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A Longitudinal Study on Students' Foreign Language Anxiety and Cognitive Load in Gamified Classes of Higher Education

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Abstract: Using gamification as an instructional intervention to manage students' learning emotions has become a trending topic. Meanwhile, the cognitive load resulting from gamified learning environments may impact learning emotions negatively. In order to clarify students' foreign language anxiety and cognitive load in a gamified English as a foreign language class, this study designed a gamified flipped learning context in a Chinese university and conducted five surveys, three semi-structured interviews, and consecutive in-class observation in 15 sessions. This study has the following findings: First, neither the foreign language anxiety nor the cognitive load of the students changed significantly through the entire course; second, the game elements produced contradictory effects on the students' multiple-sourced foreign language anxiety (communication apprehension, fear of negative evaluation, and lack of self-confidence); third, the introduction of games had transient effects on extraneous cognitive load, and the immersion in games indirectly influenced the intrinsic and germane cognitive load; in addition, foreign language anxiety and cognitive load correlated in a complicated and dynamic manner as a result of diverse gamification factors. These findings are expected to provide useful insights for researchers into the significance of utilizing gamification in emotion management while taking cognitive dimensions into account from both the collective and the individual perspectives.

Keywords: foreign language anxiety (FLA); cognitive load (CL); gamification; English learning; higher education

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1. Introduction

Foreign language anxiety (FLA) is a distinct complex of self-perceptions, beliefs, feelings, and behaviors, related to the uniqueness of the foreign language learning processes [1]. On the one hand, anxiety can impede learners' processing of language stimuli [2], cognitive performance [3], willingness to communicate [4], and learning outcomes in foreign language acquisition [5]. On the other hand, having certain levels of anxiety is likely to motivate and encourage students to deal with new challenges in learning [6,7]. As an optimal level of FLA can be beneficial to language learning, how to manage students' FLA by integrating different tactics or strategies has been drawing an increasing amount of attention from researchers [8–11].

In the past decade, with the development of educational technology, more and more gamified designs based on mobile technology and artificial intelligence have been applied to teaching practice. The potential of applying gamification, using game elements in non-game contexts [12] to regulate learning emotions, such as FLA, has been increasingly explored [13]. It is noteworthy that when gamified education is beneficial in regulating learning emotions, it also potentially impacts students' cognition because students need to call upon cognitive resources to process the game-related information. Then, the change of the students' cognition may affect their learning anxiety levels. The existing research has studied the anxiety levels and cognitive load in the gamified learning environment, respectively, but the interaction between the two has not been fully explored. Whether

the cognitive resources occupied by game-based instructional design increase students' learning pressure or affect learning anxiety is an unknown problem. Moreover, considering that the students' emotions and cognition status are relatively stable [4] and that the impact of a learning environment usually takes time to be effective [14], longitudinal studies about how the two variables vary and how the gamification learning methods take effect over time are limited. In addition, there are studies that have examined the integrated influence of gamification [15], but there are few investigations of how students perceive the influences of specific gamification elements or mechanisms on FLA generated from different sources and CL of different types. Given the aforementioned perspectives, the research questions in this study are proposed below:

1. How do students' FLA and CL in a gamified English course change over time?
2. How do students' FLA and CL influence each other in the gamified learning context over time?
3. How do students perceive the influence of gamification on their FLA and CL?

In order to address the above research questions, this study was conducted in a collaboration-and-competition-driven gamified English as foreign language (EFL) course for 15 weeks. Combining surveys, semi-structured interviews, and in-class observation, this study documents the changes in the multiple-sourced FLA and CL over time and reveals the students' perceptions about the influencing gamification factors. This study is expected to contribute to existing literature by (1) explicating the complex mechanism of the provoking and mitigating effects of gamification on FLA and CL; (2) illustrating the effects over time from both the collective and the individual perspectives with quantitative and qualitative evidence; and (3) elaborating on the interplay between students' learning emotion (FLA) and cognition (CL) in a gamified learning environment.

2. Literature Review

2.1. Managing Foreign Language Anxiety with Gamification

A growing body of literature suggests that gamification can create enjoyable learning experiences [16–18], enhance students' learning motivation and engagement [19–22], and improve academic performance [23–25] when properly designed [26,27]. In the field of language learning, however, studies examining the effectiveness of gamification in managing students' FLA have yielded inconsistent findings. Some researchers have pointed out that, because of its entertaining and dynamic nature [28], gamification may reduce students' FLA by providing less stressful learning environments and enabling students to be more relaxed and confident [29]. For example, [30] developed a game-embedded English pronunciation practice system in which students had less anxiety than their peers in a traditional drill environment. However, in the quasi-experiment of [15], there was no significant difference in FLA levels between students learning in a problem-based English listening game and their counterparts taking conventional instructions. These inconsistent findings about gamification effects on students' FLA can probably be explained by the multidimensional and dynamic features of both FLA [11] and gamification design [26].

Regarding the complicated formation of FLA, it has been investigated from two major perspectives. One is to discover the interrelations between the arousal of FLA and the learners' variables, such as gender [31], language-learning history [32], and language-learning beliefs [8]. The other focuses on anxiety-provoking scenarios in foreign language learning, including interpersonal communication, negative evaluation, classroom interactions, and tests [33]. Studies exploring FLA-regulating strategies should consider the intricate factors that influence FLA and how FLA caused by different variables reacts to regulation in independent and integrative ways.

As for the gamification design, the game elements and mechanisms need to be tailored to the affective needs of students to effectively deal with their FLA [34]. Specifically, as a supportive system with peer recognition and positive feedback alleviates FLA [8], gamified collaboration can likewise reduce FLA levels through ideas such as teamwork and collective honor. Meanwhile, game competition may encourage further learning engagement by

evoking emotions such as anxiety and stress [35]. Moreover, the joint use of collaboration and competition can enhance team cohesion by creating shared goals and can motivate individual contribution by intensifying intragroup competition at the same time [36]. In summary, considering that collaboration and competition have both conflicting and reciprocal effects on students' FLA levels in the context of gamified language learning, how the integration of the two contributes to successful FLA management needs to be further explored.

2.2. Cognitive Load and Anxiety in Gamified Learning Environments

According to the cognitive load theory (CLT), the learners' working memories can process a limited amount of information at one time, and learning will be adversely affected when their processing capacity is overloaded [37]. Specifically, there are three types of CL in this theory; these are intrinsic cognitive load (ICL), germane cognitive load (GCL), and extraneous cognitive load (ECL). Among the three types of CL in this theory, ICL depends on the complexity and difficulty of learning tasks; GCL emerges when students form and regulate mental structures; and ECL results from inappropriate instructional design [38]. The resources of the three types of CL are listed in Table 1. As ECL is not related to learning content and causes additional interactional elements that need to be processed, it should be properly managed by utilizing well-planned teaching materials and instructional interventions [39].

Table 1. Resources of three types of cognitive load.

CL	Resources
ICL	depends on the complexity and difficulty of learning tasks
GCL	emerges when students form and regulate mental structures
ECL	results from inappropriate instructional design

Theoretical and empirical studies both suggest that integrating game factors into instructional design may interfere with students' CL [40,41]. The (highly) interactive and immersive educational games usually require a substantial amount of mental effort in exploring learning-irrelevant gaming environments and processing visual/audio stimuli, inducing more ECL [42]. A number of game mechanisms in education contexts have also been identified as causes of CL. For example, in a competitive gaming environment, students might spare their cognitive resources to figure out how to outperform their peer competitors [43]. Social interactions in game-based learning may also require students' mental effort in knowledge construction when they need to build and maintain interpersonal relationships in learning groups [44].

Within the context of gamified learning environments, students' CL and anxiety levels can theoretically intertwine with each other in the learning process. On the one hand, students' anxiety about stimuli irrelevant to learning tasks, such as competition, could distract them from knowledge construction [45], imposing more CL to compensate for reduced learning efficiency [46]. On the other hand, the overwhelming cognitive processing caused by game factors in learning environments may raise students' anxiety levels and inhibit them from absorbing subsequent inputs [47]. Considering the two-way interactions between CL and anxiety in the gamified learning context and the academic call to investigate the relationship between CL and emotional variables [7], it seems necessary to take CL into account when the effects of gamification on FLA are examined.

3. Method and Materials

This study was conducted in a course entitled "English Listening and Speaking Fall 2020–2021" at a university in southern China. This 15-week course was offered to non-English-major freshmen, aiming to improve their English communicative competencies. This flipped course guided students to engage in a series of weekly pre-class self-learning tasks (40–60 min) and in-class activities (105 min). The students used two smart mobile

applications to complete the pre-class activities—Rain Classroom (listening tasks) and FiF Speaking (speaking tasks). For the in-class part, the students learned by following the teacher's instructions.

3.1. The Collaboration-And-Competition-Driven Gamification Design

Instead of adopting a full-fledged educational video game, this course put in place a set of gamified rules. The game narrative was a magic world where the students, who had their avatars in the game, were to acquire magic skills by gaining English knowledge and winning virtual gems as game points. The gems came in three colours: blue, purple, and red. Specifically, in Rain Classroom, blue and purple gems would be awarded when the students correctly answered basic and advanced questions, respectively, while in FiF Speaking blue gems would be distributed when the tasks were completed, and purple gems corresponded to scores won (see Figure 1). Red gems were given when the students participated in an in-class activity (see Figure 2). All gems were recorded on team-based game ladders (hard copies) by the instructor (pre-class) and students themselves (in class) on a weekly basis (see Figure 3). Based on these records, two class-based game leaderboards (one for teams and the other for individuals) were updated and displayed in each class (on soft copies, see Figures 4 and 5). The winners would receive stationery as game prizes. Gold or silver badges would be awarded to teams once their accumulative points reached the criteria determined as the course proceeded. In order to render a gaming atmosphere, the course materials included game buttons, progress bars, and a non-player character (the teacher) (see Figure 6). All the rules of the game were explained to students in the first class, and a game manual PDF was provided afterwards.

Figure 1. Examples of awarding blue and purple game gems in pre-class activities. The left side of Figure 1 shows listening exercises students performed to gain four blue gems and six purple gems on the platform of Rain Classroom. The right side of Figure 1 shows speaking exercises students performed to gain two blue and six purple gems on the platform of FiF Speaking.

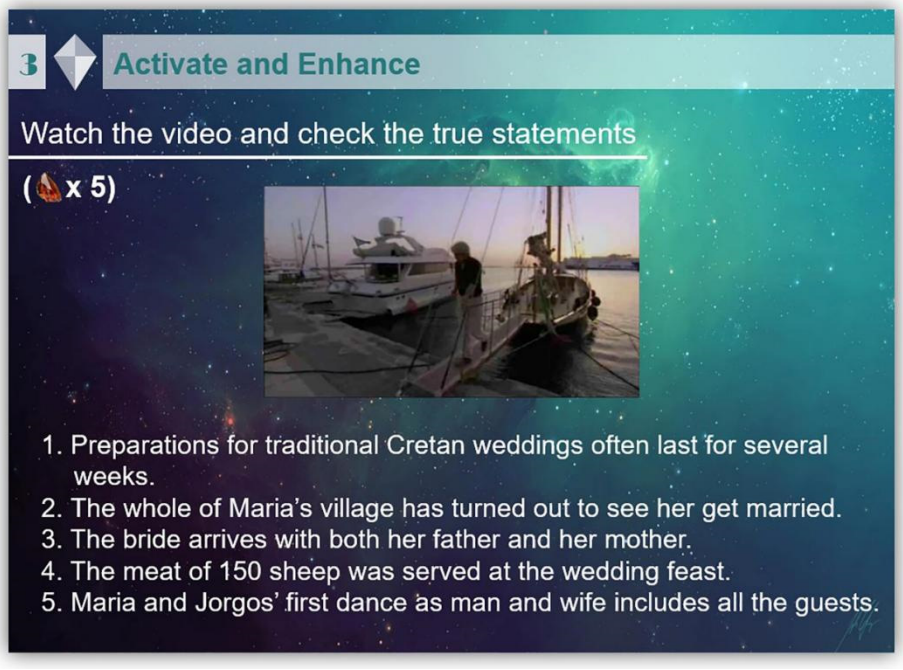


Figure 2. Examples of awarding red game gems in in-class activities. According to the instruction on this picture, students watch a video in class and check the true statements listed in the lower side of the picture based on the video. Students will receive five red gems for correct answers in this game.

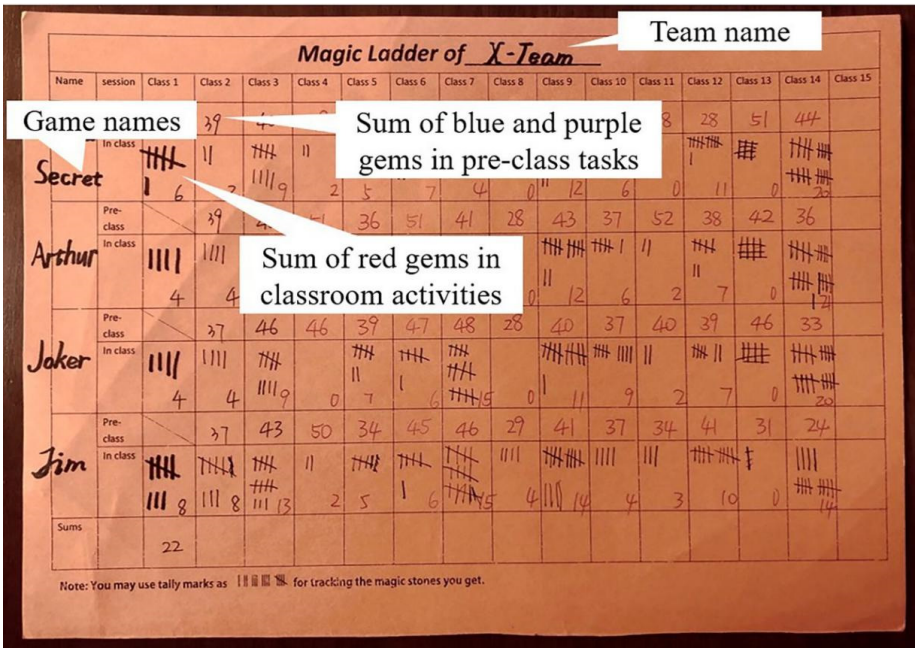


Figure 3. Sample of a team-based game ladder. The ladder consists of team name, students' game names, sum of blue and purple gems in pre-class tasks and sum of red gems in classroom activities in each class. For example, this card belongs to a team whose name is "X-Team", the four players of this team are Secret, Arthur, Joker, and Jim. In class 12, Secret won 28 gems in pre-class tasks and 11 gems in classroom activities; Arthur won 38 and 7, respectively; Joker won 39 and 7, respectively; and Jim won 41 and 10, respectively.

Ranking	week 1	week 2	week 3	week 4	week 5	week 6	week 7	week 8	week 9	week 10	week 11	week 12	week 13	week 14
1st	X-Team	temperament of emperors	X-Team	Green Green Grassland	Green Green Grassland	SUP	Green Green Grassland	hitmen	X-Team	X-Team	Green Green Grassland	hitmen	RNG	Green Green Grassland
2nd	Forgiveness Group	X-Team	SUP	Forgiveness Group	Forgiveness Group	X-Team	X-Team	Forgiveness Group	Gryffindor	hitmen	SKT	X-Team	98K	X-Team
3rd	SUP	Forgiveness Group	Gryffindor	temperament of emperors	X-Team	Green Green Grassland	SKT	Green Green Grassland	Green Green Grassland	98K	X-Team	RNG	Green Green Grassland	98K
4th	RNG	SUP	Forgiveness Group	X-Team	hitmen	Gryffindor	Gryffindor	temperament of emperors	SKT	Green Green Grassland	hitmen	Green Green Grassland	X-Team	hitmen
5th	SKT	Green Green Grassland	hitmen	SUP	SUP	98K	RNG	SUP	hitmen	SUP	98K	Gryffindor	hitmen	RNG
6th	hitmen	RNG	temperament of emperors	98K	SKT	RNG	Forgiveness Group	X-Team	temperament of emperors	Gryffindor	SUP	SUP	SUP	SUP
7th	Green Green Grassland	Gryffindor	Green Green Grassland	hitmen	RNG	SKT	hitmen	RNG	RNG	Forgiveness Group	temperament of emperors	SKT	SKT	SKT
8th	98K	SKT	SKT	Gryffindor	98K	temperament of emperors	SUP	Gryffindor	98K	temperament of emperors	Forgiveness Group	98K	Forgiveness Group	temperament of emperors
9th	Gryffindor	98K	RNG	RNG	Gryffindor	hitmen	temperament of emperors	98K	Forgiveness Group	RNG	Gryffindor	temperament of emperors	temperament of emperors	Forgiveness Group
10th	temperament of emperors	hitmen	98K	SKT	temperament of emperors	Forgiveness Group	98K	SKT	SUP	SKT	RNG	Forgiveness Group	Gryffindor	Gryffindor

Figure 4. Sample of class-based game leaderboard of teams.

Ranking	Group	Members	Red Gems		Blue Gems		Purple Gems		Total
1st	Green Green Grassland	pleasant sheep	16	39	11	64	24	110	213
		Lazy Sheep	10		17		28		
		Wolf Grey	5		18		31		
		Force Sheep	8		18		27		
2nd	X-Team	secret	20	75	17	56	27	81	212
		Arthur	21		14		22		
		Joker	20		11		22		
		Jim	14		14		10		
3rd	98K	Checkmate	8	34	15	59	20	96	189
		shadow	13		18		32		
		Wang Xian	7		9		11		
		Yang Qing	6		17		33		
4th	hitmen	Edgar	9	26	11	61	14	99	186
		Pluto	7		18		32		
		Sam	10		16		27		
		Yu	0		16		26		
4th	RNG	HongweiDeng	5	20	17	64	22	102	186
		Maia	5		15		21		
		antarc	4		16		31		
		Pablo	6		16		28		
6th	SUP	heyufan	15	55	18	44	27	71	170
		Jason	14		12		16		
		zone	13		0		0		
		Sheep	13		14		28		
7th	SKT	Rock	11	41	14	46	17	64	151
		Bangi	11		14		19		
		Faker	10		14		22		
		Lahm	9		4		6		
8th	temperament of emperors	mushroom hunter	7	36	17	46	31	64	146
		Claire	14		11		7		
		Sunny	8		18		26		
		YANG	7		0		0		
9th	Forgiveness Group	Carbon Dioxide	5	27	9	36	16	56	119
		Violet	8		12		22		
		Actually	9		9		16		
		Geraldine	5		6		2		
10th	Gryffindor	Mark	4	20	13	39	18	50	109
		Azure	4		16		25		
		Tom	4		8		7		
		Amber	8		2		0		

Figure 5. Sample of class-based game leaderboard of individuals (week 14).

Figure 6. Sample of game elements: buttons, progress bars, and a non-player character.

In this gamified course, the students formed teams of four of their choice and named their teams in the first class. Collective honour was gained based on team leaderboard rankings determined by all four players' aggregated gems. In addition to working on pre-class assignments individually, the students participated in in-class activities as teams to contribute to team achievement. For example, the students were asked to work in teams outlining the details of an invitation and then go out separately and invite as many guests as possible in a speaking task on "wedding invitation". Gems were awarded for both successfully inviting and being invited. Figure 7 shows a sample worksheet that guides students through the two-phase tasks, and Figure 8 illustrates the collaborative learning within and outside the teams.

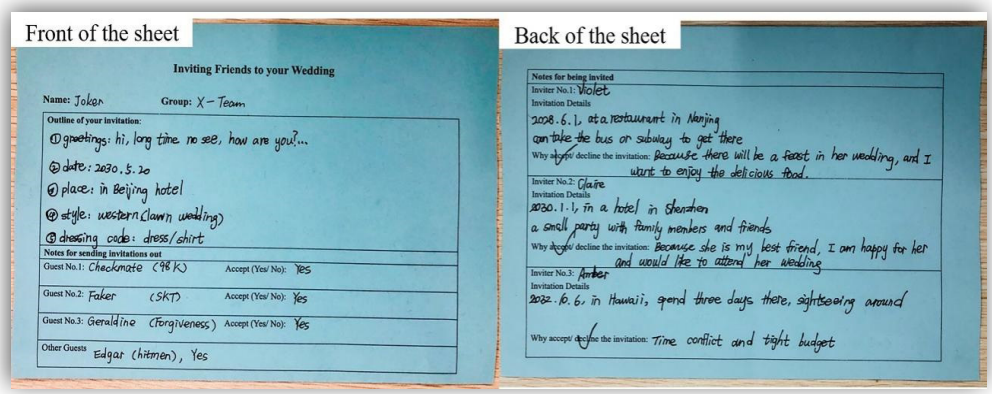


Figure 7. Sample of "wedding invitation" worksheet.

Figure 8. Students completing tasks in cooperation within and outside teams.

3.2. Participants

Thirty-seven out of forty students taking the course participated in the first survey voluntarily in week 1, after signing the consent form that explained the research aims, the independence of the course grade from participation, withdrawing rights, and participation compensation (RMB 5 per survey and RMB 50 per interview). Based on the first survey results, 12 participants with different FLA levels were invited to participate in the interviews and in-class observation. Five participants dropped out over the course of this multiple-round study. In the end, data collection was completed among the 32 survey participants (male = 25, female = 7) and ten interview and in-class observation participants (male = 7, female = 3). The demographic information of the two groups of participants is illustrated in Tables 2 and 3.

Table 2. Demographic information of the survey participants.

Survey	N	Gender	N	Major *	N
Survey-1	37	Male	29	MATH	18
		Female	8	EE	19
Survey-2	35	Male	28	MATH	18
		Female	7	EE	17
Survey-3	35	Male	28	MATH	18
		Female	7	EE	17
Survey-4	34	Male	27	MATH	18
		Female	7	EE	16
Survey-5	32	Male	25	MATH	17
		Female	7	EE	15

Note: * MATH is the abbreviation for Mathematics, and EE for Electronics and Information Engineering.

Table 3. Demographic information of participants in the interviews and in-class observation.

Label	Gender	Major	FLA Level	Major FLA Sources *
I-1	Male	EE	1.79	FNE
I-2	Male	MATH	1.96	FNE
I-3	Male	MATH	2.79	CA/FNE
I-4	Female	MATH	2.79	CA/FNE/LCE
I-5	Male	MATH	3.14	CA/FNE/LCE
I-6	Female	EE	4	FNE/CA
I-7	Male	EE	4.04	FNE/LCE
I-8	Female	EE	4.11	CA/FNE/LCE
I-9	Male	EE	4.25	CA
I-10	Male	MATH	4.29	CA/FNE/LCE

Note: * CA is the abbreviation for "communication apprehension", FNE is for "fear of negative evaluation", and LCE is for "lack of confidence in English".

3.3. Data Collection

This study employed five rounds of surveys, three rounds of interviews, and 15 in-class observation sessions throughout an entire semester, as shown in Figure 9.

The five surveys were delivered to participants through the online survey website (https://www.wjx.cn/) (accessed from September 2020 to January 2021) in Chinese. The five surveys were identical in question items and were based on the Foreign Language Classroom Anxiety Scale (FLCAS) [1] and the Cognitive Load Scale (CLS) [48], except for survey-1, which contained extra questions about demographics. Among the 38 items of the surveys, 28 were related to FLCAS and 10 to CLS. The surveys used a five-point Likert scale, with "1" representing the lowest level and "5" the highest. Table 4 demonstrates the Cronbach's α of the FLCAS questions and CLS questions in the five rounds. All reliability values ranged between 0.79 and 0.96, which surpassed the recommended threshold value of 0.7 [49] and indicated a strong internal consistency. Additionally, a principal factor analyses with varimax rotation revealed a KMO value of 0.6 ($p < 0.001$) and 0.7 ($p < 0.001$), respectively, in the questions of the FLCAS and CLS, indicating their validity in this study.

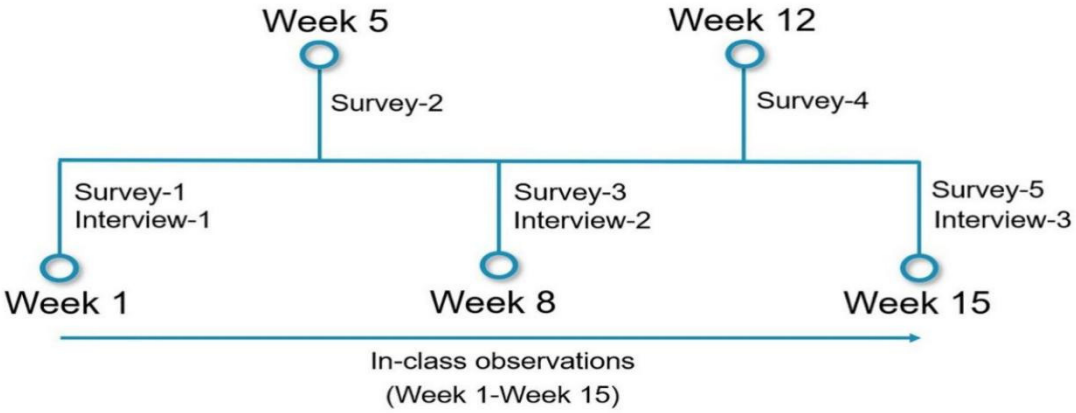


Figure 9. Timeline of data collection.

Table 4. Cronbach's α of FLCAS and CLS over time.

	Survey-1		**Survey-2**		**Survey-3**		**Survey-4**		**Survey-5**	
	F1 *	C1 **	F2	C2	F3	C3	F4	C4	F5	C5
Cronbach's α	0.96	0.86	0.96	0.80	0.95	0.79	0.95	0.86	0.95	0.82

Note: * F: FLCAS, ** C: CLS.

The three interviews were scheduled with ten participants individually and conducted offline in Chinese. Each interview lasted 30–40 min and was audio recorded. The three interview rounds asked similar questions with different focuses. The first one focused on the students' initial levels of FLA and CL, the sources of FLA, and attitudes towards gamification design in this course. Example questions of the first interview included: "How do you perceive the difficulty of this class?" and "Do you have difficulty understanding the teacher's explanation of activity rules?" The second and final interviews paid attention to the participants' changed or unchanged perceptions over time and the reasons. Example questions of the second and third interviews included: "How do you perceive the difficulty of learning tasks in this class now?", "Are there any differences about your perceptions about learning in this class between a few weeks ago and now?", and "How do you think the game design influence they way you complete learning tasks?"

The fifteen in-class observations were implemented throughout the entire course to supplement the interview and survey findings as data triangulation. Two of the authors of this article observed the class as teaching assistants to reduce the interference of their presence to the students. Field notes regarding the ten interviewed participants' facial expressions, body language, verbal expressions, and interactions with others were taken in detail.

3.4. Data Analysis

The quantitative and qualitative data of this study were processed separately. The quantitative data, i.e., the survey results, were analyzed by SPSS 26. After adjusting the data of five reversely stated items, a descriptive statistical analysis was carried out to illustrate the distribution of the participants' FLA and CL levels. Then, because the Shapiro–Wilk test showed that the FLA data followed a normal distribution, but the three types of CL did not, an ANOVA analysis was performed to identify changes in FLA, while a nonparametric Friedman test was employed to examine changes in CL [50]. Afterwards, a Spearman analysis was conducted to explore the relationship between FLA and the three types of CL in each of the five surveys.

The qualitative data consist of the interview results and the in-class observation notes. First, a total of 1050 min of interview recordings was transcribed verbatim. Then, content analysis was conducted by reading the interview transcripts and the observation field notes repeatedly to extract the relevant codes within and across the cases, with the guidance of

the research questions [51]. The codes within the individual cases were compared to detect changes over time, while cross-case comparisons were conducted to discover individual differences. The identified codes were checked and revised by the authors collectively until the data were saturated.

4. Results

4.1. Quantitative Results of CL and FLA over Time

Figure 10 demonstrates the mean and standard deviations of the 32 participants' FLA in the five survey rounds. The mean of the FLA started at its highest value of 2.92 and dropped to the lowest value of 2.76 in week 5, followed by a continuous increase until week 12, and finally a decline. The one-way repeated ANOVA results of the five survey rounds showed df = 4, F = 0.262, and p = 0.902, indicating there was no significant change in the students' FLA as the classes proceeded, because the p value is larger than 0.05. At the individual levels, multiple variation patterns were identified from the data of ten interviewees (see Figure 11).

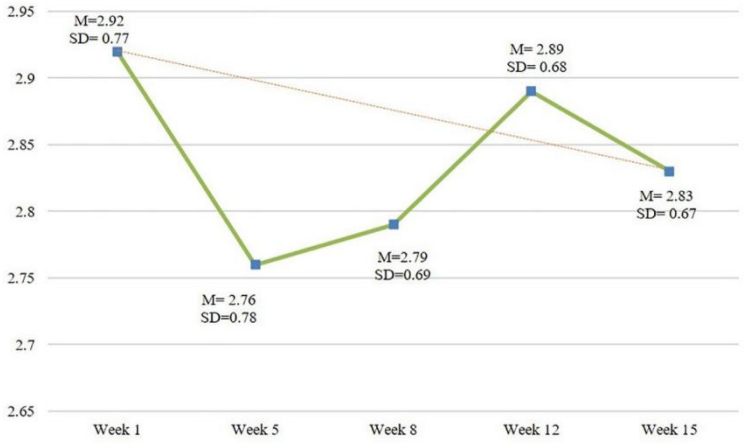


Figure 10. Students' FLA over time.

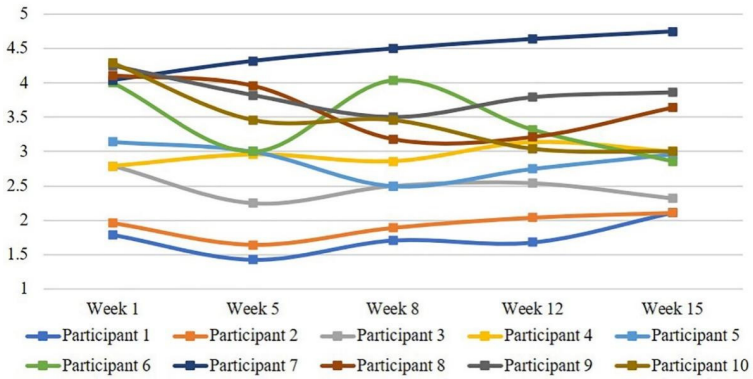


Figure 11. Ten interview participants' FLA over time.

The descriptive statistics of the three CL types in all the survey rounds are illustrated in Figure 12. The Friedman test results of the five rounds show that the p values for GCL, ICL, and ECL are 0.406, 0.09, and 0.27, respectively, which are all bigger than 0.05, meaning that each CL type did not change significantly over time. The fluctuation patterns of the three CL types among the ten interviewees are displayed, respectively, in Figure 13.

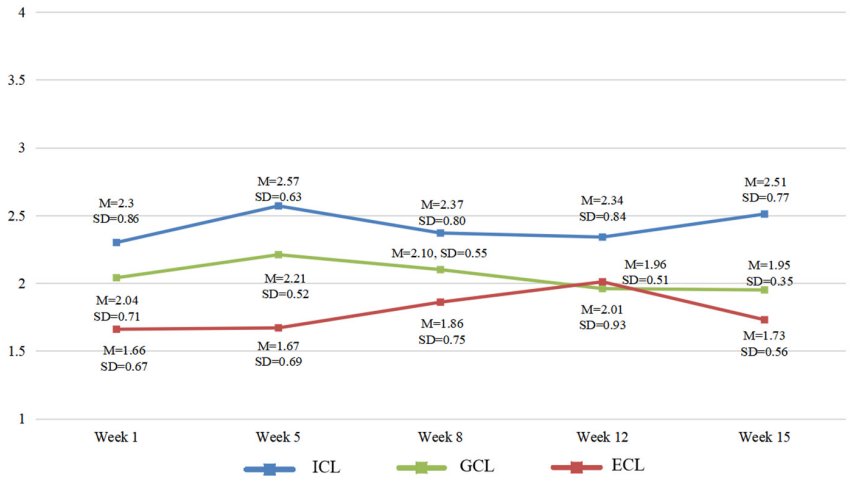
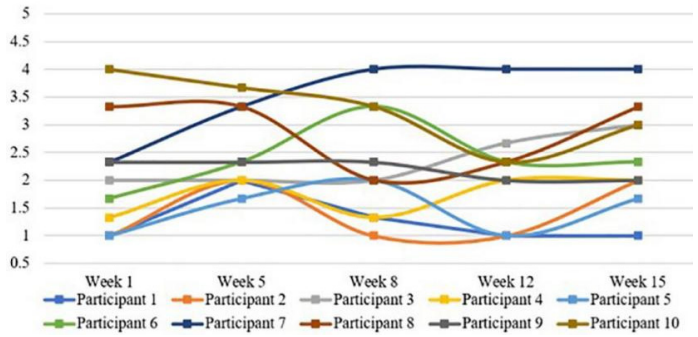
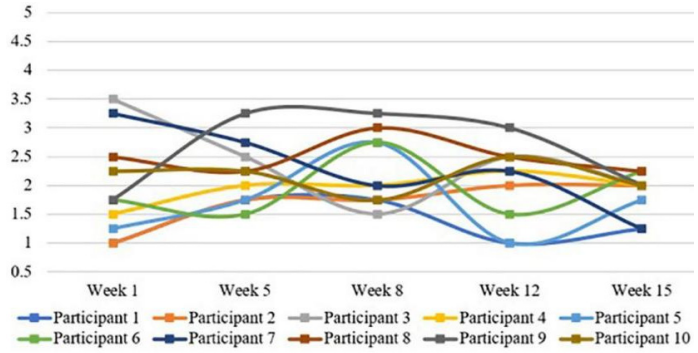


Figure 12. Students' three types of CL over time.



(**a**)



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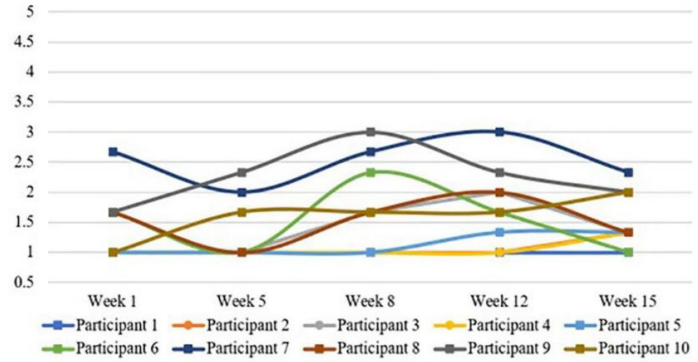

(**c**)

Figure 13. Ten interview participants' three types of CL over time: (**a**) ICL, (**b**) GCL, (**c**) ECL.

Spearman correlation analysis results demonstrate that the students' FLA is positively correlated with ICL in all five surveys as the five Spearman values are all significant statistically, as 0.512, 0.540, 0.769, 0.508, and 0.361, with the five p values lower than 0.05. As for the other two types of CL, FLA is positively related to GCL in survey-1 (0.517, $p < 0.05$), -2 (0.462, $p < 0.05$), and -3 (0.416, $p < 0.05$) and to ECL in survey-1 (0.395, $p < 0.05$), -3 (0.509, $p < 0.05$), and -4 (0.366, $p < 0.05$) (see Table 5 and Figure 14).

Table 5. Correlation between the students' FLA and the three types of CL.

	Survey-1		Survey-2		Survey-3		Survey-4		Survey-5	
	Spearman	**Sig.**	**Spearman**	**Sig.**	**Spearman**	**Sig.**	**Spearman**	**Sig.**	**Spearman**	**Sig.**
FLA-ICL	0.512 *	0.003	0.540 *	0.001	0.769 *	0.000	0.508 *	0.003	0.361 *	0.042
FLA-GCL	0.517 *	0.002	0.462 *	0.008	0.416 *	0.018	0.224	0.218	0.055	0.765
FLA-ECL	0.395 *	0.025	0.282	0.118	0.509 *	0.003	0.366 *	0.039	0.244	0.178

Notes: * indicates statistical significance at a $p < 0.05$ (two-tailed).

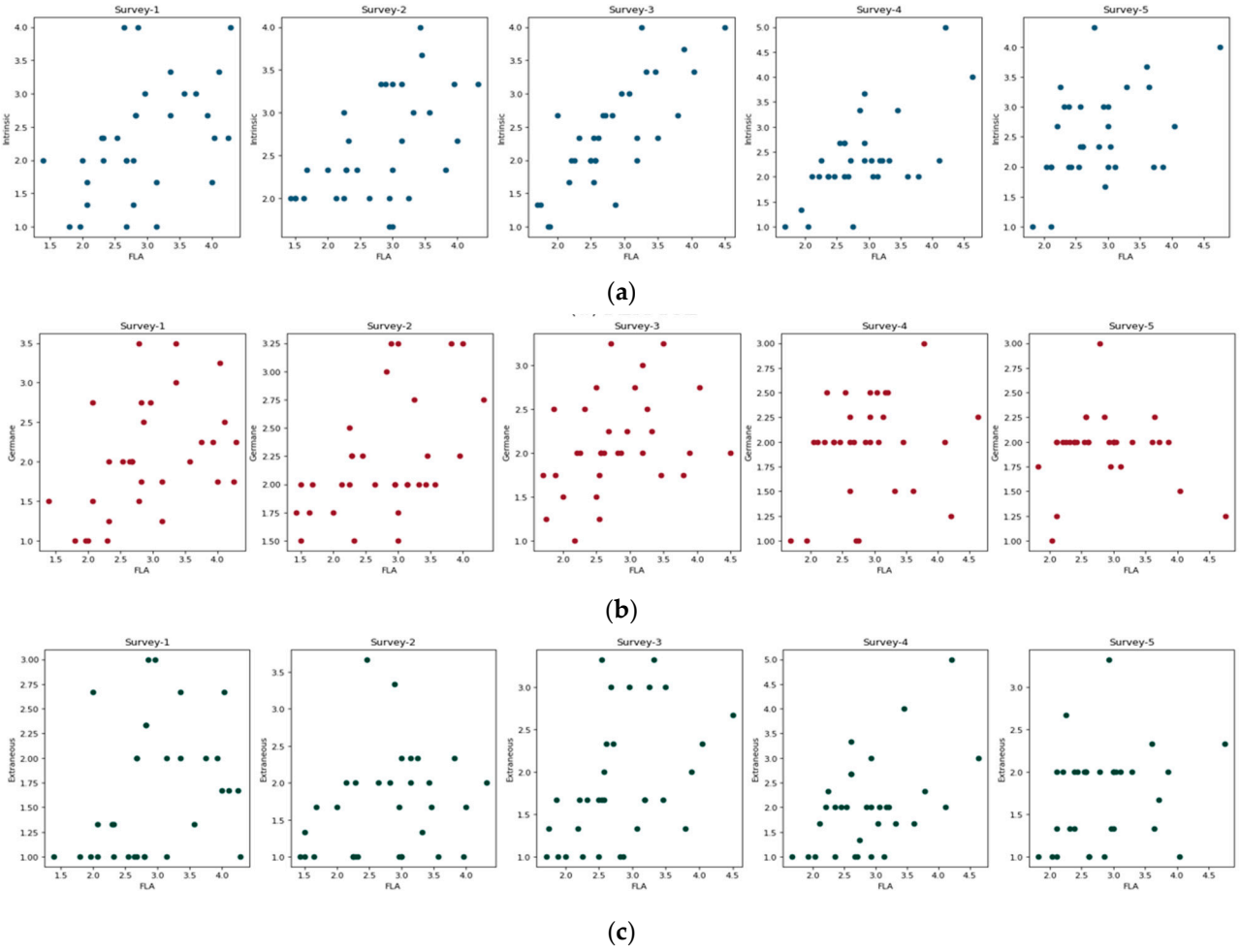

Figure 14. Graphical illustration of correlation between FLA and CL: (**a**) FLA-ICL, (**b**) FLA-GCL, (**c**) FLA-ECL.

4.2. Qualitative Findings of Gamification Influences

4.2.1. Influences of Gamification on Multiple-Sourced FLA

The qualitative data identified that the students had three types of FLA sources in this study; these were communication apprehension, negative evaluation, and lack of confidence in English. Communication apprehension was identified in seven interviewees (I-3, 4, 5, 6, 8, 9, and 10), who reported difficulties in and were observed to be uncomfortable

with public speaking and communicating with others. All the interviewees except I-9 reported different levels of worries about negative evaluation from the teacher or their classmates. I-4, 5, 7, 8, and 10 experienced FLA about lacking confidence in their English abilities. The collected perceptions of the gamification influences are organized based on these FLA sources.

First, the game settings gradually mitigated anxiety related to communication apprehension through distraction. For example, I-5 and I-10 became more active as the classes proceeded (class observation sessions 3–6), and they attributed their transformation to the game-like atmosphere created by the magic world settings in which "the desire of collecting gems beat the nervousness about public English-speaking" (I-10, interview-2) and "earning gems became the priority" (I-5, interview-2). As initiating conversations with other students was packaged as game tasks with magic gems as rewards, some students reported that they overcame the fear of communication because of the sense of reciprocity. This can be illustrated by the case of I-8, who was too shy to practice with others at the beginning (interview-1 and class observation sessions 1–4). Later, however, as she realized that collecting gems was a "common goal" of the class, she felt it was like "players helping each other" and was more willing to participate in these mutually beneficial activities (interview-2).

However, the data show that the "magic" of the game gems did not effectively reduce everyone's anxiety. For the interviewees who struggled with severe anxiety about interpersonal communication, the competitive gem collection tasks worsened their learning experience. I-9 described himself as an "introvert" and "extremely embarrassed when talking with unfamiliar people in any language" (interview-1) and viewed the competition as an "anxiety enhancer" as "it generated more worries" (interview-3).

Second, gamification alleviated anxiety related to negative evaluation through the euphemistic reinforcement system emphasizing positive feedback and class rapport, and the effect emerged a few weeks into the course. For example, I-8 reported declining anxiety about criticism as she saw the positivity brought by constant rewards (interview-2 and -3). Although they "understood that the gems were not essentially different from grades" (I-7, interview-1), the interviewees acknowledged that the gamified measurement softened the conventional grading system. In addition, the avatars helped to allay worries about being judged negatively. For example, I-4 was happy about the relative anonymity: "I was more comfortable when being addressed by Violet (her avatar) since others might not have realized it was me when I didn't do well" (interview-1). I-7 felt less affected than he otherwise would have been by others' unfavorable comments, which were delivered to "Maia", his favorite character from a novel and his avatar in his favorite video game (interview-1).

Meanwhile, the game leaderboards worsened the fear of negative evaluation and enhanced the competitive atmosphere for some students. For example, I-5, I-6, I-8, and I-10 became increasingly concerned about their performance in pre-class tasks as they did not want to be "a burden of the team" (interview-2). I-7 even said that "compared with ending up with a poor final grade, I was more worried that my team's ranking would drop because of me" in his second interview. Two cases of decreased anxiety about "letting the team down" were found in the latter part of the semester: I-3 realized that his teammates did not care much about the ranking (interview-2 and -3), while I-5, whose team constantly topped the leaderboard, found the other teams were "not as competitive as expected" (interview-3).

Third, anxiety sourced from lacking confidence was alleviated by the team setting with intense collaborative competition, which advocated collective honor and created close bonds among team members, like players in gaming guilds. I-5 felt a strong sense of support from team discussions before answering in class, which made him less insecure (interview-3). I-10 gained inspiration from his confident and hard-working teammates, with whom he shared the goal of "winning a gold badge for SUP (the name of his team)" (interview-3). By comparison, however, I-7 had his confidence activated by teammates who were not fully engaged: "I realized that I was in a dominant position to win gems

for my team, and my teammates relied on me" (interview-3). Nevertheless, students who were extremely unconfident about their English proficiency perceived limited influence from the game teams. As explained by I-8, "Neither support from my teammates nor the pressure of team rankings could do anything to address the worries about my poor English pronunciation."

4.2.2. Influences of Gamification on Three Types of CL

Consistent responses from the ten interviewees suggest that the games' visual stimulus and operation did not induce extra mental effort because they "spent most of their attention on learning content and not much in dealing with the game elements, especially after getting used to the environment" (I-6, interview-2). The in-class observation substantiated the findings that recording gems on game ladder cards took the students little time and effort. The qualitative data also revealed some subtle differences that the gamification design made to the students' perceived CL. At the beginning, some interviewees had difficulties in comprehending the game's rules, even when the online game manual was provided. However, the phenomenon was only temporary, as I-8 indicated, "The confusion soon disappeared as I figured the rules out naturally by participating in the games" (interview-3). Later, as the students were gradually immersed in the gamified system, they started to invest some mental effort into developing gaming strategies, such as topping the leaderboards. For example, I-6 found after a few weeks that she had to do her best in pre-class assignments to obtain a good ranking as she was not good at the in-class activities (interview-2).

The qualitative data also show that the students' FLA and CL are correlated in some cases and unrelated in the others in this gamified learning context. On the one hand, some interviewees expressed that they exerted more mental effort to acquire new knowledge, with their thinking process interfered with by "multi-tasking" when their anxiety was augmented by team-based competition (I-5, interview-2) and experienced less "nervous blanks about speaking English publicly" when their anxiety was alleviated by the relaxing gaming atmosphere (I-8, interview-3). The interviewees reported aggravated FLA when they were working on difficult or complicated learning tasks. As I-4 described, "I tended to get more nervous when I struggled to understand the learning materials or complex sentences from the classmates" (interview-2). On the other hand, there was a lack of correlation between the students' perceived CL and FLA in some scenarios, where the interviewees believed that the extra CL over interpreting the game rules hardly affected their FLA as they knew they would be fine as long as they completed the scheduled learning tasks. In addition, a unique case was about I-7, who maintained a great deal of cognitive effort in leading his team's discussions as an opinion leader, although his FLA was alleviated by the game team (interview-3; class-observation sessions 12–15).

5. Discussion

5.1. The Variation of FLA and Students' Perceived Gamification Effects

The quantitative results show that the students' FLA was maintained on a mild level (according to the definition by [52]) throughout the 15 weeks without significant changes. However, the qualitative findings reveal the subtle but noteworthy differences between the FLA increment and decrement at individual levels over time. At the beginning of the course, the avatars displayed FLA-alleviating effects earlier than the other gamification factors, supporting the intrapersonal and interpersonal emotion regulation of game avatar identification in young adults [53]. As the course entered the middle stage, the students' FLA was constantly moderated by the deepening game immersion under the "familiarization effect" of gamification [14]. The salient feature of this period was the considerable emotional impact of the game leaderboards. At the end of the course, rather than negative effects on the learning motivation and learning outcomes [45], the leaderboards displayed a positive impact on alleviating the FLA, especially for students at the top and the bottom.

By integrating the quantitative and qualitative results, it can be concluded that the students perceived that gamification has two types of contradicting effects on FLA.

The first one is about the joint action of anxiety-provoking and -alleviating factors in this gamified learning system. Specifically, on the one hand, the game environment formed by the magic world narrative, the gems, and the avatars decentralizes students' learning pressure. This compound learning–gaming experience introduced a self-distanced perspective to the students, which helped to manage their negative emotions [54]. Unlike the typical collaborative learning in non-gamified classes, the gamified model highlighted peer support through team bonding and strengthened cross-team exchanges, which established a safer psychological base that alleviated anxiety and gave the students a stronger sense of security [55]. The gameful hero role-play enhances students' self-efficacy [56], makes them feel capable of completing learning tasks, and leads the team to win the learning challenges. On the other hand, the team-based game competition aggravated the FLA of students by adding social comparison pressure to their language learning experience. Owing to the close bonds that the games created, the students valued their contributions to the teams and attached more importance to their performance. Accordingly, emotions triggered by social comparison, such as shame or pride, increased the students' anxiety levels. Introversion and strong collective consciousness worsened these effects because social anxiety was aggravated by interpersonal communication difficulties [57] and a sense of responsibility [58].

The second one is about the balance resulting from the dynamics of the different sources of FLA. A student's FLA had a number of sources, and the gamified team-based competitive learning alleviated one source while reinforcing another at the same time. In some cases, the students were able to become more confident by activating a combination of team efforts and individual potential with less capable teammates. In others, however, assuming team responsibilities reinforced their anxieties about unsatisfactory personal performance and negative evaluation. Although the students received inspiration and encouragement from the role models in their teams, which alleviated their anxiety about communication apprehension or lack of confidence, they tended to worry more about being a drag on the teamwork compared with their stronger teammates. Based on the heterogeneous peer effects [59], our findings detailed the psychological impact of the different team roles on the students' FLA from an interdisciplinary perspective of collaborative learning, gamified education, and learning emotion.

5.2. The Variation of Three CL Types and Students' Perceived Gamification Effects

Similar to the results about FLA, no significant statistical difference was identified in the three CL types over 15 weeks, but some transient changes and the influence of gamification on them were captured from the case findings. A possible explanation for the short-term fluctuation of some of the interviewees' ECLs at the beginning was that, in contrast to children [60] and teenagers [61], adult students saw the game rules as the equivalent of the traditional learning evaluation system soon after they were exposed to the rules. They did not want to invest too much mental effort into processing the rules based on their previous learning experiences, nor did they need to, as learning with just the game elements or mechanisms would create less burden on their limited mental resources than it otherwise would with full-fledged video games [27]. These factors related to the students and the design could explain the findings about unnoticeable extra mental efforts in the game's visual stimulus and operation. In the later stage, the direct effect of task-irrelevant extraneous distraction from gaming strategies on ECL may have indirectly affected ICL and GCL. When the students were immersed in the gamified learning environment, they would automatically devote an increased amount of effort to monitoring the states of competitive scenarios [45]. Devising winning solutions might result in overloading ECL and minimizing ICL and GCL resources in the working memory, which would have a negative impact on learning outcomes.

5.3. Dynamic Correlations between FLA and the Three CL Types

Among the three CL types, the consistent positive correlations between ICL and FLA in all five surveys suggest the significant and stable role that the learning material complexity played in arousing the students' FLA, which seemed unaffected by any teaching technique, such as gamification. According to the flow theory [62], when the difficulty of a task or a challenge is constantly adapted to people's abilities, they remain immersed in a balanced psychological state where they feel neither too bored nor too anxious. Similarly, the positive correlation between ICL and FLA indicates that the difficulty of the learning content needs to be continuously adapted to students' abilities to avoid overwhelming or exiguous FLA caused by too much or too little involvement of cognitive resources and to keep the students immersed in a balanced emotional state in foreign language learning.

GCL positively correlated with FLA in the first half of the semester, but not in the second. The correlation can be explained by the attentional control theory, which holds that people tend to allocate more attention resources to determining responses in anxiety-provoking circumstances than to the current task [63]. Within a foreign language learning context, more GCL, which optimizes learning efficiency, is activated for completing a learning task when the increased FLA lowers learning efficiency by crowding out attention resources. Later, the insignificant correlation between GCL and FLA may be because of other influencing factors of GCL that changed under the long-term effect of gamification. For example, besides emotions, motivation also played a significant role in the students' willingness to invest GCL [64]. As the positive impact of educational gamification on intrinsic learning motivation emerges over several weeks [14], the students were increasingly motivated to devote mental effort in learning tasks by their gamified learning experience in the latter part of the semester. Then, this emerging learning motivation may have interfered with the simultaneous influence of FLA on GCL.

ECL positively correlated with FLA discontinuously. The correlation identified in the beginning may have resulted from the use of English as the instructional language. Instructions given in English aggravated the additional CL that the complex rules of gamified learning imposed on foreign language learners. Then, the independency between the temporary ECL caused by game onboarding and FLA could be related to the influence of the long-term controlled motivation of the college students, who were used to the behavioral norm of completing assigned tasks and obtaining the corresponding grades [14]. The confusion of grading details did not interfere with their habitual learning process so much as to cause additional anxiety. The correlation in the second half of the course can possibly be explained by the ECL about game strategies, which appeared when students were familiar with and immersed themselves in a gamified learning environment after several weeks of adaptation [14]. Similar to the correlation between CL caused by game competition and anxiety in the game context [65], the ECL of strategic thinking in gamified learning was positively correlated with students' FLA. By the end of the course, the positive correlation was no longer significant because the leaderboards tended to be stable, and the rankings were increasingly unlikely to change.

5.4. Theoretical and Pedagogical Implications

This study yields four major theoretical implications. First, it explored the impact of the gamification on college students' FLA management and CL, caused by an integrative perspective of emotions and cognition. By presenting empirical evidence, it extends the literature on the application and effects of gamification in foreign language education. Second, by introducing collaborative and competitive elements and mechanisms to pre-class autonomous learning tasks and in-class interactive learning activities, this study designed a gamified learning context for a flipped college EFL course and examined the effects of anxiety-provoking and -alleviating gamification factors on students' multiple-sourced FLA. It is expected to provide theoretical insights for the development of research materials about foreign language learners' emotion management. Third, taking anxiety sources and CL categories into account, this research scrutinizes three types of FLA and CL,

respectively, and delineates how these variables are influenced by gamification, facilitating a better understanding of the mutual influence between language learning emotions and cognition under the gamified learning context. Fourth, this study proves the validity of illustrating the prominent effects over time of gamification on the students' emotions and cognition with a mixed method. In this study, the quantitative results describe the FLA and CL at the class level, while the qualitative findings complement the statistics and reveal the fine changes and their reasons at an individual level.

This study also proposes three pedagogical implications for gamification design in the educational context. First, the contradicting effects of gamification identified suggest that language educators need to have an in-depth understanding of students' FLA sources and to apply anxiety-provoking and -alleviating game elements/mechanisms accordingly. Given that the game elements/mechanisms at play vary over time, teachers can keep a close eye on students' FLA variations and iterate their course design by referencing the effective gamification patterns found in this study. Second, the effects of gamification on students' CL indicate that foreign language teachers can consider employing scaffolding strategies when introducing the "game" settings, such as using visual aids, instructing in the students' native language, and informing them of game-winning tips or game strategy guides, to spare the students' excessive mental efforts in the gamified learning context. Teachers should also take into account the characteristics of the cognition, motivation, and learning habits of adult students, which can be different from those of children, and adjust the cognitive burden of gamification in line with their learning experiences. Third, the complex correlations between FLA and the three CL types recommend that language educators strike a balance between the difficulty of content learning and gamification design and consider the students' cognitive construction abilities. The challenges of learning and gaming need to be coordinated and to complement each other so that students are less likely to feel either bored or anxious. As a low level of FLA is likely to debilitate students' mental effort in knowledge construction, teachers may utilize gamification to enhance their emotional engagement and regulate their cognitive investment, especially in the later phase of a learning cycle. To address the fading effects of gamification when students realize that their efforts can hardly make a difference to game achievements towards the end of a course, teachers may extend the gamification system into longer learning periods or other courses, provided that there is sufficient institutional support.

6. Conclusions

In order to enable a deeper understanding of how students' FLA and CL change over time and how specific game elements and mechanisms affect these two variables, as well as the relationship between them, this research conducted a nuanced exploration with multiple surveys, semi-structured interviews, and in-class observation. The quantitative results show no significant changes in students' FLA and CL and reveal the dynamic correlations between the three types of CL and FLA over time, while the qualitative findings delineate a more detailed picture of the gamification effects on the students. The findings of the interplay between FLA, CL, and gamification are expected to provide useful insights for foreign language instructors and other educational stakeholders using gamification to manage FLA or other emotions in foreign language learning with students' cognitive states taken into account.

This study has three limitations. First, the research sample of this study is limited to students from two majors with an imbalance between male and female participants. Future studies could involve a larger and more heterogeneous sample to yield more representative conclusions. Second, the survey and interview data of this study are based on the participants' self-reports, which may be affected by social-desirability bias. Future studies may use biometric measurements, such as by asking participants to wear data-collecting devices, to obtain objective and real-time data about their emotions and cognition. Third, the study is limited in scope with regard to other potential influencing factors, such as English proficiency levels, language learning beliefs, and previous game experiences.

The role that students' personal variables play in the perceived effects of gamification also deserves further exploration.

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