Games Literacy for Teacher Education: Towards the Implementation of Game-based Learning

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ABSTRACT: Game-based learning (GBL) has been widely recognised in research, and evidently benefited for learners. However, what GBL is perceived by teachers and learners has been a concern that might impact on quality of teaching and learning in the GBL environment. Game-based pedagogy meticulously designed from a teacher's perspective was regarded as harping on the same string without fun by learners. This paper aims to explore games literacy capabilities in supporting teachers to implement GBL that meets learners' needs and expectations. Semi-structured interviews and surveys with experienced teachers of GBL and experts in the relevant field were conducted, followed by an Analytic Hierarchy Process seeking perceptions of a group of academics and researchers. Findings suggested five key capabilities in game literacy required by teachers in implementing GBL. They are (1) basic games literacy, (2) high-level games literacy, (3) instructional design for GBL, (4) organisation and management for GBL, and (S) evaluation of GBL. Amongst the five, instructional design for GBL and high-level games literacy were rated highly impacting on the quality of teaching. Based on the findings, aiming at informing teacher education and professional development, we proposed a framework providing a guidance to improve game-based design and pedagogical practices for teachers in the implementation of GBL in their classrooms. It concludes that teachers' capabilities in games literacy require specific attention to instructional design – that demands a thought-provoking process for GBL.

Keywords: Game-based learning, Games literacy, GLTE framework, Instructional design, Teacher education

1. Introduction

Over the past decades, there has been a growing attention for the use of digital games in learning and instructions, often referred to as serious games or game-based learning (GBL). In this respect, two dimensions of learning are regarded to contribute to GBL: cognitive and affective (O'Neil, Wainess, & Baker, 2005). Both dimensions of learning emphasise the adaptation of learning to accommodate learners' cognitive needs and interest, and provide motivation for learning (Malone, 1981).

Previous studies have shown that GBL is more effective than conventional instructions, such as lectures or classroom instruction (e.g., Sitzmann, 2011; Wouters & van Oostendorp, 2013). However, it is argued that GBL often involves complex learning environments, where players can be easily overwhelmed by information and activities provided for learning (Wouters & van Oostendorp, 2013). This raises a question that whether GBL environments can afford learners to engage in processing cognitive activities as it requires a careful instructional design and support (e.g., scaffolding, giving feedback etc.) from teachers as designers and facilitators (Wouters & van Oostendorp, 2013).

There is also a debate that GBL is perceived by teachers as an effective approach in educational practices. Teachers often acknowledge the merits of games whereas they complain the difficulty of completing effective instructional design, which seriously hinders the advantages of GBL. Merrin (2009) believed that new media posed a threat to teachers' authority in practice. One of the reasons may relate to differentiated interests and understandings of GBL. Although many teachers are confident in developing computing skills as presented in the "Serious Play" project (Beavis, 2017), a fear over adopting digital technologies to teaching does exist (Pivec, 2009; Zhu & Wang, 2018).

Furthermore, it is believed that many teachers separate "digital technologies" from GBL as they tend not to see it as an entity for learning and teaching (del Blanco et al., 2012; Yukselturk, Altiok & Başer, 2018). This indicates constructivist pedagogical approaches which often emphasise games enabled authentic learning opportunities where learners are agents in the process (Mama & Hennessy, 2013). It is most likely that teachers use the same pedagogical practices for the use of provided tools or platforms like other tools or resources in their classroom (Prestridge, 2017).

A systematically conceptualised games literacy is much needed to equip teachers in achieving GBL. This is particularly discussed in Zimmerman's (2009) work, where he argued that games design is a paradigm for understanding and addressing the key components of digital literacy. It is essential that a theory-based practical measurement should be developed to instruct literacy diagnosis and educational strategies in the implementation of GBL (Klimmt, 2009). According to Zimmerman's (2009) three concepts of gaming literacy (which we prefer "games literacy" in this paper), namely systems, play, and design, teachers' literacy on games and capability development of understanding the dynamics of games are key to achieve GBL.

Given all the concerns, the present study aims to explore what GBL informed games literacy for teachers is and what teachers think about their needed capabilities in games literacy for the implementation of GBL in the classroom. It is notable that teachers' capability development in games literacy caters for learner's needs and expectations in a GBL environment (Osatuyi et al., 2018). In line with the principle and value of the digital game culture, the role of teachers needs to be explicitly expressed when GBL is usually co-designed and conducted with learners. We aim to address the following research questions by conducting this study:

- Research question 1: What are the essential capabilities in games literacy for teachers informed by GBL?
- Research question 2: What are the most important capabilities in games literacy that teachers need to prioritise in the implementation of GBL?

The exploration of the key capabilities in games literacy informed by GBL for teachers will enable us to propose a framework providing a guidance to improve game-based design and pedagogical practices informing teacher education and professional development in the GBL pedagogy. As discussed briefly, there are many terms and concepts relative to GBL hence how we define and use them in this study is very crucial.

2. Literature review

2.1. Defining terms: GBL and games literacy

The term GBL mostly emphasises a type of gameplays for learners during learning and achieving positive outcomes (Shaffer, Halverson, Squire & Gee, 2005). In other words, this term identifies learners' ownership and student-centred learning experience. In a technological approach, game-based teaching is often used as differing from the traditional teaching approach (Jackson, 2009). This relies on instructors' design in terms of the nature of games and learning objectives in line with curricula (Becker, 2017). Therefore, in this paper we specifically focus on GBL as it highlights a student-centred approach.

According to Day (1973), the practice and understanding of games literacy was limited to the observation of games. It was believed that games literacy was an ability that players must build through multi-plays of the games in a successively changing environment, including game scenes and various platforms. In other words, games literacy was highlighted for its functionality and usefulness contributing to sound gaming experience for learners (Day, 1973). Subsequently, games literacy was regarded as a distinctive literacy similar to the television, film and literature, belonging to cultural media literacy (Buckingham & Burn, 2007). In that, games literacy, instead of being understood as a theory, was more appropriately derived from three dimensions, namely culture, criticism, and creativity (Partington, 2010). Although the content of games literacy varies in contexts it is emphasised in different aspects (Kim, 2008; Wang, 2010; Zagalo, 2010).

Meanwhile, the functions of games literacy also vary in addressing challenges of the recent developments in the digital games industry (Klimmt, 2009). To be specific, games literacy as an effective mechanism could potentially protect (adolescent) players from undesirable gaming effects, avoiding the impact of gaming violence (Cantor & Wilson, 2003) or preventing youths from games addiction (Tao, 2009). In the field of education, based on Gee's notion of literacy (Gee, 2003), Zagal and Jose (2008) developed a framework implemented as an assessment tool of developing students' games literacy competence.

Apperley and Beavis (2013) developed a model for critical games literacy in which they defined the gaming literacy instead of games literacy as games are enacted by players, mostly students in educational contexts. As new literacies, they are associated with traditional 'literacy' such as reading and writing. This implies that gaming literacy involves "texts" as well as "action" which is believed that gaming literacies (Zimmerman, 2009) were informed in actions of digital gameplays (Atkins, 1993). Zimmerman (2009) specified three concepts of gaming/games literacy: systems, play and design, which highlighted the role of teachers in the process. However

little research has examined the importance of teachers' games literacy and essential capabilities they need for designing, implementing, and facilitating game-based learning in various educational settings.

2.2. Games literacy for learners

Nowadays, 21st century skills have been stressed, which urges the change to a third perspective to observe games literacy, that is games literacy could be of social and cultural capitals much needed for young learners (Bourgonjon, 2014; Partington, 2010; Yeh, Chang & Chen, 2019). In addition, it is seemingly that it develops a necessary systematic, critical thinking skill demanded for learners (Salen, 2007) and other new sets of ideas and skills as well as practices (Zimmerman, 2009).

Some scholars assert that games literacy is necessary to be acquired by players/learners, and received recognition or understanding of by people around, including parents and friends (e.g., Robertson, 2018). Chuang, Chen, Chen, Shen and Tsai (2011) pointed out that the understanding of games literacy and its emerging advantages for learners should be explained to parents in order to avoid potential family cognitive conflicts regarding digital gameplays. It is important to address scaffolding that is typically provided by parents and teachers to engage with children/students for effective interactions for learning purposes in informal or formal context respectively (Tollånes, Aarsand & Sandberg, 2011).

It is notable that not all learners are games players, and not all teachers are keen advocates for the use of games or experienced with adopting games to engage students with learning in the classroom (Beavis, 2017). Therefore, it is important to understand what capabilities are required for teachers to at least attempt to experience the GBL pedagogy.

2.3. Games literacy for teachers

Kali, McKenney and Sagy (2015) suggested that teachers should be seen as designers of digital learning with the aid of technology. McKenney (2005) synthesised "ecological" as the term to describe the complex and dynamic settings in which teachers have to work in designing learning for learners. In addition to "design", teachers are also facilitators of learning when it occurs (Carey, 1993). Given the strength of the learners have in terms of games literacy, what teachers should do to design and facilitate such GBL pedagogical learning is vital (Hsu, Tsai, Chang & Liang, 2017).

Catherine Beavis and her colleagues (Beavis, 2017) developed an Australian Research Council funded study on literacy teachers' beliefs in "Serious Play" (2015-2017). They adopted a term "Serious Play" comprising of educational games or game-based activities for both informal and formal learning. Rowan and Beavis (2017) reported that those literacy teachers interviewed expressed a clear belief in the potentially successful educational outcomes. In light of their belief, they showed confidence of innovation within an existing curriculum and inside the boundaries provided by different education authorities, schools and individuals. Researchers indicated teachers' pedagogical beliefs typically expressed in three areas: developing computer skills, delivering the content of the curriculum, and enacting change in teaching and learning (Prestridge, 2017). These imply that teachers engaging with digital games rely on their belief and roles in student learning (Prestridge & de Aldama, 2016).

Drawing on two case studies, Beavis and O'Mara (2010) believed that successful gameplay entails simultaneous attention to a number of elements in the use of a wide range of literacy practices which go well beyond what most literacy required in subject-based curricula. Crucially, Beavis (2013) emphasises active and creative dimensions of work with texts from a design perspective. She warned that teachers should look forward not backward when reimagining curricula to engage with texts and literacies of "old times." Teachers should consider that games play an important role as challenging but important hybrid textual forms that are closely linked with action.

There is a scarcity of research looking into teachers' games literacy but in fact, it can impact on the uptake and implementation of GBL and discouraging young learners' interest in and engagement with GBL. According to the review above, our proposed framework refers to the knowledge and emotion of teachers in the process of GBL, and the competence to strike a balance between games, teaching, and students by endorsing game thinking. To provide clear guidelines to teachers in supporting their games literacy capabilities development, this study investigates the essential and prioritised factors drawn attention to experienced teachers. We take these

into account to develop an emerging framework on games literacy for teacher education and professional development as required in the implementation of GBL.

3. Methodology

3.1. Research design

The present research aims to explore what GBL informed games literacy for teachers is and what teachers think about their needed capabilities in games literacy for the implementation of GBL in the classroom. The design of the present research is essential, where teachers were the key participants to study, including their perceptions and experiences of GBL. Employing a combination of quantitative and qualitative research (Creswell, 2012), the study contains three phases of research in which semi-structured interviews (Phase One), a quantitative systematic review of literature (Phase One), one online survey (Phase Two) and one email survey (Phase Three) were conducted.

A critical evaluation of the findings was followed and led to proposing an emerging framework for teachers to develop games literacy in the GBL environment. The study sought to answer the two research questions (see Section 1). Both questions are answered in the findings of the study and Research Question 2 is further discussed in constructing the proposed framework.

3.2. Data collection

This study involved three phases of data collection: (1) a quantitative systematic review of literature, and interviews with teachers, (2) online survey with selected teachers and researchers, and (3) email survey with experts and scholars in the field of educational technology and teacher education.

3.2.1. Phase One: Semi-structured interviews and a quantitative systematic review of literature

Interview participants: The first phase of data collection, semi-structured interviews, recruited two groups of teachers and researchers. One was out reached in March 2018 where eight participants who were awardees of Competition in Educational Games 2016-2017 were invited to join one-on-one tele-interviews. The other one involved six participants including five teachers and one principal from various primary and secondary schools who were contacted in May 2018. These participants were the members of a distinguished teacher group and they often delivered professional development workshops addressing GBL to other teachers.

Design of the interviews: A selective sampling was adopted when choosing the interview sample as the objects that can provide insights in relation to research questions (Bernard, 2017). It was aimed at collecting and completing key items of games literacy which were evidently required in the implementation of GBL from a practical perspective. Besides bio-data related interview questions, two principle topics as follows were designed in the protocol. All interviews were recorded with a total of 240 minutes. No demographic information was aimed to gather as the focus of the interviews was only the questions presented below:

- If you were invited to give a lecture for teachers about GBL, what procedures would you follow?
- What capabilities are required for teachers to design and deliver GBL?

A systematic review of indexed journal articles: the research team conducted a systematic review in a quantitative approach. The aim is to examine any missing relevance of "Games Literacy" appeared in the indexed SSCI and AHCI journals. This step complemented the results of the interviews and assisted in defining key concepts of games literacy.

3.2.2. Phase Two: Online survey

Participants: An Online Survey was designed and distributed to experienced GBL teachers and researchers who attended the Game-based Teaching Excellence Class Exhibition – the 3rd Game-based Learning International Conference. The research team generated an Online Survey QR code and invited all conference participants to fill out the survey. The team also held a couple of presentations where they were able to embed the QR code in the presentation slides to recruit participants. The team also approached teachers who they had known and

attended the conference to complete the online survey. This event provided the research team with a great opportunity to reach out experienced teachers and researchers of GBL.

Design: In accordance with the reviewed literature and results from the interviews, we compiled the items collected in the first phase into a survey. The purpose is to use the results of exploratory factor analysis (EFA) (Yong & Pearce, 2013) to classify and reduce the dimensionality of all games literacy to make it more logical. The Phase Two survey was an online survey accessible from July 2018 to January 2019. The survey received a total of 240 respondents. After eliminating the invalid responses, 231 were included for analysis. Invalid responses were defined as those incomplete and/or with a consistent single selection throughout. The effective survey recovery rate was 95%. The Cronbach's alpha was $\alpha = 0.948$.

Every question in this survey was designed in a five-point Likert scale in the form of "1 = strongly disagree" to "5 = strongly agree." Questions were all delivered in the formatted expression starting with "I think teachers who adopt game-based teaching should be of…". There were 39 items presented in the survey including sections such as, a brief introduction, a description of game-based learning, 5 bio-data questions, and 34 research variables seeking perceptions of respondents (see Appendix B).

To examine the validity of the survey, instructors from a primary school in Futian District, Shenzhen, China helped respond to pilot survey questions. The instructors were expected to provide feedback on the feasibility and sensibility of each question. Based on the feedback from a total of 50 samples, the original version of the survey was modified. Of five questions were removed from further analysis as the score of Corrected Item-Total Correlation (CITC) was tested smaller than 0.6. Whereas the retained items were refined based on the opinions.

3.2.3. Phase Three: Email survey

Participants: A relevant comparison matrix in accordance with Analytical Hierarchical Process (AHP) was designed (see Appendix D). In that the second survey was aimed to seek knowledge and perceptions of experts and scholars on games literacy. These experts worked in the field of educational technology and teacher education. The Phase Three survey was distributed through emails. In total, 20 experts and scholars from highly reputable higher education institutions in China were contacted to provide consolidated opinions. The response rate was 100%.

Design: The main purpose of this phase was to consolidate professional opinions of experts in GBL and identify the most important games literacy factors and capabilities needed to be prioritised for teachers to develop given their busy schedule. AHP was used here to make a pairwise comparison of literacy elements, and to judge their relative importance in the form of scores. Specifically, it helped identify the key literacy that instructors can prioritize to improve teaching quality, which is beneficial to evaluation and self-examination. Merits on the importance of these factors can be done by giving weights to each one. The results of the survey contribute responses to the RQ2 identifying the most important capabilities that should be prioritised by teachers to develop in games literacy.

3.3. Data analysis

Each phase was undertaken differently, therefore analytical tools and approaches varied due to the nature of their designs aligned with the research questions.

3.3.1. A systematic review and interview data analysis

The "Sougou Hearing" voice transfer software was used to transcribe the interview recordings. Four research assistants manually checked recordings to ensure the alignment of the voice text and the voice content. These research assistants were coded as A, B, C and D and worked systematically; for instance, A was responsible for extracting key words from the transcribed texts, which followed by B and C's reviews and D's finalisation.

An extensive literature review was conducted to search for items that might not be mentioned in the interview, and to ensure the factors of GBL completely converted. Researchers used Games Literacy as the keyword to search for peer-reviewed scholarly articles listed in SSCI and AHCI indexes. Eighteen refereed articles and two

books containing a clear claim about items of games literacy were incorporated for analysis. 19 key words were identified and added to our list of correlated items generated in the first online survey (see Appendix B).

3.3.2. Online survey data analysis

The online survey data were loaded to SPSS version 24.0 and analysed starting from an internal consistency of the instrument. The data were entered into the SPSS software to produce descriptive statistics focusing on frequency, means, standard deviations and percentages. Exploratory Factor Analysis (EFA) was employed to generate factors (or components) demonstrating the relationships among the statement questions (variables). A couple of initial tests, such as descriptive statistics and KMO and Bartlett's Test, were conducted to check if it was worthy of factor analysis. Then, a varimax method of factor rotation was used along with multiple loadings to ultimately generate main factors underlying statistical validity. Each factor interpreted grouped items (or variables) for a clear report of the data.

To ensure the reliability of the generated factors, Cronbach's alpha (α) was used to indicate the overall reliability of the scale. It was then followed by an EFA that was conducted to identify the underlying correlation within the 39 items which are also key factors to GBL. Each factor's reliability testified with Cronbach's alpha was examined. An alpha level of 0.05 was used for the statistical tests.

3.3.3. Analytic Hierarchy Process (AHP) for email survey

Analytic Hierarchy Process (AHP) is a multi-criteria decision-making method combining qualitative and quantitative analysis. It allows to take simple pairwise comparison judgments of experts to determine overall priorities in order to rank the alternatives (Saaty, 2008). AHP has been used in various settings to make decisions and such analytical method has been adopted and written by scholars (e.g., Bhushan & Ria, 2004; Hummel, 2001).

To complete a hierarchical analysis, a structure of the problem as a hierarchy was first established which was acquired from the result of the EFA that was employed to analyse the findings of the Phase One online survey. The identified five factors were then divided from two dimensions as the results of the factor analysis showed a distinctive property between generating games literacy (basic games literacy, high-level games literacy) and practical game-based learning literacy (instructional design of GBL, organisation and management of GBL, evaluation of GBL).

Based on the findings of the previous two phases, a three-level hierarchy containing 2 dimensions, 5 constructs and 18 items were emerging as criteria to examine the importance of the factors in a given level with respect to some or all of the items in the adjacent level above. The study then followed the 1~9 scale method specified in the AHP. A three-level hierarchy as the form of the matrix was established, which was followed with an elicit pairwise comparison assessment (see Figure 1).

In terms of data processing, we used a software that specializes in processing AHP data. This software was developed by a technology company, and we purchased the license to use it. Therefore, the data processing was assisted by computer software according to the principle of AHP.

Figure 1 illustrates the calculation idea. The last step was to use the formula to sort out the factors in the matrix. The Formula 3-1 (see below) was used to calculate the scoring results, and the relative importance weights between the lowest layer and the highest layer in turn. Formula 3-2 was used to calculate consistency ratio (CR.) – test the consistency of the matrix on individual perceptions. Random index (RI.) can be obtained by referring fixed figures (see Appendix C).

$$\omega_i = \frac{1}{n}\sum_{j=1}^{n}\frac{a_{ij}}{\sum_{k=1}^{n} a_{kj}} \quad \text{.....Formula 3-1}$$

$$\text{CR.} = \frac{CI.}{RI.} \quad \text{..... Formula 3-2}$$

Figure 1. Formula of Analytic Hierarchy Process (AHP)

4. Results

4.1. Results from interviews and a systematic review

As explained in the analytical process, both the interviews with two groups of teachers and the keyword "Games Literacy" search in the scholarly articles indexed in SSCI and AHCI contributed to the correlated items in relation to essential capabilities in games literacy for teachers.

19 capabilities were mentioned in the interviews and literature search which were emerging into 6 sections consisting of 39 survey questions:

game knowledge, game belief, game spirits, game thinking, game awareness, game morality, game critique, game creativity, game access, game operation, game identity, activity design of GBL, curriculum design of GBL, product design of GBL, organisation and implementation of GBL, the gamification management of classes and schools, assessment of game-based activities, assessment of game-based curriculum, assessment of game-based environment.

4.2. Demographic information in Phase Two's online survey

Demographic characteristics of the respondents were examined. Among the 231 respondents, 64.0% were male and 36.0% were female. In terms of years of teaching experience, 2.7 years was reported as a medium. Instructors in Information Technology disciplines accounted for a maximum of 28.4%, followed by instructors in Others (23.46%) who were specialised in subjects like Educational Technology and Mobile Learning – are the common subjects in the universities of China.

About 32.2% indicated that they were employed in higher education, followed by instructors who were engaged with teaching projects in primary schools (22.22%) and high schools (22.22%). It could be understood that GBL is widely focused in tertiary level since tertiary students are often mature in handling the relationship between technique-related games and formal learning. In addition, approximately 23.46% reported that they were also teaching other disciplines.

Moreover, GBL is more commonly accepted by younger-aged teachers that is related to their stress level at work and willingness of adopting digital technologies. More than half of participants (65%) reported that they did not play games every week, alternatively spending less than 2 hours on games weekly.

4.3. Results from Exploratory Factors Analysis (EFA) on Phase Two's online survey

The EFA extraction method used on the scales was Principal Axis Factoring. The rotation method selected was Varimax. The level of commonality among the items was considered wide (from 0.6-0.8) scales. The Principal Component Analysis was used to help establish the number of factors to retain. Factors are often retained if the eigenvalue for the actual data is larger than 1.0 (Kaiser, 1974). All the factors retained for scales had an eigenvalue > 1. It was determined through these criteria that the five factors indicated by the Principal Component Analysis were retained, accounting for 71.550% of the variance (Table 1).

Table 1. Adoption factors total variance explained and reliability

Factors	Eigenvalues			Number of items	Cronbach's alpha
	Total	% of variance	Cumulative variance		
1	10.967	21.612	47.684	7	0.901
2	1.984	16.307	56.311	6	0.878
3	1.282	14.590	61.885	4	0.865
4	1.172	11.337	66.982	3	0.854
5	1.051	7.309	71.550	3	0.844
6	0.787	3.422	74.973		

With the 5 factors, the Kaiser-Meyer-Olkin measure of sampling adequacy was 0.878, which is above the minimum threshold of 0.5 suggested by Kaiser (1974). Bartlett's test of sphericity had a Chi square of 4187.751 ($p < .001$), indicating that the intercorrelation matrix contained variables with sufficient collinearity for analysis (Bartlett, 1950). The rotation converged in 9 iterations. The factor loadings were evaluated through using the

items and the weight of their loadings on each factor. A descriptive label was assigned to each factor. Table 1 contains the variance in relation to each factor, the enclosed number of items and each factor's Cronbach's alpha.

The first factor contained 7 items from the 5 concepts in GBL, such as activity design, curriculum design, product design, game creation and design of such environment. These items are related to the procedures of design when teachers integrate games (game-related elements) into classroom, including the design of environment, the design of learning activities and the design of assessments. The term Instructional Design (ID) refers to instructional system development (ISD), namely the stages of analysis, design, development, implementation and evaluation (Dick, Carey & Carey, 2005). It involves the utilization of strategies, assessments and techniques to integrate educational resources to accomplish an instructional design. As the evaluation of learning needs to be gamified, some game-related elements, regarded as normal assessment tools, such as scoreboard, ranking and reward need to be embedded before introducing them while teaching in the classroom. Therefore, this factor was named as Instructional Design of GBL accounting for 21.612% of the variance, indicated that this is a very important construct of the emerging GLTE framework (details can be found in Section 5).

The second factor contained 6 items from the 4 concepts of game belief, game critique, evaluating GBL, and evaluating learning with gamification. These items related to issues of distinctive games, keeping a critical attitude towards games, and evaluating GBL. Therefore, this factor was named as evaluation of GBL. There are two different connotations to this literacy construct: one refers to an evaluation method involving game-related elements in the evaluation; and the other refers to an object which can be evaluated by educators (Chen & Zhang, 2019).

The third factor contained 4 items from the 4 concepts of game knowledge, game manipulation, game morality and game access. These items relating to issues of the basic qualities are necessary for better gameplays, implying that without this literacy element players are hardly exposed to a good gaming experience. Therefore, this factor was named as basic games literacy.

The fourth factor included 4 items from 3 concepts of game thinking, game identity and game spirits, involving the application of games and resolution to real life problems. Games literacy takes the developmental processes and social personal resources into account. The social personal resources can be explained as cognitive skills and social support from friends which is contrary to states of psychological crisis (Klimmt, 2009). Therefore, this factor was named high-level games literacy.

The fifth factor is relevant to the following three contexts: applying designed game-based instructions into practice, organizing GBL in the classroom, and using gamification to manage learning and teaching. This factor contained three items from the two conceptual domains: organisation and implementation of GBL, and the gamification management of classes and schools. Therefore, this factor was named as organisation and management of GBL.

The first research question explores what literacy factors are necessarily equipped by teachers. This was mainly responded by conducting the EFA involved in the Phase One online survey. The results demonstrated the following five game literacies: basic games literacy, high-level games literacy, instructional design of GBL, organisation and management of GBL, evaluation of GBL, which are emerging to become key factors in developing the games literacy framework for teachers and continuing education for successful GBL.

4.4. Analytic Hierarchy Process (AHP) on Phase Three's email survey

The weight value of each evaluation index is the eigenvector value of the comparison matrix (see Table 2). The calculated weights of the two dimensions relative to the target layer are 0.5025 (Practical game-based teaching literacy) and 0.4975 (Generate games literacy). In turn, among the items contained in practical game-based teaching literacy, instructional design of GBL weights the largest (0.3348), followed by organisation and management of GBL (0.3337) and evaluation of GBL (0.3315). In general games literacy, the proportion of high-level games literacy (0.5028) is slightly higher than the basic games literacy (0.4972).

The results of AHP provided a partial answer to Research Question 2: What are the most important capabilities of games literacy that teachers need to prioritise? It indicated that instructional design for GBL and high-level games literacy were the literacy capabilities to be prioritised affecting the quality of game-based teaching utmost. The perceptions among the 20 experts of capability development for teachers' games literacy were

collected and analysed in the method of AHP. Their perceptions were consolidated and became judgmental criteria to ascertain the most important capabilities that should be prioritised and more targeted for teachers to develop their games literacy. The result suggested that teachers need to prioritise instructional design GBL and high-level games literacy as guidelines for the improvement of their teaching practices in the GBL contexts.

Table 2. The weights and consistency test results

Target layer	Constructs	% of weights	Domains	% of weights
0.5025	Instructional design of GBL	0.3364	Game creation	0.1973
			Curriculum design of GBL	0.2032
			Activity design of GBL	0.1998
			Product design of GBL	0.1990
			Design of GBL environment	0.2002
	Organisation and management of GBL	0.3354	Gamification management of classes and schools.	0.5095
			Organisation & implementation of GBL	0.4950
	Evaluation of GBL	0.3332	Evaluate learning with gamification	0.2506
			Evaluate GBL	0.2491
			Game critique	0.2497
			Game belief	0.2506
0.4975	Basic games literacy	0.4972	Game knowledge	0.2491
			Game access	0.2497
			Game manipulation	0.2506
			Game morality	0.2506
	High-level games literacy	0.4978	Game spirits	0.3315
			Game thinking	0.3348
			Game identify	0.3337

5. Developing a Games Literacy for Teacher Education (GLTE) framework

Previous research on GBL has rarely focused on the capabilities in games literacy for teachers, and the measurable capabilities were much needed to be explored (Osatuyi et al., 2018). The present research evaluated experienced teachers' and researchers' perceptions of GBL. In order to explore the latent variables in games literacy, a synthesis of quantitative and qualitative research conducted was necessary and supported the development of an emerging framework for teachers to develop games literacy in GBL. This framework provides guidelines for instructors to integrate games into teaching and learning at all levels in different settings to implement GBL.

The proposed Games Literacy for Teacher Education (GLTE) framework illustrates the connections between design and delivery of GBL and teacher's capability development in games literacy. We present this framework drawing on the insights of experienced teachers and scholars to emphasise practical understandings of GBL and situate teachers' capabilities development as key for the successful practices in teaching and learning.

Our framework was inspired by a model for Critical Games Literacy (Apperley & Beavis, 2013) which they argued that digital games are different to other digital media due to players' enactment. This model focused on the learning opportunity and learner-centred approach which provided a good foundation to our framework for teachers and their continuative professional development; specifically, presented as two interlocking layers: games-as-action and games-as-text. "The games-as-action addresses the experience of gameplay by examining the virtual worlds of digital games and the dynamic interplay between game and player. The games-as-text examines the connection between the digital game and the lifeworld of the player, where the game play is embedded, enacted and given meaning" (Apperley & Beavis, 2013, p. 2).

This model is clearly developed from the learner's perspective and intended to provide a framework for game-based curriculum planning and pedagogy as it characterises the features of digital games and game play. However, it lacks the clear guidance for teachers to engage in this model. It mentions that design "embraces several crucial and related meanings and should be regarded as both noun and verb indicating the relationship between meaning making elements on a screen or page, and action – the process of designing as a creative activity, with multimodal literacy reconceptualised as 'design' " (Apperley & Beavis, 2013, p. 8).

In our proposed framework, we regard teachers as designers and facilitators whose capability in games literacy directly resulting in the quality of teaching and learning in the complex GBL contexts. Based on the research findings, five literacy capabilities for teachers' game literacy development can be used to measure the quality of teaching and construct a systematic process of design and delivery of GBL: (1) instructional design of GBL, (2) evaluation of GBL, (3) organisation and management of GBL, (4) basic games literacy, and (5) high-level games literacy.

5.1. Instructional design of GBL

The literacy of instructional design of GBL is highlighted by the experts in the related fields, regarded as the most important literacy weighted the highest in comparison with the equivalent constructs, containing 7 items (see Table 2) about GBL. It elaborates the importance of instructional design before adopting games in the classroom. Games design is essential for games literacy (Buckingham & Burn, 2007), as it closely relates to learning outcomes (Gauthier & Jenkinson, 2018). Notably, these correspond to other games literacy in this research, that supports the development of this framework.

It has to be admitted that the teachers involved in the study were working in urban areas, which means that the first-order barrier (extrinsic to teachers) and the second-order barrier (intrinsic to teachers) (Ertmer,1999) are not obviously high when teachers use technology in the class. However, many teachers are still confronted with the third-order barrier: design thinking (Tsai & Chai, 2012). The dynamics of creation might be an obstacle when encountering the advancement of GBL. The improvement of design thinking helps overcome both the first and second order barriers as presumably all barriers are seen as problems that need to be tackled and resolved through human creative thinking (Tsai & Chai, 2012; Makki, O'Neal, Cotten & Rikard, 2018). It is revealed that teachers should focus on the instructional design of GBL which is identified as a key literacy construct in games literacy.

5.2. Evaluation of GBL

The literacy construct of evaluation of GBL contains 6 items (see Table 2). These emphasise the instructors' attitudes toward adopting games in teaching as an effective educational approach, and the implementation of GBL depends upon the role of teachers to a large extent (Ma, 2018). Teachers should first examine games from a critical perspective taking pros and cons of games into consideration and accept this concept of teaching – potentially increase the willingness to incorporate games in the class.

A critical analysis of student motivation, social growth and cognitive gains is important for teachers to recognise effectiveness and accessible functionality of selective games that might be feasible for teaching, as a result, their belief can be shifted to acknowledging the advantages of games for learning (Prestridge, 2017). The evaluation of GBL centres the purpose of the analysis that is not to just represent an object for evaluation, more importantly an evaluation method to observe the process of learning (Chen & Zhang, 2019). Educators are expected to be cautious about evaluating existing empirical evidence before adopting any new pedagogy (such as games and game play) in their own practices.

5.3. Organisation and management of GBL

Although the organisation and management of GBL is not as critical as instructional design for GBL, it had been carefully considered in teaching practices, according to the research findings. It does matter because instructors are comfortable with using games endorsed elements in class such as badges, leader boards, social competition, and reward system. These are all conducive to encourage engagement and increase students' motivation (Kapp, 2012; Hamari et al., 2016).

On the other hand, as mentioned earlier, fears about using games or conducting GBL do exist because some teachers are not confident in dealing with unexpected events or requests while teaching a game-based class, and to some extent that they may be challenged to find ways to bring students back to focus on learning content towards the end of each game. Such fears are subtle and underpinning the competency of teachers in digital technology and pedagogical practices, which are also reflected on the underlying beliefs and the pedagogies that teachers might be used to appropriate digital games in the classroom (Prestridge, 2017). When teachers use games in the classroom, they need necessary operating skills to control the length of the process and avoid the

unnecessary delays to the class schedule. Therefore, the organisation and management capabilities are specifically needed in teacher training, especially for the novice cohort.

5.4. Basic games literacy

Basic games literacy promotes GBL although it may not be limited to education. However, teachers are required to acquire such literacy skills as they should be aware of good games and understand the importance of games selection impacting on the successful GBL implementation (Becker, 2017). The acquisition of this literacy enables educators to access educational games and experience of gameplays at a degree of ease, which caters for the needs of young learners and reduce the personal resistance due to lacking support in digesting basic technological knowledge.

The result of the interviews in the study confirmed that it was difficult to design and carry on high-quality game-based activities if teachers were not aware of basic games literacy. Consequently, it could prevent instructors from experiencing and perceiving the essence of the games in which their students can interact and engage. Teachers who are less exposed to the concept of games are less likely to comprehend the intended purpose of games design and potentially fail to engage students with games for learning purposes. Games ethics are served as principles to design and adopt games. Thus, the basic games literacy is key in the implementation process of typical digital technologies because games cannot even roll out until all the necessary resources and elements are put in place. This factor could be regarded as necessary resources and capability to conquer mainly the first-order barrier before a teacher starts to embrace games into class.

5.5. High-level games literacy

Not only is the high-level games literacy (See Table 2) welcome instructors, but also embracing all gamers. According to the result of AHP, game thinking is the most important quality, which has been described as an umbrella term encompassing gamification, serious game, game-inspired design, and play that can be used for problem-solving (Armstrong, Landers & Collmus, 2016). The key to integral of games and education lies on the connection between knowledge and games, which are delivered to students through creative designs. This kind of design as indicated by Zimmerman (2009) requires a systems-based game thinking.

Game spirits value the characteristics such as self-contained, active and open, self-generational, self-renewal, non-subjective and dialogue. Integralism, one of Gadamer's three interpretations of the games, refers to the re-creative and recurring spiritual communication by a mutual involvement of the game entities (Gadamer, Weinsheimer & Marshall, 2004). It inspires us to explore a relationship between teaching and gaming from a unique perspective integrating the support of game spirits (Wang, 2002). Teachers explore the possibility of GBL through game spirits, with consistency and continuity, that can be observed in stimulating creativity and innovation since teachers are encouraged to be creative in instructional design as game spirits afford. The instructors' willingness to implement GBL is usually high, whereas actions carried by instructors are rare due to the existing problems such as the three-level barriers (Zhu & Wang, 2018). This indicates that instructors who are with game spirits tend to show more persistence and endurance when challenges occur in the procedures.

Game spirits also encourage instructors to make continuous efforts to improve games literacy to advancing their game-based learning pedagogies. Game identity aims to solve the confusion between the virtual avatars and the real humans. Once the game is introduced in the classroom, the role of an instructor changes – thus it is necessary for instructors to take ownership of games and claim their gaming identity, which will enhance the effectiveness of games for education.

The GLTE framework complemented the research findings and responded to Research Question 2. This framework urges teachers to take an opportunity of exercising gameplays to improve games literacy in the implementation of GBL; however, it is not to recommend teachers of sparing all their time on this activity, or becoming a gamer (Prestridge, 2017). The purpose of gameplays is to acknowledge the effort of games being designed for education and be aware of good games for learners that can be used for teaching. Prior to adopting a game in the classroom, instructors are expected to improve general games literacy capabilities including, understandings of the knowledge related to games and GBL, and highlighting different game types, rules and operation. This fosters a foundation for stimulating aspirations for better instructional design, ensuring that games are effectively played in the classroom and met students' expectation for learning through selecting meaningful games with joy.

6. Implications and conclusion

The present study focuses on the essential literacy capabilities of instructors in the field of GBL Its significance is inevitable as little research has touch based on this matter. This study aims to provide a guidance through developing a framework addressing key and prioritised capabilities that will enable teachers to develop games literacy to cater for learner's needs in the GBL contexts. This framework can be used for educators to evaluate their practices of GBL. It specifically highlights the significance of instructional design for teachers to uptake the GBL pedagogy. As Zimmerman (2009) argued, games literacy requires a growing conversation and attention in all sorts of educational settings, given the moving forward digital or online learning in the current events it is important to build a rigorous connection group within the faculty, school or organisation. Through developing this framework, we are also calling for more research-led practices involving both teachers and researchers to establish ongoing collaboration.

Five literacy constructs for educators were identified that can be further explored, confirmed, and updated. The importance of these capabilities in games literacy ranked by AHP will assist educators in identifying key features and examine individual capabilities more efficiently and precisely. The result of AHP showed that practical game-based teaching literacy is equally important to general games literacy, providing a practical suggestion for instructors – that is it is necessary to be cautious about developing games literacy as well as strengthening teaching practices. It is certain that developed games literacy helps instructors accumulate materials and trigger inspiration for game-based learning. In addition, it helps eliminate the games and gaming caused potential knowledge gaps between instructors and students.

This research strives to be rigorous and critical. However, limitations are worthy of consideration. In the aspect of verification of the validity of the first survey data, opportunities can be provided to conduct Confirmatory Factor Analysis. For future research, the framework can be verified by means of post-survey or -tests with other cohorts, including students. It is suggested that future research explores the relationship between these literacy factors through mediation effects. In-depth analysis on the various literacy constructs proposed in this study and framework could be conducted to identify the procedures of instructional design and evaluate effective games design and each would often significantly impact on learning outcomes and experience.

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Appendix A. Semi-structured interview questions

1. Do you play games? How long/often do you spend on gameplays weekly? What types of games do you play?
2. How do you think gameplays? Do you think there is a relationship between playing games and using games for learning and teaching in the classroom?
3. If you were invited to give a lecture for teachers about GBL, what procedures would you follow?
4. Could you describe an impressive GBL experience you have encountered? Any challenging experience you have encountered?
5. What capabilities are required for teachers to design and deliver GBL?

Appendix B. Game Literacy in Teaching Practice (GLTP) survey

I. Demographic information

Gender: Male / Female
Grade taught: Kindergarten / Primary School / Middle School / High School / College
Teaching age: less than 1 year / 1-3years / 4-10 years / 10-20 years / over 20 years
Incumbent disciplines: Literature/Language/Math/Information technology/Physical science/Social science/Others
Weekly game time: less than 2hours/ 2-7hours / 7-14 hours /over 14 hours

II. Formal questionnaire

In the following items, please give your opinion by choosing 1 to 5 to express the importance of these literacy from "very unimportant" to the "very important."

I think teachers who conduct GBL should be of (following literacy):

D1: ability to combine the game-based teaching activities with teaching objectives and content
D2: ability to develop game products or tools based on teaching objectives and conditions
D3: ability to use game products or tools according to the teaching objectives and conditions
D4: ability to design and develop game-based teaching activities based on teaching objectives
D5: ability to design and develop game-based curriculum based on teaching objectives
D6: ability to use external resources to create a gamified physical environment and atmosphere
D7: ability to adapt gamification products or tools according to teaching objectives and actual conditions
M1: ability to apply gamification in the management of classes and schools.
M2: ability to organize and implement game-based teaching activities
M3: ability to organize and implement game-based courses
A1: ability to discover and evaluate a gamified school environment;
A2: ability to evaluate the game-based teaching process in a gamified manner (i.e. using game elements or game mechanics in non-gaming situations);
A3: ability to assess the game-based teaching activities and courses;
A4: ability to evaluate the pros and cons of a game software/application/tool

U1: knowledge to understand game elements (such as leaderboards, rewards, timely feedback, etc.) U2: knowledge to understands the concepts and concepts related to game-based teaching and Game-based learning; U3: ability to create the game which could be used in teaching; U4: skill to game operation; U5: ability to access a game, such as know how to download/find a game;
C1: ability to distinguish the pros and cons of a game objectively, C2: ability to distinguish the different among game genres; C3: ability to view the game from a critical point of view; C4: The belief that the game can be used to solve practical problems better; C5: ability to recognizes the virtual thing in the game. It does not use plug-in to hang up, flash back, compete with the rules of the game, and experience online game in a timely, appropriate and moderate manner; C6: ability to distinguish the virtual world in game and the real world; C7: awareness to realize that game can be reflected in real-world situations and may have a reference to real life.
H1: game think to solve practical problems by using game elements and game mechanics; H2: ability to distinguish the identity and role in the game world and the real world; H3: spirit to confront challenges, never give up, keep an optimistic mentality when playing games.

Appendix C. The average random consistency index table RI

The average random consistency index table RI. (The calculation results of 1000 positive reciprocal matrix)

Matrix order	1	2	3	4	5	6	7	8
RI.	0	0	0.52	0.89	1.12	1.26	1.36	1.41
Matrix order	9	10	11	12	13	14	15	
RI.	1.46	1.49	1.52	1.54	1.56	1.58	1.59	

Appendix D. Example for Analytic Hierarchy Survey scoring matrix

Game-based teaching product design VS *game-based learning curriculum design* indicates the importance of *i* compared with *j*; game-based teaching products refer to various teaching aids and learning tools for game-based teaching.	1	3	5	7	9	1/3	1/5	1/7	1/9	other
Curriculum design of GBL VS. Activity design of GBL										
Activity design of GBL VS. Product design of GBL										
Curriculum design of GBL VS. Product design of GBL										

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Chen, S

2020