Diagnosing student acceptance and designing digital gamified learning: an integrated UTAUT and TPACK perspective

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General Discussion

6.1. Introduction

This dissertation aims to contribute to the theoretical and practical understanding of digital gamified learning from the perspective of the pre-class stage. The first aim is to understand the determinants of students' acceptance of using digital gamified tools in their learning activities. The second aim is to suggest implications for pre-class design to improve the effectiveness of digital gamified learning, benefiting schools, teachers and learners. It is important to understand target students' willingness to be involved in gamified learning environments since they are the key agents for in-class activities and their perspectives or attitudes will influence the use of educational tools (Carmi & Tamir, 2023; Klemenčič, 2020; Fielding, 2001). In addition, class design is another vital factor that affects the classroom effectiveness (Dubin & Olshtain, 1986), and students' personal needs and preferences should be sufficiently considered during this process (Krath et al., 2021). Therefore, it is also important to offer insights regarding how to design digital gamified classes, including "what to learn", "whom to teach", "with what technological tool", and "how to use the technological tool". In doing so, four studies were performed focusing on (1) Unpacking students' acceptance of digital gamified learning through an extended UTAUT model (Chapter 2); (2)Research on students' game element preferences and learning needs: Implications for the instructional design of the digital gamified class (Chapter 3); (3) A systematic literature review study on student information in user profiles for tailored gamified learning (Chapter 4); (4) A systematic literature review study on the approaches and game elements used to tailor gamified learning (Chapter 5).

In this final chapter of this dissertation, the main findings of each chapter are summarized first, followed by a discussion of the findings. Next, the limitations and directions for future research will be provided. Finally, implications for the practice of self-directed learning are discussed to further promote qualified pre-class preparation, which can enhance the gamified learning process and thereby contribute to students' learning achievement.

6.2. Main findings per chapter

Chapter 2. Unpacking students' acceptance of digital gamified learning through an extended UTAUT model

The objective of **Chapter 2** was to investigate which factors drive or hinder students' willingness to use digital games/gamification for their learning activities in class. Regarding the theoretical framework, we extended the Unified Theory of Acceptance and Use of Technology (UTAUT) model (Venkatesh et al, 2003) by adding variables related to 'game-specific' contexts. A mixed-method study was developed within Chinese universities as the application context. A quantitative questionnaire survey was used to collect data about demographic information (age & gender), prior experiences that students had participated in when using digital games or

gamification, and the performance expectancy, effort expectancy, social influence, facilitating conditions, learning motivation, preferences for game types and game design principles, and learning compatibility. A total of 610 students completed the questionnaire. Structural equation modeling (SEM) with SPSS and AMOS statistical tools was employed to analyze the quantitative data. Moreover, to gain a comprehensive understanding, qualitative insights from student semi-structured interviews were integrated to identify other potential influencing factors beyond the modified UTAUT framework. Content analysis was used to understand interviewees' perspectives on digital games/gamification in educational contexts. Two main research questions guided this first study. Firstly, we examined how the independent variables included in the modified UTAUT model were related to university students' technology acceptance of using digital games for learning in class, and what additional factors have emerged from student perspectives. Secondly, individual characteristics were regarded as the moderators between other principal variables and technology acceptance (Kreijns et al., 2013). To clarify the extent to which individuals' different prior experiences have indirect effects, we examine their moderating roles in digital game-integrated class activities.

The quantitative findings indicated that the performance expectancy, effort expectancy, facilitating conditions and learning motivation were all significant indicators of student acceptance of digital games in formal classroom environments. Performance expectancy emerged as a particularly influential factor, reflecting the strong emphasis students place on the perceived instructional value of digital games in curriculum-driven classrooms. The qualitative data further showed that this construct was quite vulnerable within the gamified contexts, as the student expectations were easily compromised not only when the games did not match the learning goals but also when learning-driven mechanisms, such as excessive hints, were considered as potential threats to their critical thinking capacity. Effort expectancy also played a prominent role, with students showing lower acceptance when the gamified interface or rules involved extra cognitive load. This phenomenon was particularly strong in class environments, where their focus on navigating elaborate game systems took direct attention away from teachers' instructional explanations. Moreover, facilitating conditions proved to be significant, with findings extending prior research by emphasizing the fact that students paid much attention to institutional support (e.g., stability of platforms and compatibility of devices). Additionally, although the correlation between learning motivation and acceptance was high, the qualitative data indicated that the same game elements may motivate some students while demotivating others. Some students were also found to have resistance towards gamified learning because of deep-rooted beliefs about what they thought constituted serious learning, highlighting the great importance of intrinsic motivation.

In contrast to some prior studies, social influence had a significant positive effect, reflecting the influence of teacher authority in the Chinese context. Conversely, prior experience did not moderate the motivation and acceptance relationship, suggesting that at a mature stage of interest development, acceptance is driven more by perceived value and autonomy than by past learning experiences. Finally, this study extended the UTAUT model by demonstrating that

students' game type preferences, game design principles, and perceived learning compatibility significantly shaped acceptance as well.

After understanding students' acceptance of digital games and /gamification for learning, **Chapters 3 to 5** would focus on the instructional design itself, providing an in-depth analysis of one or more core knowledge dimensions of the TPACK framework, respectively.

Chapter 3. Research on students' game element preferences and learning needs: Implications for the instructional design of the digital gamified class

Chapter 3 was also a mixed-method study using questionnaires including both closed and open questions (Creswell & Plano-Clark, 2017). With English writing classes in Chinese universities as the application context, this chapter (what to learn) focuses on the content knowledge **(CK)** by analyzing students' learning needs comprehensively from three aspects: necessity, lacks, and wants (Hutchinson & Waters, 1987). Furthermore, this study attempted to build technological content knowledge **(TCK)** by examining the fit between game elements and learning needs. In doing so, five key research questions were addressed. Firstly, to introduce digital gamified learning into class, it is important to have a comprehensive understanding of students' game element preferences. The following two research questions were drawn up: (1) Which preferences do university students have concerning game elements? (2) Which game elements do university students mention as making their English writing homework effective? Secondly, to provide English writing exercises that are suitable for students, we answered two research questions: (3) What do university students need in learning to write in English? (4) What kinds of English writing homework do university students report as effective? Thirdly, to gain insight into which game elements can be most matched to university student needs concerning English writing, it is important to examine the connection between the two: (5) To what extent do university students' game element preferences relate to their English writing needs? There were 505 respondents who filled out the questionnaire and they were required to provide their demographic details, namely, age, gender, major and educational level. The quantitative data was analyzed using the structural equation modeling (SEM) with the SPSS statistical software in the current study and content analysis was used to analyze the qualitative data.

The results suggest that most students had positive perceptions of the adoption of game elements in English writing tasks. Competition, cooperation and reward were identified as the top three preferred among the five game elements examined. Further qualitative data also indicated that various game elements were seen as useful based on varied reasons such as improving motivation, offering positive feedback, enhancing peer interaction and creating a sense of achievement. Meanwhile, several students demonstrated negative attitudes toward gamified learning, largely due to limited prior experience or deeply rooted beliefs that games were incompatible with serious academic learning. Concerning students' English writing needs, it has been revealed that students placed more focus on text types and learning content, especially the ones that corresponded to course requirements. Also, many students shared that they had difficulty with specific writing components, especially the methods section, and highlighted the importance of supplementary materials and timely feedback. In terms of effective homework

design, students emphasized clear feedback mechanisms, appropriate task difficulty, and manageable time constraints as key factors to enhance engagement and learning effectiveness. Structural equation modeling further revealed that, despite the positive relationship, using students' preferred game elements did not have more than 30% effect on satisfying their specific writing needs.

Chapter 4. A systematic literature review study on student information in user profiles for tailored gamified learning

Since the development of a teacher's **PCK** is based on the structured understanding of the learners (Shulman, 1987), in **Chapter 4**, we collected different types of learner information for creating user profiles (whom to teach) and explained instruments for collecting them using a systematic literature review study. It is a first step to using tailored gamification in class and allows teachers to build effective user profiles for students. The research questions that guide this literature review were (1) What information in the user profiles can be used to differentiate students in tailored gamified learning? (2) How is this information about students' user profiles collected? To address these issues, we followed PRISMA guidelines. Based on our inclusion and exclusion criteria, we found 31 peer-reviewed articles between 2011 and 2024 from the electronic search and snowballing method.

According to the taxonomy of Missaoui and Maalel (2021), student information in gamified contexts was grouped as 'learner information' (e.g., learning goal and skill), personal information' (e.g., demographic data and personality), and 'player information' (e.g., player type and preference). Yet, apart from them, our review concluded that students' contextual information should be involved in building user profiles in tailored gamified learning environments. Among these categories, we found that player information, particularly player type and motivation type, was the most frequently employed in tailored gamified designs. The trend indicates that a strong focus was given to the game aspects of gamified learning and researchers were highly dependent on validated player typologies like Hexad, BrainHex models to categorize the learners and offer them game elements accordingly. Learner information, including learning styles, learning behaviors, and performance, was also used to support personalization, specifically in adaptive systems that reacted to the learner's real-time behavior. Nonetheless, the impact of other learner-specific characteristics (e.g., intelligence type, learning disability, prior knowledge, skills, interests, and learning objectives) was not often assessed empirically and their influence on learning outcomes was not explored widely. Personal information, particularly personality traits, was found to have considerable effects on learner participation and performance. Conversely, age and gender were used infrequently and lacked empirical justification in most reviewed studies. This suggests that currently tailored gamification or games often overlook how fundamental demographic factors could interact with game mechanics to create different learning experiences.

Regarding data collection, questionnaires were the dominant method for gathering static student information, whereas dynamic data, such as gamified action traces and performance metrics, were less frequently used despite their higher potential accuracy in capturing students' real-time

needs and preferences. The review further implied that most studies relied on a single type of student information when tailoring gamified learning. Although positive effects were often reported, evidence from a small number of comparative studies suggested that integrating multiple types of student information may lead to more effective personalization than one.

Chapter 5. A systematic literature review study on the approaches and game elements used to tailor gamified learning

Chapter 5 was also a systematic literature review study, which aims to understand technological pedagogical knowledge **(TPK)** by examining the relationships between the technological knowledge **(TK)** of game elements used in tailored gamified systems, and the pedagogical knowledge **(PK)** of approaches for personalizing learning. The principles of the PRISMA statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Moher et al., 2009) were used as a guideline to conduct and report this review work. In addition, a snowballing technique was utilized to identify additional studies by searching the reference lists of eligible publications in the included databases. Regarding the data analysis, the tailored approaches were categorized as user modeling, personalization, adaptation, and recommendation by adopting the taxonomies of Klock et al. (2020). Besides, we applied the methods of Toda et al. (2019) to categorize game principles for tailored gamification in education into five types: personal, social, ecological, performance, and fictional game principles.

The results show that more than half of the reviewed studies focused primarily on user modeling, aiming to identify which types of student information could be collected to build individual user profiles. While user modeling was an important basis for tailored gamification, this finding suggests that many studies remained at the preparatory stage and did not implement the gamified intervention into concrete in-class environments using approaches such as personalization, adaptation, or recommendation. Among these tailored approaches, adaptation was the one most often used, followed by personalization. Yet, the recommendation-based systems were little mentioned in this study. Personalization was usually based on user static data, which was mostly gathered through questionnaires or interviews. At the same time, adaptation was based on dynamic student data such as their gamified action traces and real-time behaviors, enabling continuous or partial adjustment of game elements and learning activities. The present study indicates that the use of dynamic data might be a better way to identify the real-time needs of learners and reduce the weaknesses of using static profiling.

Regarding the game elements applied to gamified educational environments, 23 elements were found and divided into 5 clusters, which are performance, social, personal, ecological, and fictional. The use of performance elements (such as rewards and feedback) was the most prevalent in any tailored approaches, indicating a high degree of concern for instant responses to learner performance. There was also a wide application of social and personal clusters, especially competition, challenge, customization and goal setting, which closely aligned with the motivational and psychological aspects of learning. Ecological elements, such as access and choice, might influence learner behaviour through environmental factors. Conversely, fictional elements (like storytelling and narrative) were the least frequent ones, thus implying that

immersive and narrative-based design was not well developed in tailored gamified research.

6.3. General discussion: From learner acceptance diagnosis to curriculum design planning

The dissertation gives a profound insight into digital gamified learning by combining the student acceptance diagnosis (UTAUT) with TPACK oriented pre-class instructional design planning. The findings do not see acceptance, design, and implementation as separate issues but instead highlight that their systematic integration would lead to sustainable course development in gamified learning environments.

6.3.1. Understanding student acceptance as a pre-class diagnostic mechanism

Students act as active participants of the learning process and the effectiveness of the in-class activities largely depends on their involvement (Carmi &Tamir, 2023; Klemenčič, 2020; Fielding, 2001). Therefore, it can be concluded that the implementation of digital games or gamification for learning essentially relies upon students' perceptions and attitudes towards these tools. Educational interventions that do not receive adequate acceptance among learners are unlikely to provide successful learning outcomes despite possible pedagogical value (Chen, 2011). To solve this issue, this dissertation has initially carried out mixed-method research in order to reveal the hidden causes of student acceptance. In Chapter 2, data obtained through a sample of 610 university students were analyzed using the theory of the UTAUT framework (Venkatesh et al., 2003) to investigate the motivating factors and barriers influencing students' willingness to participate in digital gamified learning.

Performance expectancy has been found to be the strongest predictor for student acceptance as shown in Chapter 2. The finding was supported by previous findings in higher education, all of which emphasize it as one of the most significant factors influencing adoption (Abbad, 2021; Al-maizan et al., 2019). The present study extends the results of prior research showing that, during the use of in-class digital games, performance expectancy is not a consistent belief, but a fragile and continuously evaluated judgment. Qualitative findings revealed that students' perceived learning value of games could be undermined not only when games were poorly aligned with course objectives, but also when game designs overscaffolded their learning through excessive hints or simplified challenges. Students perceived such mechanisms as threats to their critical thinking development. As a student can perform a high performance expectancy in a technological tool only if he or she thinks that it was useful in learning (it can enhance grades or skills), the declining perceived learning value could have a direct effect of reducing or even destroying students' performance expectancy. This finding is consistent with Hanus and Fox (2015), suggesting that gamified learning effectiveness may not necessarily be determined by the presence of game elements but by achieving a careful balance between the game type and frequency of game elements and the learning content they are intended to support.

Curriculum design can easily undermine students' perceptions of instructional value if game elements and the curriculum requirements are not consistent. Importantly, this result supports the significance of content knowledge (CK) and pedagogical content knowledge (PCK) as determinants of how students view gamified learning. The teacher should not only have the

explicit knowledge of disciplinary content (CK) but also understand how technology can be useful in supporting particular content areas (PCK).

Another important predictor of acceptance was effort expectancy, similar to previous studies based on UTAUT (Venkatesh et al., 2016; Al-Adwan et al., 2022). Nonetheless, the relationship in this research was stronger than most earlier reports, which might be due to the setting of the current study being in the in-class context where students had to focus on instructional explanations, peer interaction, and game-based tasks at the same time. Complex interfaces, unclear rules, or extensive visual stimuli distracted students, shifting their attention away to teachers' explanations and learning tasks. This finding is consistent with Cognitive Load Theory (Sweller, 2011), as it states that instructional materials that are poorly developed place additional cognitive load that impedes meaningful learning. Moreover, this finding challenges a common assumption that more advanced or more sophisticated game mechanics can always contribute to deeper engagement. Instead, it underlines the significance of technologically and pedagogically informed design decisions, highlighting the impact of Technological Pedagogical Knowledge (TPK) in determining how technological features influence learning activities. The task simplicity and game element selection is not only a technical issue but also a pedagogical consideration, which involves comprehending the relationship between technology and instructional strategy, and classroom dynamics.

As it was observed in the previous studies (e.g., Yakubu et al., 2020), facilitating conditions were also found to be strong predictors of acceptance. Nevertheless, according to the qualitative data presented in Chapter 2, there was some evidence indicating that students were interpreting facilitating conditions not only as a technical issue. The consistent platforms, sufficient devices and trustworthy networks mean that gamified learning must be an officially supported pedagogical approach. The suggestions given by the students on cross-platform synchronization, battery life and offline access demonstrated that they did not merely consider whether technological conditions affect acceptance or not, but also how these conditions operated in practice. Moreover, these conditions do not refer only to the technological knowledge (TK) at the institutional level, but also to the technological pedagogical knowledge (TPK), because the introduction of technology into classes should be more supportive than destructive to the educational process. Hence, the findings in this chapter extend prior UTAUT research by shifting the focus from the mere availability of resources to the quality of their integration within authentic learning contexts.

The implications in Chapter 2 also challenged the perspective that familiarity or previous exposure would result in greater acceptance of educational technology (Venkatesh and Davis, 2000). On the contrary, it was found that once students had established steady learning interest, their acceptance of gamified learning was influenced significantly by their own individual learning objectives (Hidi and Renninger, 2006). Based on TPACK, this implies that the acceptance of students is highly related to pedagogical knowledge (PK) and pedagogical content knowledge (PCK). In particular, teachers need PK to know what motivates students, and PCK to recognize how students judge whether a learning activity is appropriate within a particular discipline. Without these pedagogical concerns in the pre-class design process, technological tools may be

poorly aligned with students' expectations, which can reduce acceptance even if the technology itself is well designed.

Through integrating preferences of game types, game design principles, and learning compatibility, this study extends the UTAUT framework to cover the micro level of digital games. The findings show that student acceptance was not only based on the use of games but also on whether particular game designs can be compatible with learning content and learner needs. These additional factors deal with one of the most significant shortcomings of prior work on acceptance, which frequently perceives technology as a single instrument and does not consider the variety in game design. In contrast, digital games vary greatly in how they function, and their educational value depends on whether specific game designs are suitable for types of learning content. From a TPACK perspective, this highlights the role of technological content knowledge (TCK), as teachers need to understand which game types and design principles are suitable for representing, practicing, or assessing kinds of content.

Unlike some earlier research indicating that social influence might not be important in higher education settings (Joo et al., 2014; Khechine et al., 2020), this work has found social influence to be one of the key positive predictors of acceptance. This underscores the significance of contextualizing the technology acceptance frameworks instead of using them generally. Teachers are central roles of authorities and norm setters in the Chinese higher education context. Qualitative data showed that teacher endorsement or skepticism had a very strong impact on student willingness to accept digital games. This result is consistent with the sociocultural views of learning, which state that students develop ideas regarding appropriate learning behaviors as a result of extended periods of academic socialization. Furthermore, age difference revealed that younger students, especially those who have just been transferred directly out of exam-oriented secondary education, were more resistant to gamified learning. It did not arise due to the lack of technological familiarity, but because of deeply internalized ideas that serious learning could not be accomplished through games. Therefore, student acceptance is influenced not only by the immediate class design but also by their previous educational experiences.

6.3.2. Pre-class design planning of digital gamified learning from a TPACK perspective

Chapter 2 demonstrates that students' acceptance of gamified learning is not only determined by the inclusion of game elements, but by whether specific designs align with their learning needs, values, and expectations. It implies that teachers should make reasonable decisions about content, pedagogy, and technology integration. Hence, this section uses TPACK as an analysis model to discuss how teachers can implement pre-class design in order to create effective gamified learning environments. Specifically, building on the findings of Chapters 3 to 5, this section explores how effective pre-class design of digital gamified learning can be achieved through the TPACK framework. As opposed to research focused on implementing or assessing gamified learning within the classroom, this dissertation views the pre-class phase as a key stage where teaching, learner characteristics, and technology selections ought to be considered strategically. The discussion will be based on three key components of TPACK and their intersections, that is, Content Knowledge (CK), Pedagogical Knowledge (PK), Technological

Knowledge (TK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), and Technological Pedagogical Knowledge (TPK).

Content Knowledge (CK): "What to learn" in gamified pre-class design

Content knowledge (CK) is the basis on which all instructional decisions are made (Koehler & Mishra, 2009). To elaborate further in the context of this dissertation, CK means not merely the disciplinary knowledge (e.g., English academic writing) but also the comprehensive knowledge of students' learning requirements, such as what can be seen as essential, challenging, and valuable before class.

Within the English writing classes as the application context, the results of Chapter 3 indicate that the EFL university students have specific learning needs (CK) for academic English writing in order to meet the external curriculum requirements (Necessities). Learning to write general argumentative essays and theses was seen as the greatest need (M = 3.37). The argumentative essay is an important basis of EFL writing in the Chinese higher education system, and graduation requires considerable weight on the thesis. Therefore, students showed a high interest in the rules and organization of these genres. Moreover, qualitative analysis revealed that several participants, mainly English majors, wanted to learn content that can facilitate their personal development and contribute to career preparation. It can be seen that this tendency to connect the acquisition of CK to long-term self-development has become significant, reflecting the significance of autonomy (Wei et al., 2023). Learning participation and achievement improve when learners feel that the instructional content is personally relevant or valuable.

It is worth noticing that the mixed-method study in Chapter 3 uncovered the discrepancy between students' metacognitive awareness and their own CK deficiency. Although quantitative data indicated that the most difficult skill was writing the method section (M = 3.42), no more than 1.1% of all students were able to express their particular writing skill shortcomings in open-ended answers. This supports Aleven and Koedinger's (2002) view that learners do not always possess the metacognitive skills to accurately diagnose their own knowledge gaps (Lacks). Therefore, teachers cannot rely solely on students' self-reported needs for curriculum design. While a learner-centered approach should emphasize respecting student perspectives, the teacher's role as a content designer with diagnostic experience is indispensable. Teachers must consider both student self-assessments and their own professional judgment, derived from classroom observation and formative assessment, to identify and address the unseen or poorly articulated deficiencies in students' CK (Hyland & Hyland, 2019). Based on the findings related to students' learning needs, we assume that the effective CK pedagogy in learning contexts should integrate students' voiced necessities (e.g., course requirements) and wants (personal interests), while also incorporating the teacher's diagnostic expertise to explore the lacks (skill gaps) that students themselves may not fully comprehend.

Technological Content Knowledge (TCK): Examining the fitness between game elements and learning needs

Chapter 3 also examines the application of digital gamification in EFL writing instruction and addresses a key issue of Technological Content Knowledge (TCK), namely, how gamified elements can be meaningfully integrated with subject-specific content such as English writing. The findings indicate that gamified elements such as competition and rewards can effectively enhance students' learning motivation, with 87% of students expressing positive attitudes toward these elements. Nevertheless, the findings of the structural equation modeling show that their direct impact on students' particular writing learning needs (e.g., types of texts and writing skills) is somewhat low, with the path coefficients less than 0.3. It indicates that even though students consider digital gamification to be motivating and engaging, they do not necessarily view it as directly enhancing their writing competence. Such findings can explain the inconclusive findings noted in past research on digital gamified learning. Previous research has proposed that gamification can be used to improve motivation and learning outcomes in foreign language education (Zainuddin et al., 2020). However, other studies have found no significant difference between gamified and conventional instructional methods concerning learning performances (Rachels & Rockinson-Szapkiw, 2018). The current research provides a deeper interpretation of this inconsistency by showing that gamification should not be viewed as a guaranteed solution for content learning. Instead, its value lies more in how it can be used to stimulate learner engagement and motivation, thus making them more likely to spend the necessary effort to learn content knowledge. This challenge highlights the complexity of TCK in practice. Successful TCK involves not just knowing technologies themselves, like game mechanics, but also being aware of how technologies can support specific instructional contents and learning objectives (Mishra & Koehler, 2006). For example, the design principles that students perceive effective, (e.g., timely feedback, moderate time pressure and task difficulty levels), are not only not exclusive to gamification but are essential design principles of good teaching. Gamified elements, including badges, progress bars, and leaderboards, merely serve as more engaging ways to implement these principles. Poorly aligned with instructional goals, gamification can divert student attention towards non-learning issues and raise their cognitive load, which in turn affects their writing development (Turan et al., 2016). This also explains why there exists a small percentage of students (3.6%) who viewed gamified learning as negative and perceived it as a waste of time.

In general, the results indicate that the development of TCK should not be based on the superficial use of game elements but focus more on the content-driven integration. When designing gamified activities, teachers should begin by clarifying their writing objectives and then consider which technological or gamified mechanisms can best support those objectives. For instance, to help students understand argumentative structure, time-limited challenges can be used to practice paragraph organization. Only when technology is clearly aligned with writing content and learning goals can gamification function as a meaningful component of instruction.

Pedagogical Content Knowledge (PCK): Understanding "Whom to teach" by learners' information types in user profiles

In the design of gamified learning environments, the development of effective Pedagogical Content Knowledge (PCK) depends largely on teachers' ability to understand who they are teaching, as emphasized in Shulman's (1987) framework. The systematic review study on

personalized gamified user profiles in Chapter 4 identifies several types of learner-related information, including learning-related characteristics (e.g., learning behaviors and skill levels), player-related information (e.g., player and motivation types), and personal characteristics (e.g., personality traits). This allows teachers to learn more about their students as learners and understand individual differences (e.g., needs and preferences) in a gamified learning environment.

The review shows a significant discrepancy between the integrated PCK required for effective gamified design and the use of learner information in research and educational practices. Many studies focus heavily on player-related data like player typology with less significance placed on how this information connects with learners' actual learning needs. For instance, knowing whether a student tends to be an 'achiever' or a 'socializer' may inform the choice of competitive or collaborative game elements, but this represents only one aspect of the learner. Effective PCK suggests that such information needs to be combined with specific learning difficulties faced by students, such as a weakness in writing structure. Previous studies have demonstrated that the combination of different types of learner information can result in better learning outcomes compared to only using one dimension (Hallifax et al., 2020; Abbasi et al., 2021). This implies that the instructional decisions can become more efficient when they are founded on a comprehensive consideration of learners instead of separate traits.

Therefore, these results suggest that teachers should be moving away from merely one method of collecting data to a more unified employment of user data in the gamified teaching contexts. Specifically, Chapter 4 emphasizes the value to integrate user static data (such as questionnaires that capture learner traits and preferences) with dynamic learning analytics that represent learners' real-time behavior and performance within gamified settings. This method helps teachers classify learners at the beginning but also changes the teaching strategy in response to ongoing learning processes.

Pedagogical Knowledge (PK): Understanding "How to use the technological tool" by analyzing tailored approaches in digital gamified environments

Pedagogical Knowledge (PK) focuses on the knowledge of teachers related to instructional strategies, learning processes and scaffolding. To a great extent, the successful application of tailored digital gamification depends on teachers' pedagogical knowledge, that is, their ability to create and adapt courses according to the differences in students. In Chapter 5, this systematic literature review concludes that tailored games/gamification are mainly established on three approaches, which are personalization, adaptation, and recommendation and all of them are based on user modeling. It means that teachers should grasp the ways of collecting and analyzing student data, whatever it is static data obtained through questionnaires (e.g., learning styles, player types) or dynamic data measured recorded in digital systems (e.g., task completion speed, frequency of help requests), to build student profiles and plan learning pathways accordingly. For example, the paper by Hallifax et al. (2020) has shown how the dual personalization of combining students' player and motivation types led to better motivational effects in math learning. Nevertheless, one of the main findings of this review is that over half of the studies were at the

user modeling stage, simply interpreting what learner information can be gathered without using a particular tailored approach in the classroom setting. Similar to other previous reviews like the one conducted by Aljabali and Ahmad (2018), it concentrated more on variables for identifying individual differences without going deep into any particular tailoring strategies. This implies that teachers need to find a way to transfer their abstract knowledge about student differences into practice and make it actionable, i.e., personalize teaching in complex classroom settings. Future efforts should thus promote more design-based research, allowing teachers to work along with researchers to develop and validate tailored gamification plans in actual teaching contexts. This could yield more practical knowledge that will help teachers bridge the gap between theoretical preparation and implementation in the classroom. Additionally, although adaptation was most commonly applied in practice, most adaptive systems need to be highly automated, which puts high demands on teachers' technical operation and maintenance abilities. Compared to the earlier review by Hallifax et al. (2019), this research reveals the growing use of dynamic data in adaptation, as the technology has evolved from relying on static to supporting real-time interaction. However, the complexity of technology may also be a barrier. The future technological innovations should therefore be aimed at creating more user-friendly and transparent technical tools for teachers. For example, interactive gamification analytics dashboards might be designed to provide key data and results of analytics in a form visible to teachers (e.g., Tenório et al., 2020). This would help them understand system decisions clearly. At the same time, teacher training must strengthen data ethics education to ensure that teachers adhere to ethical standards and protect student privacy when using technology to collect and process students' personal information.

Technological Knowledge (TK) and Technological Pedagogical Knowledge (TPK): Understanding "With what technological tool" by analyzing game elements when tailoring digital gamified environments

Technological Knowledge (TK) refers to teachers' familiarity with technological tools and systems. In the digital gamified learning contexts in this dissertation, we focus on the types of game elements to understand TK. Technological Pedagogical Knowledge (TPK) is reflected in how teachers combine gamification technology with specific teaching contexts. This dissertation further investigates the relationship between game elements and tailoring approaches to develop technological pedagogical knowledge (TPK).

Regarding TK, Chapter 5 found that game elements can be grouped into five clusters, that is, performance, personal, social, ecological, and fictional elements. Each serves different pedagogical functions. For example, the performance cluster (e.g., rewards, progress feedback) provides immediate system feedback, while the social cluster (e.g., competition, cooperation) builds interaction, and the personal cluster (e.g., challenges, goals) connects to the learner's own characteristics. Additionally, high-level TPK requires teachers to make conscious choices and combine game elements of these clusters, relying on their teaching objectives and students' demographic characteristics. For example, a teacher could highlight cooperative and reputation elements of the social cluster as part of a course designed to build collaborative abilities. Nevertheless, the review shows that the fictional cluster (narrative, storytelling) was the least

used across all tailoring approaches. Toda et al. (2019) believe that these elements play a critical role in providing meaningful learning contexts and their absence can result in a superficial gamified experience. This correlates with what has been observed by Palomino et al. (2019), namely that the fictional dimension was generally disregarded when developing gamified environments. In addition, the review revealed that not much research employed all five game element clusters simultaneously, which restricts the investigation of the comprehensive effects of TPK. Unlike the earlier studies, this review not only lists game elements but also categorizes them functionally and thus offers a better actionable guidance to teachers. To improve the TPK in the future, teacher professional development programs need to be developed on how to deeply integrate different game element clusters with subject-specific pedagogies. At the same time, there is an urgent need for more empirical research to explore the specific impact on student learning motivation and outcomes when teachers systematically employ all game element clusters based on their understanding of student types, thereby providing a more solid evidence base for TPK.

6.4 Limitations and directions for future research

This dissertation provides insights into the pre-class phase of digital game/gamification learning settings through students' acceptance diagnosis and game design planning. When interpreting the results of this dissertation, some limitations need to be acknowledged.

Firstly, one key limitation is the contextual domains of empirical studies. The quantitative questionnaire and qualitative interview surveys in Chapters 2 and 3 were both conducted within Chinese universities and focused on specific disciplinary contexts, particularly English courses. Chinese universities know particular cultural, institutional, and pedagogical traditions, such as teacher authority and exam-oriented learning, which may have shaped students' perceptions of gamified learning. Consequently, the generalizability of the findings to other cultural or educational contexts may be limited. However, despite its contextual specificity, the study contributes theoretically by clarifying how acceptance and design mechanisms operate within a defined educational setting. Future research should therefore test and extend this work across diverse countries, educational systems, and disciplines to examine whether the identified acceptance mechanisms and design principles remain stable or context dependent.

Secondly, the empirical research mainly focused on self-reported data, which were gathered through either questionnaires or interviews. Even though mixed-methods were used to improve explanatory power, self-reported measurement may not represent students' actual learning behaviors or engagement during the gamified activities. The future research might adopt learning analytics, log data, or behavioral traces of gamified systems to combine the self-reported perceptions with observable behaviors, in order to give a stronger insight into how students interact with the gamified learning environments in reality.

Thirdly, although this dissertation emphasizes the significance of pre-class design as well as personalized strategies to cater to learner needs and preferences, the empirical findings (Chapters 2 & 3) failed to adopt or experiment with an adaptive game-based system in real

classrooms. Both systematic literature reviews (Chapters 4 & 5) indicated that most studies remain at the user modeling or static personalization stage, and this limitation is also reflected in the current empirical study. The next steps in future research ought to go further than the initial stages of pre-class diagnosis and design to introduce and assess the application of digital gamified system in the class. Longitudinal and experimental designs would be particularly valuable for examining their effects on learning outcomes and motivation.

6.5 Implications for practice

This dissertation enhances the comprehension of implementing gamified learning by incorporating the comprehensive UTAUT and TPACK models into a two-step framework that sequentially conducts an acceptance diagnosis before class and evidence-based instructional design. In addition to its theoretical value, it offers several practical recommendations to teachers, students, and schools aimed at improving the effectiveness of gamified learning environments.

6.5.1. Implications for teachers

The findings indicate that teachers should avoid adopting one-size-fits-all gamified strategies and instead shift their attention to the pre-class stage to improve the effectiveness of in-class implementation. Before designing gamified learning activities, it is advised that teachers explore students' acceptance of gamified learning and their learning needs and preferences using questionnaires, informal communication or any other approaches. This preliminary diagnosis is useful to ensure that there is no mismatch between game mechanics and learning goals, as was found to negatively impact student performance expectancy and intrinsic motivation. Moreover, in choosing and designing game elements, teachers ought to follow the principle of simplicity and relevance so that every game element fulfills a specific and clear pedagogical role and does not impose excess cognitive load on students due to complicated interfaces or rules. In instructional practice, teachers can use adaptive or dynamic strategies with AI-based instructional devices to identify individual differences among students and respond to their real-time needs.

6.5.2. Implications for learners

From the student perspective, this dissertation emphasizes the importance of actively participating in the pre-class diagnosis and being truthful about their own preferences and learning requirements in order to achieve successful gamified learning. Students in a gamified class should not be seen as a passive recipient, but as a joint constructor of the learning process. With a clear articulation about their expectations, problems faced, and their motivation, students may assist teachers in designing more individualized and pedagogically relevant gamified activities. Moreover, the results indicate that it might be useful to reflect on their opinions regarding what is considered as serious learning. If digital games/gamification are designed to meet particular learning objectives explicitly and when combined with self-directed learning, then they could meaningfully support deep and sustained learning.

6.5.3. Implications for schools

At the institutional level, this dissertation underscores the critical role of educational institutions in supporting pre-class gamified learning. Stable technological facilities must be supplied by schools and universities to help in creating effective digital game/ gamification environments like cross-platform learning management system and learning analytics tools to enable the collection and assessment of dynamic learning data of a student. Furthermore, institutions ought to establish regular professional growth plans that can assist educators in understanding the key principles related to games, analyzing learners' data, and enabling them to improve their compatibility of designing efficient pre-class gamified activities. Instead of advancing standardized gamified designs, educational institutions are motivated to ensure flexible implementation models, which allow teachers to make gamified strategies adaptable to the course goals, student populations, and contextual limitations.

In sum, this dissertation indicates that successful implementation of digital gamed-based activities should be achieved through more factors than only technical equipment and teachers. it is more dependent on coordinated efforts between teachers, students and educational organizations. By strengthening pre-class preparation, respecting learner diversity, and adopting context-sensitive and personalized design principles, gamified learning has the potential to evolve from a surface-level engagement tool into a sustainable and pedagogically meaningful instructional approach.

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