning performance. Learning styles have changed significantly under the impact of the epidemic, and the concept of gamification has become popular in order to make learners focus more on learning content. However, the addition of gamification may also cause learners to focus on the game rather than the learning content. It is expected that by integrating games with learning content, learners can enjoy learning without the pressure of achieving better academic performance, and the immersive and enjoyable experience of playing games will lead to better results in terms of intention to learn and learning performance. The study collected data from 234 students and analyzed the level of flow during the experiment and their intentions to learn after the activity. The results showed that students did feel flow in the gaming context, but the competition elements of the game did not lead to differences in the flow states. Learners' intention to learn and learning performance did not increase significantly with the addition of the game, and the no competition group experienced the highest level of distraction. Learners in the game group who perceived flow states could enhance their intention to learn, whereas the effect of competition on learners' intention to learn did not change significantly due to the generation of flow. It is hoped that the findings of this study will provide some inspirations and directions for instructional design.

Keywords: gamification, competition, flow, intention to learn, learning performance

doi:10.6342/NTU202402931

Table of Contents

doi:10.6342/NTU202402931

doi:10.6342/NTU202402931

List of Figures

doi:10.6342/NTU202402931

List of Tables

doi:10.6342/NTU202402931

Chapter 1 Introduction

The aim of education we concern most is the learners' achievement, which is a direct representation of learning performance. Past research has shown that by enhancing learners' interest in specific fields, they would perform better and would have the intention to keep improving knowledge in certain areas (Simões et al., 2013; Bachen et al., 2016; Putz et al., 2020). Hence, scholars and instructors have long been seeking ways to increase learners' interest and engagement in 'non-entertainment' fields, which is the reason that the concept of gamification was added to both workplaces and classrooms (Prensky, 2001; Gee, 2003). The definition of gamification is using game design elements with game mechanics in non-game contexts (Deterding et al., 2011; Liu et al., 2017). By applying games in educational occasions, the courses may become appealing and motivating (Glover, 2013). The employment of gamification is not only in physical classrooms but also in online classes. Furthermore, since the outbreak of the epidemic COVID-19, there has been a dramatic increase in the development of online collaboration, and it is becoming a mega-trend of working and learning in distance.

Virtual learning is not a novel idea for education, and the concept seems to be constantly evolving and improving. The core idea of virtual learning is to deliver educational contents via technologies. It is a broad term referring to computer-based environments with a wide variety of learning contents for learners (Piccolo, Ahmad, & Ives, 2001). As mentioned above, gamification can be applied to traditional classrooms and virtual learning environments, and with the growing development of technology, we are more interested in understanding the concept of gamification in an online learning environment. To construct a gamification environment, there are several elements contained to engage learners into games, including points, badges, leaderboards, levels,

doi:10.6342/NTU202402931

avatars, animations, missions, competitions and so on (Giannetto et al., 2013; Knautz et al., 2014; Jordine et al., 2015; Liu et al., 2013). The characteristics of gamification as games show that gamified learning settings are fun, engaging, and enjoyable. Although the electronic gaming contexts help to engage learners in things they are doing, prior research has demonstrated the online game settings of learning might have either positive or negative effects on learners' performance (Christy & Fox, 2014; Hanus & Fox, 2015; Mekler et al., 2017). Learners could be fully engaging in learning, which ended up with better learning outcomes, or the game setting might distract them, causing worse academic performance (Van Roy & Zaman, 2018; Young et al., 2012).

A meta-analytic review of distance learning studies concluded that the specific characteristics/ features of the teaching and learning environment and appropriate use of instructional strategies could promote learning outcomes (Bernard et al., 2004). There is a need for investigations of specific gamification design elements to gain better learning results and benefits of gamification (Lee & Hammer, 2011; Hamari et al., 2014). In this research, we focus on a popular gamification element 'competition'. A competition is a contest between two or more parties for the purpose of winning, victory or gaining an advantage according to the rules of the contest (Liu et al., 2013). Competition allows players to compete against each other in a gamified manner, which in turn enhances learning (Jagušt et al., 2018) and engagement (Yee, 2006; Demetrovics et al., 2011; Liu et al., 2013). There are still drawbacks to the competitive environment, not just the distraction of the online environment mentioned earlier, but the competition setting can create anxiety for learners (Kohn, 1992). Since the competition is a match involving two or more parties, it is important to consider participants' own ability and that of the opponents. According to the concept of flow theory (Csikszentmihalyi, 2014), when the

doi:10.6342/NTU202402931

task and the individual's skill are matched, it is possible to enter into a state of immersion and get better results. Once the task is out of balance with one's ability, participants may feel anxious and lose the desire to work hard because the task is too difficult and out of control, or they may feel bored because the task is too simple and below one's ability, causing them to feel unchallenged. Both task and skill imbalances may lead to slacking and inattentiveness (Csikszentmihalyi, 1997). We want to use the game setting to enhance the engagement and enjoyment of the learners, thus the existence of the competition and its difficulty become a part of the concern.

Previous studies have often equated the concept of engagement with the concept of flow (Shernoff et al., 2014; Suh et al., 2017), but we believe that flow exists as psychological outcomes, and it is only with flow that engagement or continuous engagement can occur (Hamari et al., 2014). Competition in the learning environment is a system feature that creates a psychological experience of satisfaction, pleasure, and immersion for the learner because it meets the learning needs of the participant as a learner. The psychological experience of satisfaction, pleasure, and immersion, all these dimensions can be organized into the concept of flow. According to Csikszentmihalyi's (1990) definition, flow can be distinguished and categorized into four aspects, respectively immersion, control of action, time distortion, and heightened enjoyment. As a game design element, competition is undoubtedly entertaining and promotes learners' intention to learn with its enjoyable nature in the learning field (Santhanam et al., 2016). When doing something interesting and fun, we do not perceive the passage of time and concentrate on the present moment. Meanwhile, the patterned and repetitive movements in a competition allow us to focus on the competition itself without worrying about the inappropriateness of the behavior. Through the different characteristics of the

doi:10.6342/NTU202402931

competition, we argue that the presence or absence of the competition does affect the cognitive response, i.e. flow.

In addition to the instructional environment and system features that can facilitate psychological outcomes, another important factor that affects the effectiveness of learning is learners' personality. The experience, perceived cognitive response and subsequent behavior of each individual in competition will vary depending on their personality (Bozanta et al., 2016). Everyone has a different level of motivation to learn, and in achievement motivation theory, motivation varies with the needs being met (McClelland et al., 1958). Yet this motivation to satisfy needs is innate, and learners with high needs for achievement do not easily change their original motivation due to specific system settings. In our research, we have viewed motivation as an exogenous behavior, that is, the amount of time and effort invested in learning. When an individual's learning motivation is high, he/ she will spend more effort and time on learning as well as continuous learning (Liu et al., 2013).

We use game design elements, which is competition in this research, in order to make the learners more engaged and immersed in the learning process, and thus willing to continue learning after this session. Davis et al.'s (1992) research indicated that both usefulness and enjoyment were major predictors of intention to use electronic devices in workplaces. That is, a pleasant and comfortable experience is an influential factor that leads to the user's intention to use information systems. An alike result could also be found in the education field. The learners' enjoyment is the catalyst that encourages his or her learning proactivity (Fu et al., 2009). When we perceive learning to be attractive and meaningful, we tend to continue the activity that makes us feel delightful and fulfilled.

doi:10.6342/NTU202402931

There has been extensive literature telling us that the functionality of a learning platform or system affects learning performance (Hamari et al., 2014; Koivisto & Hamari, 2019; Su & Cheng, 2015), and influences psychological outcomes, especially enjoyment (Malone, 1981; Hsu & Lu, 2004). It is therefore interesting to have a deeper understanding of whether the game design element, competition, influences the different dimensions of flow, and whether distraction due to learning tools will be solved by the addition of game design and competition feature. Then, after an immersive and enjoyable learning experience, the intention to learn is enhanced.

doi:10.6342/NTU202402931

Chapter 2 Literature review

2.1 Technology-mediated learning

As mentioned in the introduction section, the concept of virtual learning has been around for some time. Virtual learning is a major focus in the digital transformation of education, which represents providing content through digital technology (Anohina, 2005; Piccoli et al., 2001). Derry and LaJoie (2013) argue that the role for a computer system is not a teacher or expert, but rather, it should be a mind-extensive cognitive tool, demonstrating that every valuable step in learning like planning, decision-making, and self-regulation of learning are the responsibility of the learner, not the computer. The use of technology in education can be the assistance of learning, such as technology-mediated learning, which uses technology to help accomplish learning behaviors. Computers in the concept of technology-mediated learning are only supplementary tools, not instructional activities through technology, which means the contents of courses are not necessarily delivered via computers (Alavi and Leidner, 2001).

Another term included in technology-mediated learning is technology- based learning, unlike the definition of TML, which means to provide instructional content through computer technology, and be used as the principal media (Jonassen, 1995; Jones and Paolucci, 1999). Within the term, technology-based learning are two groupings: distance learning and e-learning. In distance education, instructors and learners are separated in space and/ or time, but there is a provision of two-way communication. Hence, despite the separation of the both parties, teachers and students could communicate with one another during the courses through the

doi:10.6342/NTU202402931

technology. In addition, some systems or software under this framework allows learners to participate in small group learning. Group discussions are accomplished through real-time communication channels (Keegan, 1996). As for e-learning, learners have the most control over their learning and are able to determine the scope of knowledge to be learned and the daily progress of learning at their own pace. According to the definition of scholars in the past (Anohina, 2005; Alavi and Leidner, 2001; Piccoli et al., 2001), e-learning is an educational activity conducted mainly through asynchronous video teaching, and therefore differs from distance education in that e-learning does not allow for simultaneous communication and discussion between the teaching and learning parties. There is one of the variations of e-learning called collaborative e-learning, which stands for e-learning including features like communication technology that facilitate discussions between learners (Jonassen, 2004; Radhika et al., 2008).

Gupta and Bostrom (2009) argue that despite the growing interest and progress in the use of technology in learning, challenges such as learner disinterest and distraction remain. Scholars and instructors need to find interventions that provide positive experiences and better engagement for learners.

2.2 Gamification

In order to make learners more focused on learning, as described in the preceding paragraph, the interventions in technology-mediated learning, instructors and practitioners have proposed a series of game-inspired learning designs, such as game-based learning (GBL) (Qian & Clark, 2016) and serious game (Zyda, 2005; Bozanta et al., 2016). These game-inspired learning designs are designed to provide the merits of learning through the particular purpose of the game, allowing learners to learn as

doi:10.6342/NTU202402931

they play. These learning environments are set up to put the concept of games into learning, and use games to increase learners' participation, emotional responses and interest in the subject (Jagušt et al., 2018).

Prensky (2001) and Gee (2003), among others, highlight the potential of using video games in learning. Gee describes the impact of games on cognitive development and points out the principles of learning that can be found in video games. Since 2010, there has been a new wave called gamification, which represents the application of game elements to non-game domains, designed to promote people's engagement and facilitate particular behaviors (Deterding et al., 2011). GBL or serious games treat games and learning as two discrete functions. Differ from separating games and learning, gamification is the concept of putting a game into an existing process or system with an attached layer. It refers to adding game elements to non-game contexts, such as learning (Filsecker & Hickey, 2014), work (Dale, 2014), marketing management (Huotari & Hamari, 2017), etc., through game rules and mechanics (Deterding et al., 2011; Glover, 2013; Santhanam et al., 2016).

Straightforwardly, gamification as an extension of pure gaming, its entertaining characteristic has great potential to inspire students and make schools engaging (Lee & Hammer, 2011). With the use of game design elements, students learn, not by playing specific games, but by learning as if they were playing a game (Simões, Redondo, & Vilas, 2013). Gamification is a process of inducing incentives in those non-stimulating activities, and education is a particular area (Ulicsak & Wright, 2010).

doi:10.6342/NTU202402931

Table 1. The elements of gamification

Title	Definition
Achievements	A specific objective within the game.
Avatars	A visual representation of a player's character.
Badges	A visual representation of achievement.
Collections	A group of related badges.
Competitions	A contest between players for a reward.
Gifting	The provision of aid to other players.
Leaderboards	Comparison of players' expertise.
Levels	Difficulty moderated based on player expertise.
Points	Numeric record of players' performance.
Quests/ Tasks	Predefined challenges
Teams	Groups of players collaborating to achieve goals
Virtual Goods	Assets with perceived value within the game

Werbach and Hunter (2012) proposed a framework to guide gamification system providers, which includes a list of elements that can be used to operate gamification. This framework describes how these specific elements can be incorporated into the process or activity to be gamified. The identified elements and definitions are presented in Table 1. Most notably, in accordance with previous literature, gamification is often associated with points, levels, and leaderboards (Knautz et al., 2014; Hamari et al., 2014; Seaborn & Fels, 2015). In our study, competition is the most wanted element of gamification that we would like to explore. In the world of gaming, cooperation and competition are the most common design elements (Liu et al., 2013), where players complete tasks by helping each other or competing against each other. Because the concept of cooperation involves other people, it is difficult to implement in a single-player game. Moreover, since learning and acquiring knowledge is an individual matter, even if gamification elements are added, it does not change the fact that learning must be done by a single learner, so we believe that competition is the most suitable gamification element to investigate.

doi:10.6342/NTU202402931

2.3 Competition related features

A competition is a contest in which two or more parties compete to a victory or superiority within the rules of the match (Liu et al., 2013). The competition as one of the elements of gamification is unquestionably entertaining, and because individuals play games to enjoy and have fun, the competition is considered to be closely related to the innate drive to bring enjoyment to the activity (Malone, 1981; Deci & Ryan, 1985). For these reasons, researchers are looking for ways to incorporate it into classrooms, conference rooms and management activities in anticipation of increasing the enjoyment of learning and at work (Epstein & Harackiewicz, 1992; Reeve & Deci, 1996; Tauer & Harackiewicz, 1999).

Another characteristic of competitions is 'controllability'. An important prerequisite for competition is that it must be clearly regulated (Csikszentmihalyi, 1997). The rules of the competition define what individuals can and cannot do during the activity, and eliminate the possibility of unexpected behavior. So that during the competition, all actions of individuals and their opponents can be controlled and individuals do not need to worry about facing unanticipated actions from their opponents. It is worth noting that the competition is characterized by its uncertainty. While the aforementioned participant behavior in a competition is controllable and manageable, the "uncertainty" mentioned here refers to the uncertainty of the outcome and the uncertainty of the rivals' capabilities (Baik, 2004; Santhanam et al., 2016). Since the result of competition is unpredictable and there is no way to know if the participant will win or lose until the last moment, the ever-changing situation of the competition will stimulate the participants' will to fight (Cheng et al., 2009).

doi:10.6342/NTU202402931

Several characteristics of competition can be summarized from the prior literature, and researchers have concluded the relationship between these characteristics and specific emotional responses, and demonstrated the improvement of engagement with the addition of competition. How to use the characteristics of the competition to enhance learners' state of flow is the main point we aim to explore.

2.4 Flow

Flow is a general state of experience in a wide variety of forms of play and, under certain conditions, in other activities that are not usually considered play, like mountain climbing or playing a musical instrument. Flow is the integral feeling that occurs when we are fully engaged in an activity (Csikszentmihalyi, 1975), defined as a mental state of a person engrossed in an activity so deeply that nothing else seems to matter.

According to Csikszentmihalyi's (1990) description and definition of the flow state, Suh et al. (2017) organized it into four dimensions, respectively, immersion, control of action, time distortion and heightened enjoyment. Immersion is a state of total concentration in which everything an individual does seems to become unconscious and automatic, and the individual is no longer aware of the distinction between himself/ herself and the action, which refers to the action and the individual are integrated (Guo & Poole, 2009). As mentioned in the paragraph about the "uncertain" nature of competitions, they are games designed to be won or lost, and participants do not know if they will win or lose the contest until they actually see the final result (Baik, 2004; Cheng et al., 2009). This undecided and unpredictable nature will allow participants to believe that they are capable of winning the

doi:10.6342/NTU202402931

competition and focus more on the event. Therefore, we propose the following hypotheses,

***H1a**. In an online learning environment, games will positively affect learners' immersion of the flow state.*

***H4a**. In an online learning environment, competition related features of the games will positively affect learners' immersion of the flow state.*

Secondly, the dimension named control of action means due to the repetitive actions and the automatic behavior, an individual is not worried about losing control of own actions (Hamari & Koivisto, 2013). A competition is a situation created by rules that determine what actions are allowed and what actions are not allowed, for example, in a chess game both players must move their pieces in a back-and-forth sequence within a time limit (Csikszentmihalyi, 1975). The rules of the competition restrict behavior, but they also provide predictability of behavior. By focusing on the activity, repetitive, spontaneous behaviors are easier to manage without worrying about out-of-control actions or sudden, unanticipated moves by the opponent. However, the way we conducted the experiment prevented the participants from doing much. We constrained the participants' opportunities to explore the game's features and to act freely and we dictated that participants perform each step. Therefore, we conclude that we were unable to observe participants' control of action in this experiment.

The definition of time distortion is that because the individual is so focused on the activity, the individual is not able to perceive the passage of time. Only the present activity is what the individual cares about, the past and the future are not of any

doi:10.6342/NTU202402931

importance (Csikszentmihalyi, 1990). Competition is one of the elements of gamification, so as a game, competition is undoubtedly entertaining. It was also found in the past literature that participants described perceiving time faster in fun activities (Conti, 2001). That is, the extent of interest of a competition as a game can influence the participants' perception of time flow. We have often heard the saying, time flies when you are having fun (Agarwal & Karahanna, 2000). The time perceived during the entertainment is not the real time flow, because the focus is on the highly entertaining activity, so one does not think about the past and the future. Therefore, H1b and H4b refer to be,

H1b. *In an online learning environment, games will positively affect learners' time distortion of the flow state.*

H4b. *In an online learning environment, competition related features of the games will positively affect learners' time distortion of the flow state.*

The last aspect of flow is heightened enjoyment, which refers to the pleasurable experience in the activity (Santhanam et al., 2016). As repeatedly mentioned in the article, competition appears as an element of gamification in the learning environment. The concept of the game itself is fun, engaging and motivating (Moncada & Moncada, 2014; Stansbury & Earnest, 2017). In addition to the playfulness of the game, combat in the online games, i.e. the competition itself brings a sense of enjoyment (Weibel et al., 2008). Whether it is as a game or the tension of the competition itself, the fact that the competition can trigger a joyful emotional response is widely supported and therefore H1c and H4c are proposed.

doi:10.6342/NTU202402931

***H1c**. In an online learning environment, games will positively affect learners' heightened enjoyment of the flow state.*

***H4c**. In an online learning environment, competition related features of the games will positively affect learners' heightened enjoyment of the flow state.*

The most important value of applying gamification to learning is in promoting learners' participation, enhancing the interest in learning, and improving learning outcomes (Simões et al., 2013; Grangeia et al., 2019). A pleasant user experience is an important factor for continued use of the information system (Davis et al., 1992), and the enjoyment that comes from total immersion in the activity increases the desire to keep using the system (Agarwal & Karahanna, 2000). Gamified learning through immersion achieves learning goals such as performance, engagement, etc. (Fu et al., 2009). When fully immersed in the activity, the participant's behavior is almost spontaneous, without being aware of the behavior itself. There is no need to think about what actions to take, the participant only needs to focus on the content of the activity, and because there is no other external disruption in the way, this state of mind makes the participant more willing to learn. Besides, due to the existence of rules, the actions that participants can take are fixed. By having control over the behaviors and not worrying about other options affecting the competition, participants are not disturbed by other options and are more willing to learn. With totally immersing in the competition, the competition itself is the only thing the participant cares about, and the attention to the activity increases the participant's intention to learn. Enjoyment is the basis of flow, and experiencing the fun of learning motivates the user to continue learning and to engage in continuous learning behaviors. Because it is fun, users will take the opportunity to learn. Competition

doi:10.6342/NTU202402931

as a game can promote engagement, but it could discourage learners' willingness to learn when it places too much emphasis on achievement (Tauer & Harackiewicz, 2004). In this study, scoring was not our primary concern, but rather the game-like nature of the competition allowed learners to be willing to learn and spontaneously advance their knowledge in order to win, but also because we created a more flexible and entertaining learning environment that did not put pressure on learners to learn, they would be more interested in learning and would get better learning results. Thus, the effects of games and competition features on learning intentions are summarized as H2 and H5; and the effects on learning performance are concluded as H3 and H6.

H2*. In an online learning environment, games will positively affect learners' intention to learn.*

H3*. In an online learning environment, competition related features of the games will positively affect learners' intention to learn.*

H5*. In an online learning environment, games will positively affect learners' learning performance.*

H6*. In an online learning environment, competition related features of the games will positively affect learners' learning performance.*

It's worth noting that it's not just the nature of the game and competition that makes people more engaged; the creation of the flow state makes people more immersed and more enjoyable in what they're doing. Focusing on what one is doing gives the learner a sense of competence and control, and this enjoyable experience makes one more willing to invest mental and physical effort in the activity, thus

doi:10.6342/NTU202402931

increasing willingness to do the activity and the participants' performance. We therefore hypothesize that

H7. *In an online learning environment, the flow state will positively influence learners' intention to learn.*

H8. *In an online learning environment, the flow state will positively influence learners' learning performance.*

Since we believed that flow was the psychological result of using a system, and according to Hamari et al. (2014), emotional responses caused subsequent behavioral outcomes, we considered that the time distortion, immersion and enjoyment caused by games and competition related features would make learners be willing to continue learning and achieve better learning performance. Therefore, in H9 to H12 we hypothesized the mediation effect through flow states as follows:

H9. *In an online learning environment, the flow state mediates the relationship between games and learners' intention to learn.*

H10. *In an online learning environment, the flow state mediates the relationship between games and learners' learning performance.*

H11. *In an online learning environment, the flow state mediates the relationship between competition related features and learners' intention to learn.*

H12. *In an online learning environment, the flow state mediates the relationship between competition related features and learners' learning performance.*

doi:10.6342/NTU202402931

2.5 Research model

The theoretical framework of the research is depicted in Figure 1 below.

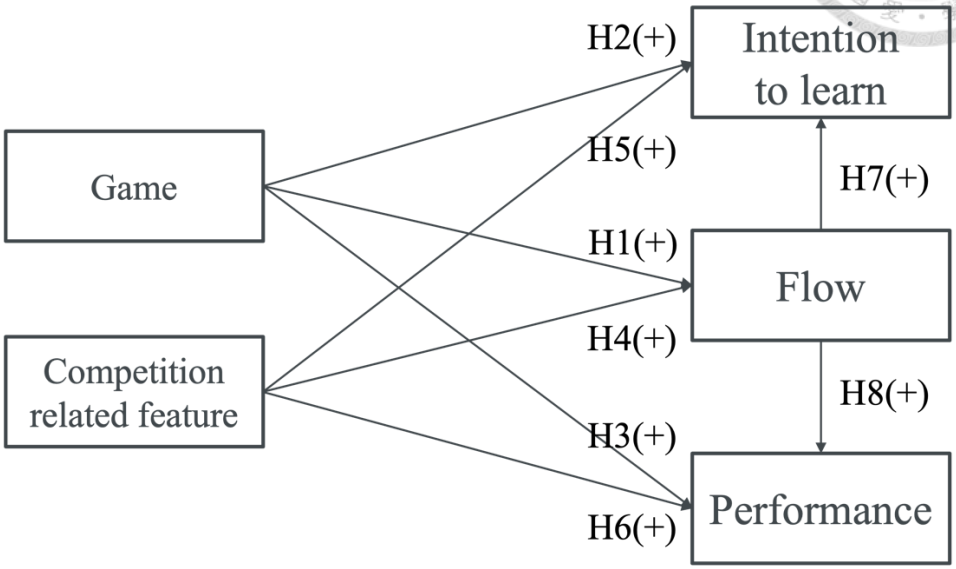

Figure 1. Research model

doi:10.6342/NTU202402931

Chapter 3 Methodology

3.1 Experimental design

In this study, we designed a 2-level nested-designed experiment with two factors, which were game (with game/ with no game), and competition related feature (with competition feature/ with no competition feature). Since the competitions would only occur in the group with the game, the experiment was designed to treat the competition related feature as a level under the game factor, and thus three scenarios were generated. Participants were randomly assigned to one of the scenarios on a class-by-class basis. Each factor was randomly assigned between subjects.

3.2 Experimental material

3.2.1 Game setting

The game design for this experiment was achieved through Kahoot! Participants needed to answer 5 questions about each video, the answers to which could be found in the footage, in order to test whether they were concentrating on learning from the videos or not.

Each question would provide four options from which the participant would have to choose the only correct answer. Participants would accumulate game score for each accurate answer, and the game score earned for each question would vary according to the game design. Participants must answer the question within the 20-second time limit and would receive 500 points for correct answers, plus an additional 25 points for each correct answer given one

doi:10.6342/NTU202402931

second ahead of the time limit, up to a maximum of 1,000 points per question. In addition, when the game progresses to the 3rd, and the 5th questions, the game score would be doubled for the correct answer.

We used the leaderboard as the presentation of the competition related feature. For groups with the competition related feature, participants could see the top 5 scores showed on the leaderboard at the end of each question. As for groups without the competition related feature, participants couldn't see the scores leaderboard.

3.2.2 Lecture video

For the experimental video selection, we selected the top three video themes that Taiwanese people watched the most when using streaming media according to NCC's 2022 Communications Market Survey, which were "Travel and Life", "Knowledge and Learning", and "News and Current Affairs". In addition to the selection of themes based on the NCC's report, we also had two prerequisites for the selection of footages: the knowledge/ the expertise of the viewer and their interest/ curiosities of the video. For the first premise, the expertise, participants must have heard of the content provided in the video but not had a particularly in-depth knowledge of it, and we did not expect participants to be fully equipped with the relevant knowledge before watching the video. If the participants have already acquired the knowledge of the video before watching the video, then the experimental video will lose its purpose of imparting knowledge. Second, we hoped that the theme conveyed by the film is interesting to the participants. It is only meaningful if the participants are interested in watching the film and are curious about the content of the film, to

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conduct experiments, to measure the level of immersion of the participants in the film, and to measure the subsequent learning effect.

In order to choose suitable videos to be used as experimental materials, we conducted a norming test, in which we found 4~5 videos for each of the three themes in advance, totaling 13 videos. In the "Travel and Life" videos, we have selected five different travel destinations to introduce, from Switzerland and Tibet, which are famous for their natural landscapes, to Milan and Egypt, which are renowned for their historical and cultural relics, and Thailand, which is a popular tourist destination for Taiwanese people. With regard to the selection of videos for "Knowledge and Learning", the NCC's report indicated that the "Cooking and Food" video genre was also a prevalent viewing choice, so we looked for four videos that delivered food- and beverage-related knowledge, videos about steak, sushi, coffee and cocktails respectively. As for the last category "News and Current Affairs", we have picked a few issues that are more relevant to the lives of the Taiwanese people, including livelihood issues, safety and security, as well as the international situation and trade. The exact content of the videos is: Youth Unemployment, Military Exercise in the Pacific, Taiwan as Pedestrian Hell, and U.S. Chip Ban. The 13 videos mentioned above were used to conduct the subsequent norming test to select the materials for the final experiment.

As mentioned at the beginning of the first paragraph, we chose the video based on two criteria: expertise and interest of the audiences. Therefore, in the norming test, we asked the participants to watch the 13 videos for us and to answer two questions for each video in a 5-point scale, "How curious are you

doi:10.6342/NTU202402931

about the video" and "Do you have any knowledge about the topic before watching the video?" In addition, we also asked participants about their interest level in each topic as a basis for choosing the experimental topic. In our conceptualization, we hoped the results would be that the participants' level of interest in the three topics varied, and they were highly interested in the videos and had a moderate level of knowledge, in which case the participants would be willing to watch the videos and could learn from the watching process.

First of all, Table 2 is the results of the descriptive statistics of the participants' interest in the three video topics. Among the three topics, "Traveling and Life" was the most interesting to the participants, with the mean of 4.27, followed by the mean of "Knowledge and Learning" 4.13, and the mean of "News and Current Affairs" 3.37. Then to analyze whether there was a significant difference in the level of interest of the participants in the three topics, an one-way ANOVA test was conducted. Based on the results (*F (2,87) = 7.67, MSe= .92, p= .001****), it could be observed that there was a significant difference between the interest levels of the three topics, and we wanted to identify which of these combinations were significantly different from each other, so we performed a Dunnett post hoc pairwise comparison. It could be seen that there was no significant difference between the mean values of "Travel & Life" (*M = 4.27, SD = 0.91*) and "Knowledge & Learning" (*M = 4.13, SD = 0.73*). Statistically significant differences occurred between "Travel & Life" and "News & Current Affairs" (*M = 3.37, SD = 1.19*), and between "Knowledge & Learning" and "News & Current Affairs". Therefore, in choosing the video topics, we choose "Travel & Life" and "Knowledge & Learning", which are of

doi:10.6342/NTU202402931

higher interest to the participants and have no significant difference with each other, excluding “News & Current Affairs”, which is of lower interest to the participants.

Table 2. Descriptive statistics results of topics (interest)

Topic	Mean	SD	n
旅遊生活(Travel & Life)	4.27	0.91	30
知識學習(Knowledge & Learning)	4.13	0.73	30
新聞時事(News & Current Affairs)	3.37	1.19	30

We then aimed to select videos from two topics that would be suitable for the experiment, starting with the topic of “Travel & Life”, where participants’ curiosity about the five locations was presented in Table 3. The subsequent ANOVA outcome showed that there were statistically significant differences among participants’ curiosity of five locations (*F (4,145) = 4.75*, *MSe= .70*, *p= .001****). Scheffe’s post hoc pairwise comparisons revealed only two pairs of locations where there were significant differences in the level of curiosity of the participants, Egypt and Tibet (M_{Egypt} *= 4.33*, SD_{Egypt} *= 0.71;* M_{Tibet} *= 3.53*, SD_{Tibet} *= 1.04*) as well as Switzerland and Tibet ($M_{Switzerland}$ *= 4.33*, $SD_{Switzerland}$ *= 0.71;* M_{Tibet} *= 3.53*, SD_{Tibet} *= 1.04*), while no statistical difference was achieved between the curiosity of other locations. Therefore, for the “Curiosity” filter, we first excluded Tibet from the selection list.

Table 3. Descriptive statistics results of curiosity (Travel & Life)

Location	Mean	SD	n
Egypt	4.33	0.71	30
Switzerland	4.33	0.71	30
Thailand	3.97	0.81	30
Milan	3.93	0.87	30
Tibet	3.53	1.04	30

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Next came the "expertise", where participants' knowledge of the five locations was presented in the following table. Thailand ($M_{Thailand}$ = *2.80*, $SD_{Thailand}$ = *1.10*) was the most recognized country, followed by Switzerland ($M_{Switzerland}$ = *2.53*, $SD_{Switzerland}$ = *1.14*), Egypt (M_{Egypt} = *2.50*, SD_{Egypt} = *1.07*), Tibet (M_{Tibet} = *2.33*, SD_{Tibet} = *0.96*), and Milan (M_{Milan} = *2.27*, SD_{Milan} = *1.01*). The findings of the ANOVA indicated that there were no significant differences in the participants' knowledge of the five locations (F *(4,145) = 1.16*, MSe= *1.12*, p= *.33*). This means that the participants' expertise of these five locations is similar, and the value can be found to be fluctuating up and down at 2.5, which means that the participants' expertise of these five locations is not extremely knowledgeable, but also not completely ignorant.

Table 4. Descriptive statistics results of expertise (Travel & Life)

Location	Mean	SD	n
Thailand	2.80	1.10	30
Switzerland	2.53	1.14	30
Egypt	2.50	1.07	30
Tibet	2.33	0.96	30
Milan	2.27	1.01	30

Taking curiosity and expertise into consideration, we finally chose the video introducing Egypt as the experiment material on the topic of "Travel & Life", since the curiosity level of the participants about Egypt was the highest among the five locations, along with Switzerland, and the value of their expertise was exactly in the middle of the 5-point scale, i.e., 2.5, which reflected that the participants had a moderate and appropriate level of knowledge about Egypt.

Moving on to the video selection on the topic of "Knowledge and Learning", there were videos about steak, sushi, coffee and cocktails, and we

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started by analyzing the participants' level of curiosity in these four contents. The result of curiosity was illustrated in Table 5, with the highest mean value 3.93 from the video which was an introduction to sushi (M_{Sushi} = *3.93*, SD_{Sushi} = *1.08*), followed by a 3.73 from the steak video (M_{Steak} = *3.73*, $SD_{Switzerland}$ = *1.01*), and 3.47s from the cocktails ($M_{Cocktails}$ = *3.47*, $SD_{Cocktails}$ = *1.07*), and coffee video (M_{Coffee} = *3.47*, SD_{Coffee} = *1.04*). The result of the ANOVA test revealed that the mean values of the four videos did not reach a statistically significant difference ($F\ (3,116) = 1.39$, $MSe = 1.11$, $p = .25$), and thus it was concluded that the curiosity level of the four clips did not differ, after which the expertise level was used to filter the videos.

Table 5. Descriptive statistics results of curiosity (Knowledge & Learning)

Topic	Mean	SD	n
Sushi	3.93	1.08	30
Steak	3.73	1.01	30
Cocktails	3.47	1.07	30
Coffee	3.47	1.04	30

The statistics of expertise level can be seen in the first place in sushi (M_{Sushi} = *3.00*, SD_{Sushi} = *1.05*), continued by steak (M_{Steak} = *2.80*, SD_{Steak} = *1.19*), coffee (M_{Coffee} = *2.60*, SD_{Sushi} = *1.07*), and cocktails ($M_{Cocktails}$ = *2.37*, $SD_{Cocktails}$ = *1.22*). The ANOVA test was conducted to find out whether the four videos showed statistically significant differences, and it was found that there was no difference between the four footages ($F\ (3,116) = 1.72$, $MSe = 1.28$, $p = .17$), which means that the participants were not particularly familiar with these four contents or were not well-versed in these four areas.

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Table 6. Descriptive statistics results of expertise (Knowledge & Learning)

Topic	Mean	SD	n
Sushi	3.00	1.05	30
Steak	2.80	1.19	30
Coffee	2.60	1.07	30
Cocktails	2.37	1.22	30

Since the curiosity and expertise of the participants in the four videos were not different, we considered that some people do not eat cold and raw food like sashimi, some people do not eat beef because of religion and beliefs, and some do not drink alcohol owing to health reasons and allergies. As a result, eventually we chose the coffee video, which is less of a taboo, as the experimental material.

3.3 Procedure

We develop a technology-mediated learning design in which participants learn through a video lecture with no instructors' intervention. We designed a laboratory experiment to test our hypotheses. The experimental process consisted of a pre-test to measure participants' intention to learn and the expertise in the specific video topic before the game, watching the lecture video, playing a game, and filling out a questionnaire after the game to assess the flow and learning intentions during and after the game. For the purpose of illustrating the study more clearly, the entire experimental procedures were plotted as Figure 2 on the following.

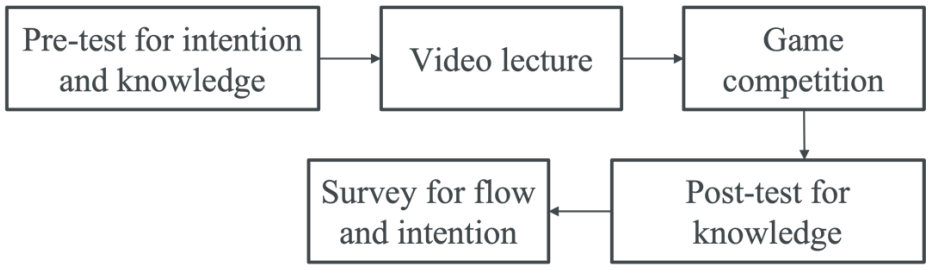

Figure 2. Experimental procedures

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The participants first needed to take a pretest for their learning intention and expertise in the upcoming videos. After the pretest section, they would be asked to watch the videos which were then selected to be a travel video about Egypt as well as an introductory video of coffee, and then played a mini-game to test their mastery of the video content. The mini-game is a question-and-answer game in which participants must select the one and only correct answer in order to gain a higher game score. Based on our experimental design, we would randomly assign classes into three different groups. There was still one group remained, which was the group without watching videos and without playing a game. This group was to help us confirm that the pre and post-tests were of the same level of difficulty.

At the end of the game, we would ask participants to do the post-test session, and then participants were asked to fill up measurement items about the state of flow and their learning intentions during the experiment.

3.4 Measurement

3.4.1 Flow

Participants were asked to evaluate the extent of flow they felt after the experiment session. Items used to operate the constructs were adapted from previous studies (Agarwal & Karahanna, 2000), which showed favorable composite reliability from .83 to .93, and modified for the context of competition. We measured the item by using a 5-point scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

The Chinese version of the flow scale was adapted from the article by 侯正裕 & 尚榮安(2018) to fit the experimental context of the study. According to

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the article, the Chinese version of the items was back translated to confirm the accuracy of the translation, and the reliability of its factors passed the threshold, with the Cronbach's alpha 0.81. The Chinese version of the flow scale is demonstrated in Appendix A.

The modified items of Agarwal & Karahanna's (2000) flow scale are summarized in the table below (see Table 7).

Table 7. The items of flow scale (modified)

Construct	Items
Time distortion	1. Time appears to go by very quickly when I am in the game-play. 2. Sometimes I lose track of time when I am in the game-play. 3. Time flies when I am in the game-play. 4. Most times when I get in the game-play, I end up spending more time that I had planned. 5. I often spend more time un the game-play than I had intended.
Immersion	1. While in the game-play, I am able to block out most other distractions. 2. While in the game-play, I am absorbed in what I am doing. 3. While in the game-play, I am immersed in the task I am performing. 4. When in the game-play, I get distracted by other stimuli very easily. (reversed) 5. While in the game-play, my attention does not get diverted very easily.
Heightened enjoyment	1. I have fun interacting with the game-play. 2. The game-play provides me with a lot of enjoyment. 3. I enjoy the game-play. 4. The game-play bores me.

3.4.2 Intention to learn

The scale to measure participants' intention to learn was based on Duan et al.'s (2010) work, and modified for the context of learning a specific topic as

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shown in Table 8. The question was on a five-point scale, with one point being very unlikely and five points being very likely.

Table 8. The item of intention to learn (modified)

Construct	Items
Intention to learn	How likely would you consider to learn “video topic”?

3.5 Participants

The experimental data were collected from the tenth-graders and eleventh-graders of a high school in New Taipei City. We looked for seven classes to conduct the experiment with a total of 234 students. Because of the experiment conducted by the freshman and sophomore students, and all of them living in New Taipei City, the demographic information of the experiment was not representative of the population, so the following table only shows the male and female ratio of the participating students.

Table 9. Information of participants and experimental groups

Gender	n	Percentage
Male	132	56.4
Female	102	43.6

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Chapter 4 Results and Analysis

4.1 Factor analysis

The measurement model was tested by assessing the convergent validity and discriminant validity. First of all, in order to determine whether the measurement items were suitable for doing factor analysis, the KMO and Bartlett's sphericity test were performed. The larger the KMO value and the significant Bartlett's test, the more common factors are among the items and the more suitable for factor analysis. In our data, we got KMO value as 0.85 and Bartlett's test was significant (*p=.000*), which meant it was appropriate for factor analysis. The total number of flow measurement items was 14 and divided into three directions, and thus we utilized principal components analysis (PCA) and Varimax rotation to extract three factors to examine the retained and deleted items. The eigenvalue of the first factor was 3.76, the eigenvalue of the second factor was 3.57, and the eigenvalue of the third factor was 2.02. The explained variance was 26.89%, 25.52%, and 14.42% respectively, which collectively explained 66.82 % of the variance.

The factor loadings after Varimax rotation were organized into the following table, and it could be found that two items, td1 and td3, were classified as the first factor, which was separated from the other three items (td2, td4, td5) of the same dimension classified as factor 3.

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Table 10. Factor loadings of measurement items

Items	Factor 1	Factor 2	Factor 3
td1	.63	.16	.37
td2	.41	.17	.54
td3	.61	.24	.42
td4	-.06	-.12	.79
td5	-.03	-.13	.81
im1	.25	.84	-.06
im2	.23	.84	.05
im3	.20	.78	.03
im4	.13	.74	-.18
im5	.24	.76	.01
en1	.85	.21	-.05
en2	.86	.22	.05
en3	.84	.22	-.07
en4	.65	.37	-.31

Therefore, td1 and td3 were deleted. The remained items were presented in the below tables.

Table 11. Factor loadings of remained measurement items

Items	Factor 1	Factor 2	Factor 3
td2	.20	.35	.48
td4	-.13	-.09	.85
td5	-.15	-.03	.84
im1	.85	.22	-.06
im2	.88	.18	-.00
im3	.79	.28	.16
im4	.74	.16	-.16
im5	.74	.29	-.04
en1	.20	.88	.02
en2	.24	.87	.13
en3	.25	.86	-.03
en4	.42	.62	-.23

The average variance extracted (AVE) values, composite reliability (CR), and Cronbach's α values for the three dimensions were calculated based on the

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factor loadings extracted from the new components to determine convergent validity. The organized data were presented in the below tables.

Table 12. Convergent Validity of measurement items

Dimension	AVE	CR	α	Item	Mean	SD	Factor loading
Immersion	0.64	0.90	0.88	im1	3.30	0.92	.85
				im2	3.39	1.02	.88
				im3	3.78	0.85	.79
				im4	3.40	0.98	.74
				im5	3.40	0.93	.74
Enjoyment	0.66	0.89	0.90	en1	3.67	0.89	.88
				en2	3.54	0.94	.87
				en3	3.49	0.89	.86
				en4	3.80	0.85	.62
Time distortion	0.55	0.79	0.63	td2	3.48	0.92	.48
				td4	3.18	1.05	.85
				td5	3.15	0.98	.84

Then we checked the discriminant validity by looking at the correlation coefficients between the 3 components. The correlation coefficients were not higher than the root of average variance extracted (√AVE) from the components themselves. Hence the discriminant validity was acceptable.

Table 13. Discriminant Validity of factors

Factor	TD	IM	EN
Time distortion	.74		
Immersion	-.04	.80	
Enjoyment	.06	.53	.81

4.2 Test of Hypotheses

We were concerned that the difference between the pre- and post-test questions might result in a gap in the difficulty level of the questions, so we first checked the difficulty level of the pre- and post-test questions by the paired sample t-test before conducting the test of hypotheses. We took the data of the baseline group, which was

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the group with no videos watching and no games playing, to test if there was a significant difference or not. The mean of correct answers in the pre-test is 1.53, and the mean of correct answers in the post-test is 1.57, and the difference between the mean of correct answers in the post-test and pre-test after the calculation is 0.04 (M_{pre} = 1.53, SD_{pre} = 1.11; M_{post} = 1.57, SD_{post} = .88; $M_{post-pre}$ = .04, $SD_{post-pre}$ = 1.41; $t(69)=.26$, $p=.80$). The result showed that there was no significant difference in the correct answers in the pre-test and post-test, and it was concluded that the questions in the pre-test and post-test were of the same level of difficulty. After confirming it, we could start testing the hypotheses.

The results of the descriptive statistics were tabulated, and the data of intention and performance were calculated by subtracting the pre-test from the post-test.

Table 14. Descriptive statistics results

Group	n	Time distortion		Immersion		Enjoyment	
		Mean	SD	Mean	SD	Mean	SD
Game	258	3.38	.71	3.46	.74	3.84	.69
Competition	132	3.42	.77	3.44	.69	3.88	.69
No Competition	126	3.33	.64	3.48	.78	3.80	.69
No Game	140	3.14	.68	3.52	.87	3.56	.73

Group	n	Intention to learn		Performance	
		Mean	SD	Mean	SD
Game	258	.01	.96	1.65	1.66
Competition	132	.23	.97	1.65	1.67
No Competition	126	-.23	.89	1.65	1.66
No Game	140	.18	.95	1.63	1.69

The data were then analyzed using a 2-level nested design MANOVA. In the model, the game and the competition related feature variables were considered fixed effects because they were only available in two states: yes and no; participants and video contents were also included in the model, being considered random effects because they were not fully exhaustive. We thought that the differences between

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individuals should be recorded in the variables of the multivariate analysis of variance instead of being put uniformly in the error items, so the item named "Participant" could be seen in the result of our MANOVA. Also, due to participants' differences taking away almost all of the model's error, the model's error term was almost zero. We recalculated the error in the model, and found that the actual differences in the model were individual differences, so the F-values of the MANOVA results were all the mean squares of each item divided by the mean square of participant. MANOVA result indicated statistically significant differences in game on time distortion ($F(1,196) = 5.20$, $p_{one\text{-}tailed} = .01$), on enjoyment ($F(1,196) = 7.13$, $p_{one\text{-}tailed} < .01$), and on intention ($F(1,196) = 2.41$, $p_{one\text{-}tailed} = .06$). As to competition related feature, the MANOVA results showed significant difference only on intention ($F(1,196) = 12.67$, $p_{one\text{-}tailed} < .01$).

Table 15. MANOVA results of model (*p one-tailed*)

Source	df	Immersion				Time distortion			
		SS	MS	F	*p*	SS	MS	F	*p*
Game	1	.33	.33	.54	.23	5.15	5.15	10.47	.01
Competition	1	.10	.10	.17	.34	.48	.48	.97	.17
Error	395	243.59	.62			194.14	.49		
Total	397	244.03				199.80			

Source	df	Enjoyment			
		SS	MS	F	*p*
Game	1	7.08	7.08	14.30	.00
Competition	1	.47	.47	.94	.17
Error	395	195.63	.50		
Total	397	203.23			

Source	df	Intention to learn				Performance			
		SS	MS	F	*p*	SS	MS	F	*p*
Game	1	2.65	2.65	2.41	.06	.05	.05	.01	.19
Competition	1	13.94	13.94	12.67	.000	.00	.00	.00	.50
Topic	1	4.65	4.65	4.23	.02	30.40	30.40	9.10	.001
Participant	196	211.08	1.10	1.66	.000	654.29	3.34	1.58	.000
Error	198	130.85	.66			420.60	2.12		
Total	397	363.17				1105.34			

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Then the study examined univariate effects (ANOVA). No significant difference presented between game and immersion (M_{game}= 3.46, SD_{game}= .74 vs. $M_{no\text{-}game}$ = 3.52, $SD_{no\text{-}game}$= .87; F(1,396) = .55, MSe = .62, $p_{one\text{-}tailed}$= *.23*), which didn't support the H1a and indicated that the inclusion of games didn't have much to do with learners' immersion. There was a significant difference existed for game on time distortion (M_{game}= 3.38, SD_{game}= .71 vs. $M_{no\text{-}game}$ = 3.14, $SD_{no\text{-}game}$= .68; F(1,396) = 10.56, MSe = .49, $p_{one\text{-}tailed}$< *.01*), which meant the time distortion experienced by the group that played the game was significantly higher than the group that did not play the game. Our H1b was supported. Besides, a significant effect of game on enjoyment was found (M_{game}= 3.84, SD_{game}= .69 vs. $M_{no\text{-}game}$ = 3.56, $SD_{no\text{-}game}$= .73; F(1,396) = 14.41, MSe = .50, $p_{one\text{-}tailed}$< *.01*). Participants in game group felt more enjoyable than the participants in no game group, which supported the H1c. As to intention, even though a significant difference was found, the direction was completely opposite of our assumption (M_{game}= .01, SD_{game}= .96 vs. $M_{no\text{-}game}$= .18, $SD_{no\text{-}game}$= .95; F(1,396) = 2.91, MSe = .91, $p_{one\text{-}tailed}$= *.04*). We hypothesized that games would make people more motivated to learn than no games, but the analysis showed that the no game group was more willing to learn subsequently than the game group, which did not support H2. The result of performance indicated that there was no significant difference between the game and no game groups (M_{game}= 1.65, SD_{game}= 1.66 vs. $M_{no\text{-}game}$ = 1.63, $SD_{no\text{-}game}$= 1.69; F(1,396) = .02, MSe = 2.80, $p_{one\text{-}tailed}$= *.45*).

We then tried to get a clearer picture of the level under the game: the effect of competition and no competition on the dependent variable. There was no significant difference between the competition and no competition groups on immersion (M_{com}=

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3.44, SD_{com}= .69 vs. $M_{no\text{-}com}$ = 3.48, $SD_{no\text{-}com}$= .78; F(1,256) = .19, MSe = .54, $p_{one\text{-}tailed}$= *.33*). So as on time distortion (M_{com}= 3.42, SD_{com}= .77 vs. $M_{no\text{-}com}$ = 3.33, $SD_{no\text{-}com}$= .64; F(1,256) = .94, MSe = .51, $p_{one\text{-}tailed}$= *.17*), enjoyment (M_{com}= 3.88, SD_{com}= .69 vs. $M_{no\text{-}com}$ = 3.80, $SD_{no\text{-}com}$= .69; F(1,256) = .98, MSe = .48, $p_{one\text{-}tailed}$= *.16*), and performance (M_{com}= 1.65, SD_{com}= 1.67 vs. $M_{no\text{-}com}$ = 1.65, $SD_{no\text{-}com}$= 1.66; F(1,256) = .00, MSe = 2.77, $p_{one\text{-}tailed}$= *.50*). All of the above ANOVA results for competition related feature indicated that the presence or absence of competition related feature didn't significantly influence learners' flow states and their academic performance. The game itself could bring the flow states, not necessarily the effect of the competition. In this study, the only dependent variable impacted by competition was intention to learn. The group with competition was more likely to improve their intention to learn than the group without competition, and this finding was statistically significant (M_{com}= .23, SD_{com}= .97 vs. $M_{no\text{-}com}$= -.23, $SD_{no\text{-}com}$= .89; F(1,256) = 16.07, MSe = .87, $p_{one\text{-}tailed}$< *.01*). The result of competition related feature on intention to learn supported our H5.

In the case of games, the direction of intention to learn was totally against our expectation. We found that the results of competition and no competition groups on intention to learn were polarized under the game group, and we believed that the reason why the intention to learn of the game group was lower than that of the no game group was because the no competition group completely canceled out the effect. Thus, we conducted a pairwise comparison of the competition group, no competition group, and no game group. The ANOVA told that there was a significant difference between at least one pair of groups (F(2,395)=9.45, *p=.000*). However, we did not find a significant difference between the competition group and the no game group

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(M_{com}= .23, SD_{com}= .97 vs. $M_{no\text{-}game}$= .18, $SD_{no\text{-}game}$= .95; $p_{one\text{-}tailed}$= *.31*); instead, the effect of no competition was very large, and a statistically significant difference was found between the no competition group and the no game group as well ($M_{no\text{-}com}$= -.23, SD_{com}= .95 vs. $M_{no\text{-}game}$= .18, $SD_{no\text{-}game}$= .95; $p_{one\text{-}tailed}$= *.00*). Therefore, it is concluded that the absence of competition in a game decreased learners' intention to learn compared to the absence of a game, so the game still had its effect, but it would be necessary to include the competition element in order to have a better intention to learn.

To examine our H7 as well as H8, we used linear regression modeling since flow states with intention to learn and learning performance were continuous variables. The results showed that flow was a significant predictor of learners' intention to learn (β = *.18,* $p_{one\text{-}tailed}$= *.03*), but not of learners' performance (β = *.09*, $p_{one\text{-}tailed}$= *.30*), which supported our H7 but not H8. Based on the results of regression analysis, we learned that the flow states affected learners' willingness to learn, but it was less likely to result in an increase in academic performance.

4.3 Test of the Mediation Effect

As flow had no significant effect on learning performance, our mediation effect only needed to be checked whether the game design affected the intention to learn through the path of flow. We would like to confirm whether there was a mediation effect through flow in the game, the competition related feature and intention to learn. Following the basic steps suggested by Baron and Kenny (1986), we also utilized the regression model to observe the effect between the two independent variables, game and competition related feature, and the intention to learn. Game (no-game= 0, game= 1) and competition related feature (no-competition= 0, competition= 1) were

doi:10.6342/NTU202402931

coded as dummy variables for regression. Consistent with the MANOVA results, the results of the regression analysis showed that both game and competition related feature were predictors of intention to learn. A significant direct effect has been found of game on intention to learn (β = *-.41*, $p_{one\text{-}tailed}$< *.01*), and so as competition related feature on intention to learn (β = *.47*, $p_{one\text{-}tailed}$< *.01*).

The second step then examined the effects between the independent variables (game and competition related feature) and the mediator (flow), and found that the regression model was significant, representing a predictive ability (F(2, 395)=9.45, *p*<*.01*). The effect of game was significant (β = *.13*, $p_{one\text{-}tailed}$= *.03*), while the effect of competition related feature was not (β = *.04*, $p_{one\text{-}tailed}$= *.24*). After controlling flow as the mediator, game significantly influenced intention to learn (β= *-.43*, $p_{one\text{-}tailed}$< *.01*), and also competition related feature had a significant predictive effect on intention to learn (β= *.46*, $p_{one\text{-}tailed}$< *.01*). The relationship between game, competition related feature and intention to learn remained significant, but a slight decrease in the coefficients of the two variables can be found. However, the decrease in the coefficients was too subtle, in order to ascertain that the two independent variables, game and competition related feature, did have an impact on the intention to learn through the flow states, which meant that the flow states mediated the effect in the model, we then performed the Sobel test.

After calculation, the Sobel test z-value for game was 1.47 (*p=0.07*), while the z-value for competition related feature was 0.68 (*p=.25*), which represented that when the game function could generate flow, there was no need to enhance the intention to learn through competition related feature, and the game function would affect the intention to learn through the mediation effect of flow states. Based on the

doi:10.6342/NTU202402931

results of the Sobel test, we knew that flow had partial mediation effects, and the effects only appeared in the design of the game, and the existence of competition related feature was not affected by the indirect effects.

Table 16. The mediation effect of flow

	Intention to learn			Intention to learn			Flow		
	β	T	*p*	*β*	T	*p*	*β*	T	*p*
Game	-.41	-3.55	<.*01*	-.43	-3.77	<.*01*	.13	2.18	.*03*
Competition	.47	3.99	<.*01*	.46	3.93	<.*01*	.04	.72	.*48*
Flow				.19	2.00	.*05*			
R squared		.05			.06			.01	
	Total effect			Direct effect			Indirect effect		
Game	-.41			-.43			.02		
Competition	.47			.46			.01		
Test of the mediation effect (Sobel test)									
Game							1.47	.*07*	
Competition							.68	.*25*	

In order to present a clearer understanding of whether the hypotheses were supported or not, we had organized it in a table.

Table 17. Overall results of hypotheses

Hypothesis	IV	DV	Supported
H1a (+)	Game	Immersion	no
H1b (+)	Game	Time distortion	yes
H1c (+)	Game	Enjoyment	yes
H2 (+)	Game	Intention to learn	no
H3 (+)	Game	Performance	no
H4a (+)	Competition	Immersion	no
H4b (+)	Competition	Time distortion	no
H4c (+)	Competition	Enjoyment	no
H5 (+)	Competition	Intention to learn	yes
H6 (+)	Competition	Performance	no
H7 (+)	Flow	Intention to learn	yes
H8 (+)	Flow	Performance	no
H9	Game+ Flow	Intention to learn	yes
H10	Game+ Flow	Performance	no
H11	Competition+ Flow	Intention to learn	no
H12	Competition+ Flow	Performance	no

doi:10.6342/NTU202402931

Chapter 5 Conclusion

5.1 Conclusion and Implications

As modern learning patterns have been changed by epidemics and technology, how to create a more engaging learning environment and how to enhance learners' intention to learn has become an important issue. Through the inclusion of games and competitions, learners are able to gain knowledge through entertainment. According to our empirical results, the inclusion of games allowed learners to lose the ability to perceive time (H1b) and gained a sense of enjoyment (H1c) while learning. Nevertheless, the appearance of flow state was not significantly affected by the addition of competitions. The competition feature with the confrontation mode did not have much effect in this experiment. This suggested that the use of games in the learning environment was more helpful than the use of competitions in order to keep learners more focused on the learning process.

We believed that the insignificant relationship between the immersion dimension of flow state and the game might be due to the fact that the duration of the game and the whole learning process were too short and too hasty, resulting in the learners not being able to forget about the environment and to fully enter the learning atmosphere within 5 to 10 minutes. Moreover, because the learners were playing the game on a class basis, the influence of peers might be greater than the effect brought by the game itself, which made it not easy to be immersed in learning and gaming. The absence of significant differences in learning performance was also explained by the fact that the learning period was quite brief, and the experiment was not a

doi:10.6342/NTU202402931

long-term survey, so it was difficult for immediate learning and immediate feedback to vary with the addition of a game and a competition.

What was less expected was that the addition of the game made the learning intention lower. When we explored the competition related feature under the level of game, we found that it might be the fact that the total value of the game group was the average of the competition and no competition groups, and the negative effect of the no competition group made the effect of competition group completely counteracted, ending up the effect of the game in the intention to learn being lower than that of the group without the game. We then delved deeper into the question of whether or not the existence of competition related feature in the game would lead to an increase in learning intention, the results of the analysis revealed that the involvement of competition related feature did have a significant positive effect on the intention to learn (H5). Participants who were assigned to the competition group were more serious about learning because they wanted to beat their peers or they just simply didn't want to lose. As they put more effort on the learning content, they would find the learning content interesting and be interested in further learning.

We mentioned the distraction caused by games earlier. Based on the results of the intention to learn, we found that this was especially obvious in the no competition group of the game. We previously supposed that the competition group emphasizing on performance would cause learners to be stressful and reject learning, but in fact, the intention to learn decreased after the activity in the no competition group. We suggested that the lack of emphasis on individual performance in the no competition group might have caused learners to believe that they didn't need to achieve good academic performance, which led to the same findings as Snow et al. (2015), where

doi:10.6342/NTU202402931

learners were distracted by the game design instead of focusing on the content. That is to say, if instructors want learners to maintain or even improve their intentions to learn after learning, it is a good and effective way to put appropriate emphasis on academic performance and to use the ranking or competition features to motivate learners. After all, a purely game-only design could lead to inattention.

On the other hand, we could find that the flow states positively affected learners' intentions to learn. When learners have a good, pleasant learning experience, they are more likely to want to continue learning later because of the focus and enjoyment they feel during the learning experience. We examined the mediation effect of flow states and found that when the game didn't activate flow, the competition function must be present in the game, otherwise there would be no competition group leading to a decrease in learners' intention to learn. When the game affected the intention to learn by activating the flow path, the inclusion of the competition was not so important. Therefore, it is meaningful to generate flow states in learning, and flow can be generated by playing simple games, such as the quiz game with sound and animation in our experiment.

5.2 Limitations and Future research

One of the major limitations of this experiment was that the sample was restricted to a single population, namely high school students. We cannot be completely sure that the results would be applicable to the nation's population, since high school students represent a very small portion of the population. As well as the fact that students are easily influenced by their peers (Hallinan & Williams, 1990), it is possible that classroom-based experimental assignments may inherently cause students' willingness to learn in groups.

doi:10.6342/NTU202402931

Second, there were also some flaws in the study that could be improved. While it is undeniable that the group allocation in this experiment was random, the three conditions in this experiment were randomly assigned on a class basis rather than randomly on an individual basis. Therefore, the results and conclusions of the experimental hypotheses may be varied due to class differences. In addition, participants were asked to watch two videos in the experiment, and the order in which the videos were shown might also cause errors in the experiment (McGrath et al., 2010). In the experiment, the Egypt video was played first and then the coffee video was played, without adjusting the order of the videos, which may cause order effect bias in the results of the study. Since the game tool we used, Kahoot!, has a countdown function, we couldn't be sure whether the countdown mechanism really made learners feel that "time flies" or tended to put "time pressure" on learners.

In order to ensure that participants did not skip any step and any video, the experiment was conducted in a way that the researcher was on-site with the participants telling them what to do afterwards. Although this guaranteed that the participants could follow every procedure in the research design, it also deprived the participants of the opportunity to control and learn independently. If this study is to be expanded in the future, consideration could be given to designing the experiment in a way that is more consistent with self-directed learning.

As mentioned in the previous section, we believed that the insignificance of the experiment was probably caused by the rush of time in which the learners ended the study before they could enter into the flow state, and it is difficult to see the differentiation of learners in a short period of time. Therefore, by extending the

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duration of the experiment and the time of observation, we may be able to see more clearly the effect of the differences in the learning environment on the learners.

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Appendix A

變項	中文題項
心流	1. 進行此遊戲時，經常不知不覺中，時間就過去了。 2. 進行此遊戲時，有些時候我會失去時間感。 3. 進行此遊戲時，我覺得時間飛逝。 4. 進行此遊戲的活動經常耗費比我原先預計的時間更多。 5. 我進行此遊戲的時間，比我打算的多。 6. 進行此遊戲時，我能心無旁騖。 7. 進行此遊戲時，我全神貫注於網站中。 8. 進行此遊戲時，我專心正在執行的任務。 9. 進行此遊戲時，我非常容易被其他事情分心。 10. 進行此遊戲時，我的注意力不容易被分散。 11. 本次遊戲體驗讓我很快樂。 12. 本次遊戲體驗帶給我很大的愉悅。 13. 本次遊戲體驗是一種享受。 14. 本次遊戲體驗使我感到厭煩。
學習 意圖	1. 你多有可能考慮學習【埃及旅遊知識】? 2. 你多有可能考慮學習【咖啡知識】?

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