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Investigating Factors of Chinese EFL Learner Engagement in Digital Game-Based Vocabulary Learning: A Control-Value Perspective

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Abstract

With the rapid development of digital learning, digital game-based language learning (DGBL) has gained popularity, particularly in vocabulary acquisition. While current research on digital game-based vocabulary learning (DGBVL) is pervasive, few studies have investigated the factors influencing students' engagement with specific platforms. Additionally, there is a lack of research exploring the relationships between the possible related factors. In view of this, this study proposes to address two questions based on control value theory (CVT) by means of a questionnaire: 1) To what extent do digital competence and App factor predict learner engagement among Chinese EFL learners when using DGBVL Applications (Apps) (Baicizhan)? 2) To what extent do technostress and digital self-efficacy mediate the relationships between digital competence, App factor, and learner engagement among Chinese EFL learners when using DGBVL Apps (Baicizhan)? A total of 154 valid questionnaires were collected, and data were analyzed using SPSS 21.0, AMOS 24.0, and Process v3.3. The following conclusions were drawn: (1) App factor and digital competence do not significantly predict learner engagement, (2) digital competence positively predicts App factor, (3) digital self-efficacy and App factor mediate the relationship between digital competence and learner engagement, and (4) technostress does not mediate the relationship between digital competence and learner engagement. Based on CVT, this study not only broadens the dimension of follow-up research but also puts forward suggestions from the perspectives of software developers, education practitioners, and learners, which will help improve related APPs and promote language learning for learners.

Keywords: control value theory, digital competence, digital learning, learner engagement, vocabulary learning

1. Introduction

1.1. Background to the Study

The integration of information technology into education has revolutionized learning paradigms, particularly in language acquisition. As emphasized in the *College English*

Curriculum Requirements (2007), colleges must adopt computer- and network-based models to promote autonomous learning. Digital learning, defined as the distribution of digital media through the Internet to enhance pedagogical efficacy (Holzberger et al., 2013), has gained prominence due to its flexibility and learner-centered design. Both the European Commission (2020, 2022) and China's Ministry of Education (2024) prioritize digital competence development, reflecting its global significance.

Vocabulary acquisition, deemed the "vital organs and flesh" of language learning (Harmer, 1990), faces challenges in traditional college classrooms, where passive methods yield inefficiency (Elmahdi & Hezam, 2020). Digital game-based vocabulary learning (DGBVL) applications, such as *Baicizhan* (with 1 million daily users; "Data analysis," 2020), address these gaps by combining gamification (e.g., challenges, rewards) with adaptive feedback. While studies confirm DGBVL's effectiveness (Chen et al., 2018; Vnucko & Klimova, 2023), factors influencing learner engagement—particularly within the framework of control-value theory (CVT)—remain underexplored.

1.2. Research Goals

This study intends to analyze the factors influencing Chinese undergraduate English as a Foreign Language (EFL) learners' engagement when using digital game-based vocabulary Apps based on control-value theory (CVT). Within CVT, digital competence and App factor are chosen to be the antecedents, digital self-efficacy, and technostress are adopted to refer to the moderators, and learner engagement is the outcome. To be more specific, this study investigates the predictive effect of digital competence and the App factor on learner engagement and digs into the mediating function of digital self-efficacy and technostress among Chinese undergraduate EFL learners based on CVT. This study hopes to give Chinese English learners and English teachers some suggestions on motivating EFL learners to use DGBVL Apps.

2. Previous Research and Theoretical Framework

2.1. Digital Game-Based Vocabulary Learning

Prensky (2001) introduced digital game-based learning (DGBL) as the integration of curriculum content with digital games to enhance teaching and learning for digital natives. With advancements in information technology, DGBL has become a popular tool in language education, particularly in digital game-based vocabulary learning (DGBVL), which focuses on enhancing vocabulary acquisition through gamification (Zhang et al., 2023; Li et al., 2021).

Current research on DGBVL emphasizes its application and effectiveness. Most studies affirm its benefits across various age groups, including primary students (Chen, 2021), middle school students (Sun, 2012), and undergraduates. A meta-analysis by Vnucko & Klimova (2023) of 13 studies indicates that DGBVL fosters a positive learning environment and often outperforms traditional teaching methods.

Influencing factors on the effectiveness of DGBVL have also been explored. Uzun et al. (2013) found that women perform better than men in vocabulary games, while Sundqvist and Wikström (2015) categorized participants into gamers and non-gamers, revealing that frequent gamers achieved higher vocabulary scores. Calvo-Ferrer (2018) identified that comfort with technology positively impacts learning outcomes, whereas multitasking may hinder vocabulary acquisition. Chen et al. (2018) categorized these factors into learner and contextual influences. However, the impact of these factors on learner engagement in DGBVL remains underexplored. This research aims to fill the gap by investigating the factors influencing learner engagement in DGBVL.

2.2. Control-Value Theory

Pekrun's (2006) control-value theory (CVT) links academic emotions (e.g., enjoyment, anxiety) to control/value appraisals, influencing motivation and achievement. In the field of second language acquisition (SLA), CVT-based studies show emotions correlate with language performance (Wang & Li, 2022; Zhao & Wang, 2023), while achievement inversely affects emotions (Dewaele & Li, 2022). Alternatively, scholars have made "control appraisal" and "value appraisal" more specific to the research context (see, Wang & Ren, 2024; Zhao et al., 2023). This study adapts CVT by framing digital competence and App factors as antecedents, with digital self-efficacy and technostress as mediators, and learner engagement as achievement.

2.3. Key Constructs

Digital competence refers to the ability to use digital technologies critically, collaboratively, and creatively (Tzafilkou et al., 2022). Foreign language digital competence research focuses mainly on teachers (Gümüş & Kukul, 2023; Falloon, 2020), with fewer studies on students (Cabero-Almenara, 2023; He et al., 2023). Apart from this, only two recent studies have paid attention to the impact of digital competence on learner engagement (Feng & Liu, 2024; Kara, 2022). This study will further explore this gap.

This study's App factor, adapted from a previous study (Li et al., 2021), includes four dimensions: skill-challenge balance (Jackson & Marsh, 1996), playability (González-González & Blanco-Izquierdo, 2012), clear goals and feedback (Kiili et al., 2014). Prior studies demonstrated these four dimensions positively affect concentration and motivation. This study will explore their links to DGBVL engagement.

Technostress refers to the stress and anxiety experienced by individuals in response to the demands and complexities of technology-driven work environments (Brod, 1984), comprising five dimensions (Tarafdar et al., 2007), negatively impacts learning (Zhao et al., 2024; Niu et al., 2022). While prior studies focused on teachers (Dong et al., 2020), students' technostress remains underexplored, particularly its interplay with digital competence and learner engagement among Chinese EFL students, making it a focal point of this study.

Self-efficacy, defined as an individual's confidence in their ability to perform tasks (Bandura, 1997), influences thoughts, emotions, and behaviors. Kim & Kim (2021) define digital self-efficacy as a judgment of one's capability to use a digital device. While previous studies have explored self-efficacy in digital learning contexts (Hong et al., 2017; Zadorozhnyy & Lee, 2023), gaps remain regarding its role in regulating digital competence and learner engagement in DGBVL settings, which this study aims to address.

Learner engagement refers to the active participation of students in learning activities (Reeve, 2012) and includes emotional, cognitive, and behavioral dimensions (Fredricks et al., 2004). Although prior research has examined engagement in various contexts (Jiang & Peng, 2023; Shakki, 2023), gaps exist in understanding the relationship between emotions and engagement in DGBVL settings, which this study seeks to explore.

2.4. Research Questions and Hypotheses

2.4.1 Research Questions

1) To what extent do digital competence and App factor predict learner engagement among Chinese EFL learners when using DGBVL Apps (*Baicizhan*)?

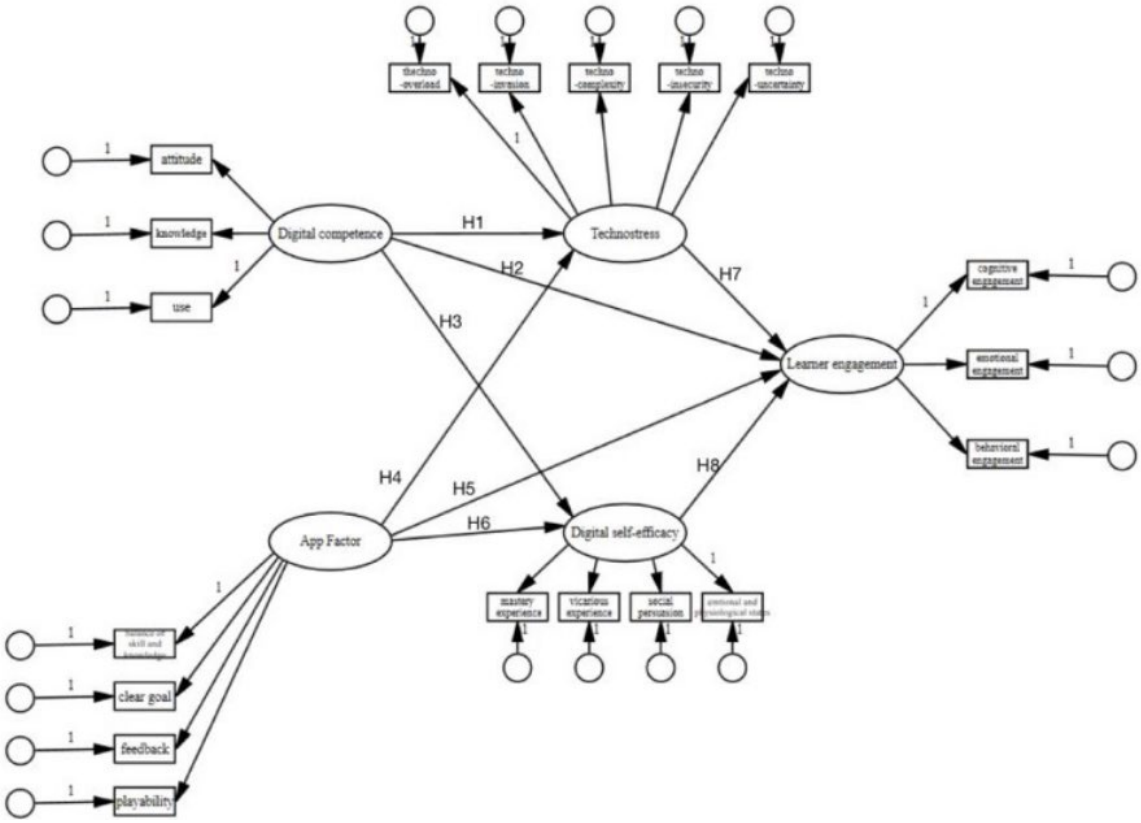
2) To what extent do technostress and digital self-efficacy mediate the relationships between digital competence, App factor, and learner engagement among Chinese EFL learners when using DGBVL Apps (*Baicizhan*)?

2.4.2 Research Hypotheses

Based on CVT as outlined earlier, Figure 2.1 depicts a conceptual model summarizing the proposed relations between digital competence, App factor, technostress, digital self-efficacy, and learner engagement. The following hypotheses were tested in the experiment:

- H1: Digital competence negatively predicts technostress.
- H2: Digital competence positively predicts learner engagement.
- H3: Digital competence positively predicts digital self-efficacy.
- H4: App factor negatively predicts technostress.
- H5: App factor positively predicts learner engagement.
- H6: App factor positively predicts digital self-efficacy.
- H7: Technostress negatively predicts learner engagement.
- H8: Digital self-efficacy positively predicts learner engagement.
- H9: Technostress negatively mediates the relationships between digital competence, App factor and learner engagement.
- H10: Digital self-efficacy positively mediates the relationships between digital competence, App factor and learner engagement.

Figure 2.1 Proposed Model



3. Materials and Methods

3.1. The Choice of Baicizhan

This study chose to use *Baicizhan*, a tutorial-type game, as the presentative case of the DGBVL App for a few reasons: (1) Compared to immersive games, tutorial games focus more on learning content (Kim et al., 2009). (2) Existing research (Hung et al., 2018; Hong et al., 2017) found younger learners prefer immersive games. (3) *Baicizhan* has more than one million active users daily. Meanwhile, it is available on either the Apple iOS or Android operating systems. Thus, considering the age of participants, the convenience of downloading, and the purpose of the research.

3.2. Participants

The study was conducted with first-year to fourth-year (including fifth-year undergraduate students in some majors, for example, medicine and architecture) undergraduate EFL learners in mainland China. With convenience sampling, the questionnaire was distributed through the Internet using *WenJuanxing*. *Wenjuanxing* has more than one million respondents answering daily and is considered one of the largest data collection websites (Lin et al., 2018; Sun et al., 2019). All participants have used *Baicizhan*, a well-known DGBVL App with one million active users daily. (Data analysis of online education industry: Daily activity of *Baicizhan* was 1,278,300 on 16th March 2020,2020), in the past six months before taking the questionnaire. This is to ensure that the participants are familiar with *Baicizhan*, thereby reducing data bias to a certain extent. 354 questionnaires were sent out, all of which were returned; 200 invalid questionnaires were eliminated, with a valid return rate of 43.5%. The 200 invalid questionnaires were eliminated because of incorrect answers to any of the five verification questions and internal illogic in the questionnaire (e.g., got 6.9 for the International English Language Testing System).

The total number of valid questionnaires was 154. Participants were a combined of 13 freshmen, 70 sophomores, 43 juniors, and 29 seniors (including undergraduates who are in the fifth year of some majors). There were 58 boys (37.7 %) and 96 girls (62.3 %).

3.3. Instruments

Instruments include questionnaires, SPSS version 21.0, AMOS version 24.0, and Process v3.3 for reliability tests, validity tests, and Structural Equation Modeling (SEM).

The questionnaire was presented in both Chinese and English to facilitate the understanding of the participants. It consisted of three parts. The first section collected demographic data such as grades, gender, discipline, English proficiency, and *Baicizhan* usage, with a filter question to exclude participants unfamiliar with *Baicizhan*.

The second part investigated the status of students' digital competence, App factor, technostress, digital self-efficacy, and learner engagement through 74 items based on existing literature (Guillén-Gámez & Mayorga-Fernández, 2020; Tzafilkou et al., 2022; Li et al., 2021; Ismail & Heydarnejad, 2023; Tarafdar & Ragu-Nathan, 2010; Yang et al., 2016; Zadorozhnyy & Lee, 2023; Wang et al., 2022). Five verification questions were mixed into the other items in order to identify invalid questionnaires. Participants rated items on a seven-point Likert scale, with 7 being strongly agree, 6 being slightly agree, 5 being agree, 4 being either, 3 being disagree, 2 being slightly disagree, and 1 being disagree. A detailed summary of the dimensions of the variables and references of each scale is presented in Table 3.1.

Table 3.1 Dimensions and References of the Questionnaire

Variables	Dimensions	References
Digital competence	Attitude, knowledge and use	Guillén-Gámez & Mayorga-Fernández (2020); Tzafilkou et al. (2022); Ministry of Education of the People's Republic of China (2024)
App Factor	Playability, feedback, clear goal, balance of skill and knowledge	Li et al. (2021)
Technostress	Techno-overload, techno-invasion, techno-complexity, Techno-insecurity	Ismail & Heydarnejad (2023); Tarafdar & Ragu-Nathan (2010)
Digital self-efficacy	Mastery experience, vicarious experience, social persuasion, emotional and physiological states	Yang et al. (2016); Zadorozhnyy & Lee (2023)
Learner engagement	cognitive engagement, emotional engagement, behavioral engagement	Wang et al. (2022); Martin & Borup (2022)

The third section included three open-ended questions about their experiences with *Baicizhan*. To ensure as much output as possible from the participants, the questions were set up to be as engaging as possible.

3.4. Data Processing

Quantitative data were collected and analyzed using SPSS 21.0 and AMOS 24.0. Initially, values for each variable and sub-dimension were calculated, followed by an examination of skewness and kurtosis to assess normal distribution. Reliability and validity tests included confirmatory factor analysis (CFA) since items were adapted from established questionnaires. Descriptive statistics for key variables were calculated using SPSS. With a minimum sample size of 100 recommended for SEM (Ding et al., 1995), this study met that requirement. SEM was then employed to examine the predictive effects of digital competence and App factor on learner engagement through AMOS, alongside testing mediating effects of digital self-efficacy and technostress Process v3.3.

For qualitative research data, this study adopted a case-by-case approach to understand how students use *Baicizhan*.

3.5. Ethical Approval

Ethical approval was obtained from the University of Hong Kong prior to data collection. All subjects were informed about the procedures and potential risks involved in the study before they began to answer the questionnaire online to seek their consent. The participants were not harmed physically or psychologically throughout the data collection process. The confidentiality of the participants was guaranteed since, despite the fact that the collected data included their personal information, they were assigned numbers to be identified when the data was processed and reported.

4. Results

4.1. Description Data and Preliminary Analyses for the Questionnaire

Each construct in this study included multiple sub-dimensions. Before the formal calculation of this study, the average value of the items contained in each sub-dimension was calculated as the score of the sub-dimension, as well as the skewness and kurtosis of each sub-dimension.

Normality was assessed using skewness and kurtosis; all values fell within acceptable ranges, suggesting approximate normal distribution. Reliability and validity tests confirmed the measurement model's trustworthiness, with Cronbach's α values above 0.70 and composite reliability (CR) exceeding 0.60 (Hair et al., 2006). Convergent validity was also established, as the average variance extracted (AVE) for each construct surpassed 0.50 (Fornell & Larcker, 1981). Confirmatory factor analysis (CFA) indicated a good model fit, with indices meeting Kline's (2011) criteria.

Table 4.1 presents the mean, standard deviation, and correlation coefficients for all variables. The correlation analysis revealed that technostress was not significantly related to other constructs, while the remaining constructs correlated with each other. The descriptive results suggested that learners had a high level of digital competence, App factor, learner engagement, and digital self-efficacy. These indicate that subjects believed that they have a high ability to use electronic products, were relatively familiar with the features of the DGBVL App, were good at using the DGBVL App, and had a high willingness to be engaged in digital game-based vocabulary learning. Subjects also believed that they could overcome difficulties or feel self-satisfied in learning. Learners' technostress was relatively lower than the four other constructs, whereas still shows a certain concern about the pressure from digital learning.

Table 4.1 Descriptive statistics and correlation analysis of each variable.

	1	**2**	**3**	**4**	**5**
1. Digital competence	1				
2. App factor	.845**	1			
3. Technostress	.127	.050	1		
4. Digital self-efficacy	.764**	.751**	.143	1	
5. Learner engagement	.758**	.751**	.143	.747**	1
M	5.834	5.807	4.792	5.657	5.710
SD	0.647	0.563	1.044	0.706	0.711

Note. **. Correlation is significant at 0.01 level (2-tailed); M, mean; SD, standard deviation

4.2. Results for the Predictive Effect

The goodness of fit indices of the suggested SEM model was assessed first, followed by an examination of the direct and indirect paths in the underlying variables of learner engagement in DGBVL Apps among Chinese EFL learners. Each of the constructs in this overall model was treated as a latent variable and its respective sub-dimensions were used as observed variables.

Table 4.2 Initial Model Fit Indices and Final Model Fit Indices

	Suggested	Initial model fit indices	Evaluated	Final model fit indices	Evaluated
CMIN/DF	<3	3.892	Poor	2.547	Good
GFI	>0.900	0.755	Poor	0.808	Closed
IFI	>0.900	0.808	Poor	0.898	Closed
TLI	>0.900	0.771	Poor	0.877	Closed
CFI	>0.900	0.806	Poor	0.897	Closed
RMSEA	<0.1	0.137	Poor	0.101	Closed

Initial model fit indices presented in Table 4.2 indicate poor fit, failing to meet the criteria for good model fit, necessitating modifications. The Modification Index (MI) was used to identify potential improvements. A MI value greater than 3.84 suggests that freeing the corresponding parameter could lead to a statistically significant improvement in model fit, as long as there is also sufficient theoretical support for the causality of that parameter.

Table 4.3 Summary Table of Modification Indices for the Initial Model

Variable	M.I.	Par Change
DG<->AF	105.837	0.232

Table 4.3 highlights an MI value of 105.837 for the path from digital competence to App factor, indicating a strong relationship between these constructs. Both digital competence and App factor are integral to the study's focus on DGBVL, with digital competence emphasizing the ability to use technology and the App Factor reflecting learners' perceptions of their capabilities with DGBVL Apps like *Baicizhan*. Few scholars have specifically studied these two variables, and this study will provide a further elaboration on the relationship between them. Meanwhile, a new hypothesis was proposed (H11).

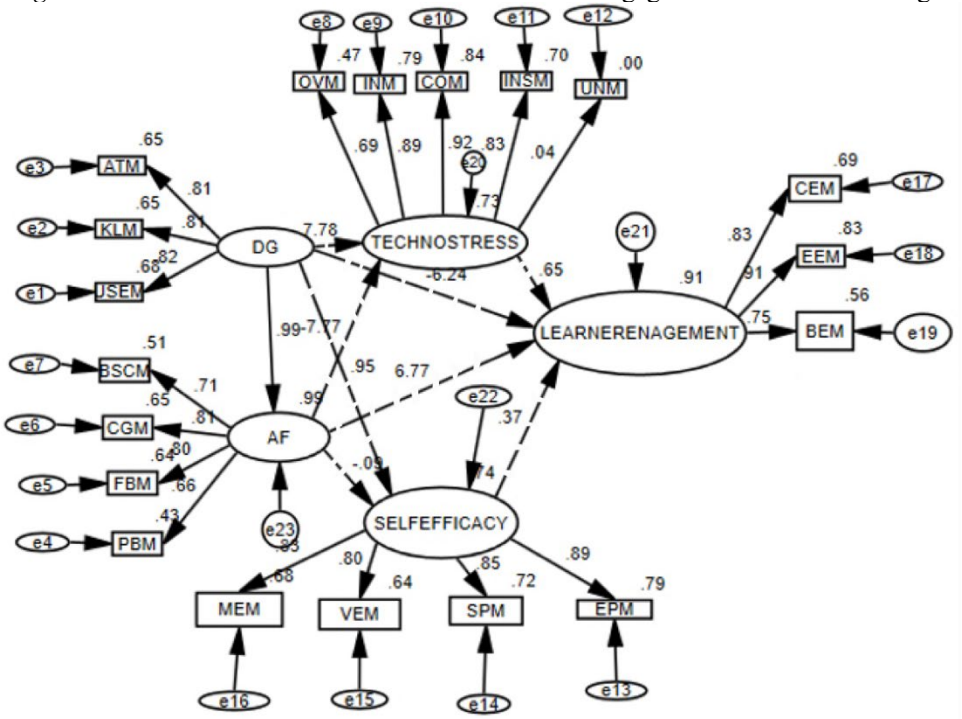
H11: Digital competence positively predicts App factor.

Following the establishment of this relationship, the model fit was re-evaluated. The revised fit indices in Table 4.2 showed improvement, with CMIN/DF at 2.547, which meets the acceptable threshold for model fit. Although not fully optimal, the fit is marginally acceptable.

Subsequently, SEM analysis was conducted, with Figure 4.1 illustrating the final results. Meanwhile, a new hypothesis (H12) was raised since the App factor may still have an impact on learner engagement and may be influenced by digital competence.

H12: App factor positively mediates the relationships between digital competence and learner engagement.

Figure 4.1 The Finalized Model of Factors of Learner Engagement in DGBVL among Chinese EFL Learners



Note: solid line indicates significant paths; ***p<.001; DG=Digital Competence; AF= App factor; SELFEFFICACY= Digital self-efficacy; ATM= attitude; KLM = knowledge; USEM = use; BSCM = balance of skill and knowledge; CGM = clear goal; FBM= feedback; PBM= playability; OVM= techno-overload; INM=

techno-invasion; COM= techno-complexity; INSM= techno-insecurity; UNM= techno-uncertainty; MEM= mastery experience; VEM= vicarious experience; SPM= social pressure; EPM= emotional and physiological states; CEM=cognitive engagement; EEM= emotional engagement; BEM= behavioral engagement

Table 4.4 Estimates and Significance of Each Hypothesis in the SEM (N=154)

Hypothesis	**Path**	**Standardized Estimate**	**S.E.**	**C.R.**	**P**	**Conclusion**
H11	Digital Competence→ App Factor	.994	.074	9.350	***	Yes
H1	Digital Competence →Technostress	7.785	28.831	.323	.747	No
H2	Digital Competence →Learner engagement	-6.240	81.371	-.085	.932	No
H3	Digital Competence →Digital Self-efficacy	.949	.720	1.459	.145	No
H4	App Factor →Technostress	-7.772	41.396	-.321	.748	No
H5	App Factor →Learner engagement	6.773	116.542	.092	.927	No
H6	App Factor→ Digital Self-efficacy	-.092	1.030	-.142	.887	No
H7	Technostress→Learner engagement	.646	6.355	.094	.925	No
H8	Digital Self-efficacy → Learner engagement	.371	.150	2.482	.013	No

Figure 4.1 and Table 4.4 display the hypotheses testing results for the direct path coefficients of the new model. The results revealed that digital competence significantly positively predicts App factor (β=.994, $p < 0.001$). Moreover, digital competence did not predict technostress, learner engagement, and digital self-efficacy. App factor did not significantly influence technostress, learner engagement, and digital self-efficacy. Technostress and digital self-efficacy did not predict learner engagement. Although all the initial eight hypotheses (H1 to H8) were not significantly identified, these findings are still important since technostress and digital self-efficacy may function as a full mediator between digital competence and learner engagement.

In summary, eight initial hypotheses were rejected, and one new relationship emerged, that is, digital competence significantly positively predicts App factor. This will be discussed in the next chapter.

4.3. Results for the Mediation Effect

A Bootstrapping test was employed with 5000-time sampling at the confidential level of 95% to examine the direct and mediating effects of digital self-efficacy, technostress, and App factor on learner engagement (Figure 4.1). Results are reported in Table 4.5.

Table 4.5 Mediating Effect Statistics of Technostress, Digital Self-efficacy and App factor

Hypothesis	**Path**		**SE**	**Lower**	**Upper**	**P**	**conclusion**
H9	Digital competence→ technostress→ learner engagement	Indirect effect	0.0061	-0.0086	0.0266	-	No Mediating Effect
		Direct effect	0.1060	0.0871	0.5060	**	
		Total effect	0.0581	0.7184	0.9481	***	
H10	Digital competence→ digital self-	Indirect effect	0.2505	0.0735	0.4841	-	Partial Mediation
		Direct effect	0.1060	0.0871	0.5060	**	

	efficacy→ learner engagement	Total effect	0.0581	0.7184	0.9481	***	
H12	Digital competence→App factor→learner engagement	Indirect effect	0.2317	0.0410	0.4014	-	Partial Mediation
		Direct effect	0.1060	0.0871	0.5060	**	
		Total effect	0.0581	0.7184	0.9481	***	

Note. ***p-value < 0.001; **p-value < 0.01The mediating effect testing was performed in Process 3.3 (confidential interval =95%; samples = 5000).

Regarding the mediating paths in the SEM, the present study found two significant indirect effects (Table 4.5).

Digital self-efficacy positively displays a partial mediating effect because the direct effect and total effect were significant; the confidence interval was (0.0735,0.4841), indicating the significant indirect effect. When the indirect effect, direct effect, and total effect are significant, a partial mediating effect exists. Thus, digital self-efficacy has a significant positive partial mediating effect between digital competence and learner engagement. A similar condition happens on App factor. Unlike digital self-efficacy and App factor, technostress does not mediate digital competence and learner factor. It is because the confidence interval of technostress was (-0.0086,0.0266), which indicates an insignificant effect.

5. Discussion

5.1. Discussion for the Predictive Effect

5.1.1 The Insignificant Predictive Effect of Digital Competence on Learner Engagement

The result of the predictive impact of digital competence and learner engagement is different from previous studies (Feng & Liu, 2024; Kara, 2022). In Kara's study, she examined how learner characteristics like digital literacy, self-directed learning, motivation, and perceived stress affect engagement in online education during the COVID-19 pandemic in Turkey. The study found that all these characteristics are important factors in predicting online engagement. Feng & Liu (2024) explored the experiences of language learners in the digital age, concentrating on how digital literacy, technostress, online engagement, autonomy, and academic success interact. Through interviews and document analysis with 20 Chinese EFL participants, the study found that technostress is multifaceted, digital literacy significantly impacts online engagement and autonomy, and these factors have a nuanced effect on academic success.

The result of this study is inconsistent with previous findings. Three possible explanations are provided:

(1) First, we need to clarify that in this study, digital competence is significantly related to learner engagement (as shown in Table 4.1), but the direct predictive effect of digital competence on learner engagement is not significant. This suggests that there may be other mediating or moderating variables between digital competence and learner engagement. Alternatively, based on Chaw & Tang (2023) and Li et al. (2022), digital competence positively predicts academic performance; meanwhile, academic performance is an outcome of learner engagement (Fredricks, 2004). This implies that

learner engagement may mediate the relationship between digital competence and academic performance. However, this study did not include academic performance as a variable, thus failing to reveal this potential relationship.

(2) The context of this study differs from those two studies. Kara's study took place in Turkey during the global pandemic in 2020. During that time, digital learning was rapidly emerging as a widespread language-learning approach. This means that digital learning, including online learning, was just beginning to be widely and frequently used in daily teaching. Students' digital competence in digital learning may not have been fully developed, and there was a significant gap in digital competence among students. Therefore, the results reflected the predictive effect of digital learning on learner engagement. However, this study was conducted in mainland China in 2024, where digital learning, particularly DGBVL, is now commonplace for Chinese EFL learners. Students are proficient in using DGBVL Apps, and the gap in skill level is relatively small (as shown in Table 4.1). Therefore, the predictive effect of digital competence on learner engagement is less pronounced.

(3) The research methodology employed in this study differs from that of Feng & Liu (2024). Their study utilized semi-structured interviews and document analysis, with documents encompassing academic records and online engagement metrics analysis. Their research primarily focused on qualitative analysis. In contrast, our study collected data through questionnaires, with open-ended questions serving as an auxiliary tool for triangulation in quantitative analysis. Consequently, our study primarily relies on quantitative analysis. The divergence in analytical approaches may contribute to variations in the findings obtained.

5.1.2 The Insignificant Predictive Effect of App Factor on Learner Engagement

In this study, the App factor encompasses four distinct sub-dimensions: playability, clear goal, balance of skill and challenge, and feedback. While playability and feedback point to the characteristics of the DGBVL App, balance of skill and challenge and clear goals are related to EFL learners. While few scholars have integrated these four dimensions into a single construct, some have explored the relationship between specific dimensions and learner engagement. For instance, Shernoff et al. (2003) posited that learners' balance of skill and challenge positively influences learner engagement. Furthermore, Zhang & Hyland (2022) and Mao & Lee (2023) argued that feedback positively impacts learners' engagement in L2 writing learning.

This study partially supports these perspectives. The App factor exhibits a positive correlation with learner engagement (as shown in Table 4.1). However, the study does not support the hypothesis that the App factor positively predicts learner engagement. This discrepancy may be attributed to the fact that Chinese EFL learners when engaging in vocabulary learning, prioritize acquiring vocabulary rather than the playability or feedback mechanisms of the vocabulary learning App. For example, some learners responded in the open-ended questions, "*Using the App is essentially just the process of memorizing words, without much complexity involved. It's just a vocabulary learning tool, nothing more.*" This suggests that playability and feedback may only exert a limited influence on engagement, and they do not effectively predict engagement.

Furthermore, Chinese EFL learners, regardless of whether they use DGBVL Apps or not, may have clear goals and a clear understanding of their balance of skill and challenge when choosing the learning Apps. This awareness likely influences their decision to choose or reject a particular DGBVL App. Some learners have expressed this sentiment, stating, "*I feel relatively calm because I know what my goal is in using the word memorization software, and I will work towards this direction.*" Therefore, consistent with the real reflections, App factor did not exhibit a significant positive prediction on learner engagement in this study.

5.1.3 The Predictive Effect of Digital Competence on App Factor

While this study did not initially propose a hypothesis regarding digital competence predicting the App factor, post-hoc model modifications revealed a potential predictive relationship between these two constructs. This finding aligns with research suggesting that digital competence significantly influences how students engage with writing feedback (Zhang & Hyland, 2022). Given that feedback is a sub-dimension of the App factor in this study, a new hypothesis was formulated and subsequently supported by the SEM results. We believe this conclusion aligns with real-world observations and logical reasoning. The very definition of digital competence encompasses the ability to use digital technologies critically, collaboratively, and creatively.

The "balance of skill and challenge" refers to learners' assessment of their capabilities and the level of challenge presented by the DGBVL App. While playability and feedback primarily focus on the App's characteristics, they are ultimately perceived by the learner, and this perception can be influenced by their digital competence. The questionnaire's clear goal item, "I have clear goals when I am learning words on *Baicizhan*," acknowledges that although some learners may already have pre-existing learning plans, it is undeniable that using *Baicizhan* might prompt learners to formulate new learning goals ("*I usually open it to complete my daily vocabulary goals set by Baicizhan*"). This process of creating new goals also necessitates the application of digital competence.

Regarding the open-ended question responses, "*I am not sure if it is because I do not know how to use it, or if Baicizhan simply does not have the daily review function. If it is because I do not know how to use it, then I will try this vocabulary memorization method again or I will discard it. However, if the App just does not have this function, then I will feel this vocabulary memorization method is not very efficient for me*." This answer implies that if my digital competence is not high enough, the student will give up using the DGBVL App. This is consistent with the conclusion.

5.2. Discussion For the Mediation Effect

5.2.1 Insignificant Mediation Effect of Technostress

This study found that technostress did not exhibit a significant mediating effect between digital competence and learner engagement, which contradicts previous findings (Niu et al., 2022).

In other studies, Hussain et al. (2022) found that performance expectancy had a substantial impact on the intention to use digital literacy and technologies, with technostress serving as a mediator. This result is also inconsistent with the findings of this study. Several potential explanations exist:

(1) According to the correlation analysis in Table 4.1, technostress is not significantly correlated with either digital competence or learner engagement. Thus, the absence of

a significant mediating effect for technostress in subsequent analyses is consistent with the results of the correlation analysis.

(2) Furthermore, this finding aligns with the responses to the open-ended questions. Most learners who mentioned "technology" reported quickly mastering the use of *Baicizhan* and expressed positive attitudes towards it. Few learners explicitly mentioned experiencing technostress.

Therefore, both theoretical considerations and learner responses suggest that technostress does not significantly mediate the relationship between digital competence and learner engagement in this study.

5.2.2 Partial Mediation Effect of Digital Self-efficacy

This study finds that digital self-efficacy has a partial positive mediating effect between digital competence and learner engagement. This finding is consistent with the concept proposed by Kahu (2013), which posits that psychosocial factors (motivation and self-directed learning skills) mediate the relationship between learner factors (digital literacy and stress) and engagement. This finding implies that learners who are more proficient in digital literacy will also show higher levels of digital self-efficacy for online learning, which raises engagement levels. One could claim that learners experience satisfaction when they possess a high level of digital competency. This state is in line with the answers to the open-ended questions. For example, one participant wrote, "*Because I am familiar with this software* (the higher the digital competence), *I like to use this App more* (digital self-efficacy) *and be able to learn more efficiently* (learner engagement)."

5.2.3 Partial Mediation Effect of App Factor

H12 indicates that the higher digital competence, the better the perception of the App; the better the perception of the App, the more engagement there will be. This tells us that in DGBVL, learners should first improve their digital competence, then their perception of the feedback and of the usability of the software, the planning of goals, and the ability to balance their abilities and challenges will be improved. After these improvements, learners will be more engaged in DGBVL.

5.2.4 Implications

Theoretically, this study innovatively applied control value theory (CVT) by selecting digital competence and App factor as antecedents, with digital self-efficacy and technostress as mediators, and learner engagement as the outcome. Notably, it found that digital competence positively predicts App factor, contributing a new perspective to second language acquisition (SLA) research. While some findings align with previous studies, such as the limited impact of technostress on learner engagement, others, like the critical role of digital competence, suggest areas for further exploration, including factors like gender and academic performance.

Pedagogically, the mediating effects of digital self-efficacy and App factor highlight the need for learners and educators to prioritize digital competence to enhance engagement. Language teachers should familiarize students with DGBVL Apps and integrate them into curricula. Additionally, focusing on self-efficacy can boost engagement. Software developers should aim to create user-friendly applications and minimize technical challenges, ensuring prompt support for users facing issues.

5.2.5 Limitations and Future Work

This research has the following limitations: a small sample size of 154 valid questionnaires may affect results, and it only focuses on five variables. Future studies should consider larger samples and explore additional factors like age and gender differences. Moreover, qualitative data were collected to supplement quantitative findings. However, this study did not process these data more systematically, so subsequent studies may consider exploring this aspect.

6. Conclusion

To sum up, based on previous research, this study explored the factors that affect Chinese EFL learners' engagement with digital game-based vocabulary learning Apps, in order to provide some enlightenment and direction for the research gaps in this field. The research results showed that digital competence predicts App factor; digital competence and App factor do not predict learner engagement; digital self-efficacy and App factor have a partial mediating effect between digital competence and learner engagement. The reasons for these phenomena are related to the context and real thoughts collected from the subjects.

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