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The Impact of an Educational Board Game on Students' Learning Achievement and Flow State in Media and Information Literacy

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Abstract: Given the increasing international emphasis on the importance of identifying and critiquing media content and the proper use of information and communication software, it is imperative to enhance students' media and information literacy education. In this study, an educational board game for media and information literacy was developed to cultivate the basic knowledge of media and information literacy among university school students in Taiwan. A quasi-experimental study was conducted to investigate the effects of the educational board game on students' learning achievement and flow state. Results showed that the educational board game increased students' learning achievement and flow state, but no difference was found between the collaborative-team gaming group and the competitive-multiplayer gaming group in terms of learning achievement and flow state.

Keywords: Media and Information Literacy, Educational Board Game, Flow State, Learning Achievement

1. Introduction

With the development of information technology, people no longer limit their sources of knowledge to traditional media such as newspapers and magazines or television news. The younger generation is inclined to access all kinds of information online using mobile devices. However, the vast amount of information available on social media is full of inaccuracies, some of which were created with the intention of falsifying real information. These articles often have the plausible presentation of real figures and information, which is known as "fake news" (Jones-Jang et al., 2019). Fake news spreads rapidly through the Internet, causing negative impacts on various sectors such as politics, business, and even philanthropy (Vafeiadis et al., 2019). For instance, intentional dissemination of fake news during a specific period led to the occurrence of the Brexit referendum in the UK, or decreased people's willingness to wear masks during the COVID-19 pandemic (Isaak & Hanna, 2018; Kouzy et al., 2020). It is evident that the public's behavior can easily be misled by misinformation. Children in the digital age are surrounded by a plethora of trustworthy and untrustworthy information on a daily basis. This places a great deal of stress on the development of their emotional and cognitive abilities, which may increase their anxiety, damage their self-esteem or distort their worldview (Howard et al., 2021). Although these young people believe that they are confident in the use of these tools in an era when they are dealing with digital products, the fact is that they are watching violent pornography and distorted news messages while using mobile devices on their own (Ofcom, 2020). Meanwhile, problems like cyber addiction and cyber bullying are growing every year (Ofcom, 2020). Therefore, it is vital that alternative media and information literacy education material be further developed (Alexander & Galina, 2020).

The term “gamification” refers to the application of game mechanics to non-game contexts. This new approach to teaching and learning has been widely accepted in recent years in education, and has been integrated into business training, as it can lead to greater motivation and engagement of participants (Caponetto et al., 2014). Gamification is now widely used in various kinds of courses, such as traditional physical classrooms, MOOCs, or other online courses, as well as mixed courses and platforms where gamified content can be applied (Dicheva et al., 2015). Gamification manifests itself in the form of, but is not limited to digital games, virtual classes, and competitive activities. Compared to simply incorporating game mechanics into the curriculum, game-based learning integrates instructional goals into a game to support teaching or student learning. It is another form of applying games in educational settings (Cardinot & Fairfield, 2022). Board games have a long history, and the integration of educational content into board games is not a recent development. Subjects such as mathematics, social sciences, language, and more have educational board game products available. Particularly in academic contexts, educational board games are a recent hit. BoardGameGeek, the world's leading board game website, has classified educational board games as a separate type of board game (BoardGeekGame, 2023). As cognitive skills are valued in the 21st century, game-based learning that incorporates elements of gameplay into the classroom provides learners with a space to explore, be creative, explore topics of interest in groups, and promote opportunities for inquiry and questioning (Pinedo et al., 2022). Learning tasks in game-based learning can reduce the complexity of cognitive learning, clarify thinking strategies, and direct learners' attention to the learning outcomes, thereby giving learners a greater opportunity to further develop and control the problem-solving learning process and thus achieve their learning goals. Learners can have a positive impact on their emotions and persistence in learning through teacher guidance, encouragement, questioning of learners and sharing of knowledge and experience while reducing the cognitive load of learning (Cai et al., 2022).

The study aimed to investigate the effects of using board games in a media and information literacy course on students' learning achievement and flow state, and provided suggestions for teachers who plan to use educational board games for media and information literacy education in the future.

The research questions are as follows:

(1). Does the expanded contextual education board game have any effect on learners' learning achievement of media and information literacy?

(2). Does the educational board game have any effect on the flow of learners?

2. Literature Review

2.1 Media and information literacy

As technology advances, diverse media from computer devices and mobile phones are taking over the traditional press’s dominant position in society. When individuals watch television, play games, or browse the web, they may be potentially interfered with by government authorities, policies or rules. These include possible issues such as cultural diversity, visual media presentation or aesthetic design, or the complexity of media presentations or text composition. Nowadays, multimedia presentation highly contrasts with the traditional linear media of the past (Livingstone, 2004). Students' media literacy in the early years is not sufficient to cope with the large volume of digital information. Therefore, other literacies, such as information literacy, digital literacy and information and computer literacy, have been proposed to help people develop robust media literacy skills.

Although there is a distinction between overlapping and independent literacy in media literacy, many scholars have suggested that an integration of the two can attempt to address the issues which are considered in the field of media and information literacy education today (Leaning, 2019; Mackey & Jacobson, 2011). As new social media and online interaction models have emerged, independent literacy skills have failed to address the challenges. In 2013, the United Nations Educational, Scientific and Cultural Organization

(UNESCO) pointed out that the ability to distinguish evidenced data and information from various information and dissemination platforms is a competency that should be possessed by digital natives in the 21st century(UNESCO, 2013).

Based on the scope of information and media literacy defined by UNESCO, critical thinking can effectively enhance students' ability to identify the accuracy of information (Al-Zou'bi, 2021). The improvement of information and media literacy can also benefit the general public in other domains. Currently, in addition to traditional lecture-based instruction, the education sector has adopted various technological tools to teach information and media literacy. For example, in the field of economics education, the integration of information and media literacy can serve as a fundamental component for students to understand the digital economy, helping them discern which economic information is usable and trustworthy, thereby avoiding financial risks and developing sound economic literacy (Mukhtar & Putri, 2021).On the other hand, games are also effective tools for assisting children in developing critical thinking about media. They promote student collaboration and discussions with peers in the classroom, aiding in the development of literacy. Games can also integrate and reflect their daily media experiences (Costa et al., 2018).

2.2 Game-based learning

The use of educational board games is more limited than that of general gameplay. The main reason is that educational board games have a specific learning objective and a specific appeal, especially for primary school students, university students and even adults (Liu et al., 2020). Their design places emphasis on balancing the learning content with playfulness. It also examines whether the knowledge retained by learners in the gameplay can be appropriately applied to real-world situations. An effective game-based learning environment should support learners in their choice of actions, in moving towards their defined goals, and in experiencing the learning outcomes of their chosen actions. Even if a mistake is made by choosing the wrong option, the risk-free setting of the game environment provides learners with the challenge of failing, inspiring them to revise their ideas and re-plan their actions to succeed in the gameplay after they figure out the correct approach (Tay et al., 2022).

Compared to traditional lecture-based lessons, game-based learning can lead to better learning outcomes and higher motivation. It is also more engaging for students to improve their problem-solving skills (Al-Azawi et al., 2016). The benefits of game-based learning are not limited to the results of tests (Sailer & Homner, 2020). Learning outcomes are generally categorized as cognitive outcomes, motivation and learning behaviors (Sailer & Homner, 2020). Cognitive knowledge involves conceptual knowledge of the intended learning objectives, including facts, principles, as well as application-oriented procedural, strategic and contextual knowledge. The result of learning motivation includes the learner's intrinsic motivation, dispositions, preferences, attitudes, confidence and self-efficacy. Learning outcomes refer to technical skills and motor skills (Sailer & Homner, 2020). Game-based learning has a significant impact on improving cognitive outcomes, and it is better able to help students improve their learning performance than traditional methods (Chen et al., 2020; Ou et al., 2021). Furthermore, another advantage of game-based learning is that it is not limited to classroom settings. It continues to have a positive impact on learners in informal educational environments as well. By setting some basic expectations, game-based learning can yield unexpected outcomes (Alam, 2022). In the 21st century, which emphasizes cognitive skills, game-based learning provides learners with opportunities to explore, unleash their creativity, engage in group inquiries on topics of interest, and foster learning spaces that promote discussion and questioning (Pinedo et al., 2022).

2.3 Flow state

A flow state is a state in which an individual focuses on an activity without noticing external things (Csikszentmihalyi, 1991). Therefore, the flow state can be influenced when learners participate in, attend, or exert mental effort during an activity (Kiili et al., 2021). The design of an educational board game must take into account the elements of participants, tasks and objects. This means that it includes clear objectives, immediate feedback, potential control over fun, ease of use and a sense of control over the activity. Flow consists of three stages, namely flow antecedents, flow experience and flow consequences. When educational games incorporate the above elements, they make it easier for learners to enter a state of mind-flow (Kiili, 2005). Flow has also been found to be strongly correlated with learning achievement. When learners have a more focused flow state, they have better learning results. On the other hand, the use of competitive elements in the game also makes a difference in the flow of learners' minds, and group game designs are more immersive than individual game designs. The relationship between flow and learning achievement is also influenced by the mediating effect of students' learning satisfaction (Chan et al., 2021; Kim & Park, 2021; Ryu et al., 2022). Moreover, flow has been found to be strongly correlated with learning achievement. When learners experience a more focused state of flow, their learning outcomes tend to be superior. The presence or absence of competitive elements in games also influences the occurrence of flow among learners. Group game designs are more conducive to immersion in activities, and the relationship between flow and learning achievement is influenced by the mediating effect of learner satisfaction (Chan et al., 2021; Kim & Park, 2021; Ryu et al., 2022). Currently, there are various scales available for measuring flow. Examples include the Flow State Scale (FSS), the Dispositional Flow Scale (DFS-2) (Jackson & Eklund, 2002; Jackson & Marsh, 1996), as well as scales designed specifically for certain activities, such as Kiili's (2006) Flow Scale for Games to understand flow experiences during gameplay and Pearce et al.'s (2005) Flow State Scale. In this study, considering the pre-test and post-test design as well as the experimental timeframe, we chose to use an 8-item flow state scale.

3. Method

Hi-MyLife, an educational board game for media and information literacy, was developed as the teaching material for this study. The board game offers two distinct gameplay modes: Faction Battle and Multiplayer Competition. In the Faction Battle mode, players team up in pairs, working collaboratively to tackle card-based challenges. Conversely, the Multiplayer Competition mode requires all four participants to independently brainstorm solutions to these challenges. The core gameplay involves drawing cards that depict various story scenarios. Players then choose answer cards from their hand to decipher the challenges and accumulate points. Following each round, learners revisit any story scenario cards they initially answered incorrectly, getting another chance to tackle the challenges. Ultimately, the player with the highest score emerges as the victor of the game. The participants were first-year students taking a digital learning theory course at a national university in northern Taiwan. A total of 28 participants took part in the study. The participants were randomly assigned by the researcher to groups of four, with 16 participants in a collaborative-team (CT) game group, while 12 participants were in a competitive-multiplayer (CM) game group.

The experimental process is shown in Figure 1. After a brief introduction and explanation of the rules of the board game, the pre-test, which lasted 15 minutes, was conducted. The pre-test consisted of a scale of flow state and a learning achievement test of media and information literacy. The scale was developed by Pearce et al. (2005) using a 5-point Likert scale with eight questions on enjoyment, engagement and control, with options of strongly agree, agree, neutral, disagree and strongly disagree. The learning achievement test on media and information literacy was developed by the research team based on the current IT textbooks for primary and secondary schools, and was reviewed by two experts. A group is assigned to a set of board games with the same game accessories. However, the

game rules vary depending on the group. The collaborative-team gaming group had four players divided into two teams to compete against each other, whereas the competitive-multiplayer (CM) gaming group was designed for four players to compete against each other. The session lasted 90 minutes. After the intervention, a post-test was administered to the participants, which consisted of an 8-item Flow State Scale and a 20-item Media and Information Literacy Learning Achievement Test. The items in the Media and Information Literacy Learning Achievement Test were different from those in the pre-test. The post-test session lasted for 20 minutes.

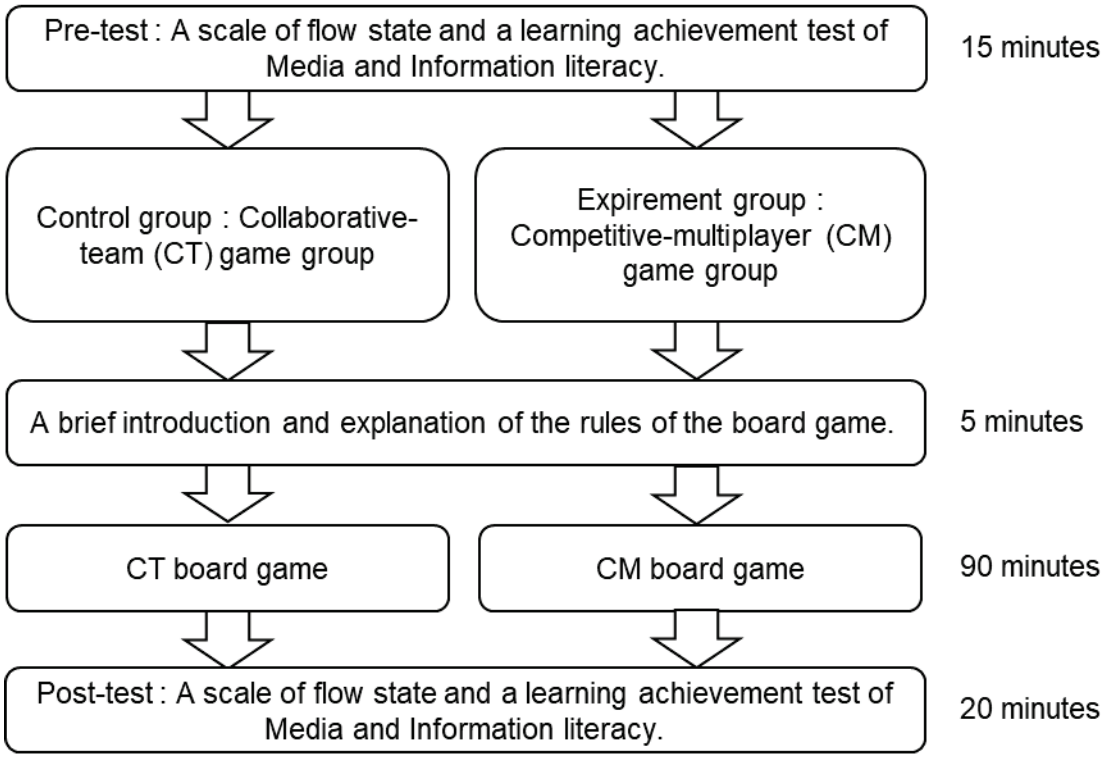

Figure 1. The experimental process.

4. Results

4.1 Learning achievement of media and information literacy

Table 1 shows the homogeneity of the CT gaming group and the CM gaming group. The results conformed to the assumption of homogeneity ($F = 0.476$, $p > .05$); however, the test of normal distribution was not found. Therefore, the Wilcoxon Signed Rank Test was used to examine whether there was a significant difference in the learning achievement of the two groups after participating in the educational board game.

The overall pretest of learning achievement ($M = 29.64$, $SD = 11.86$) was significantly different ($M = 37.32$, $SD = 11.16$) from the overall posttest of learning achievement ($Z = -2.27$, $p < .01$) in media and information literacy learning.

Table 1. *Levene's test results for learning achievement in media and information literacy*

F	*df1*	*df2*	*p*
0.476	1	26	0.496

Table 2. *The Wilcoxon Signed Rank Test of all participants*

tests	*N*	*M*	*SD*	Mean Rank	Sum of Ranks	Z
Pretest	28	29.64	11.86	9.61	86.50	-2.27**
Posttest	28	37.32	11.16	15.56	264.50	

**p < .01

To investigate whether there were any significant differences in the learning achievement of the two groups after using different modes of the educational board game, the Mann-Whitney U test was used. Table 3 shows that there was no significant difference (Z = -0.917, p > .05) in the posttest of the learning achievement of the CT gaming group and the CM gaming group.

Table 3. *Wilcoxon signed-rank test for learning achievement using board game grouping*

board game grouping	*N*	*M*	*SD*	Mean Rank	Sum of Ranks	*U*	*W*	*Z*
CT gaming groups	16	39.38	11.96	15.72	251.50	76.50	154.50	-0.917
CM gaming groups	12	34.58	14.69	12.88	154.50			

4.2 Flow state for media and information literacy learning

Table 4 presents the homogeneity of the CT gaming group and the CM gaming group according to the Levene's test, which meets the homogeneity assumption (F = 1.134, p > .05) and normal distribution for the data. Therefore, paired samples t tests were performed to examine whether there was a significant difference in the flow state of learning of the two groups after playing the educational board game. The CT gaming group showed a significant difference (t = -2.23*, p < .05) between the pretest (M = 3.41, SD = .684) and the posttest (M = 3.64, SD = .714) for flow state. The CM gaming group showed a significant difference (t = -2.32*, p < .05) between the pretest (M = 3.36, SD = 0.64) and the posttest (M = 3.79, SD = 0.60) for flow state. There was also a significant difference (t = -3.19**, p < .01) between the pretest (M = 3.39, SD = 0.65) and the posttest (M = 3.71, SD = 0.66) for the overall flow state.

Table 4. *Levene's test results for flow state when accessing media and information literacy*

F	*df1*	*df2*	*p*
1.134	1	26	0.297

Table 5. *Learning achievement for media and information literacy using paired samples t tests*

Groups	*N*	Mean(*SD*)		*t*	*p*
		Pre-test	Post-test		
CT gaming groups	16	3.408(.684)	3.643(.714)	-2.23*	.042
CM gaming groups	12	3.357(.636)	3.794(.599)	-2.32*	.041
The overall result	28	3.386(.650)	3.708(.660)	-3.19**	.004

*p < .05, **p < .01

To investigate whether there were differences in the flow state of students in the two groups after playing the educational board game, analysis was conducted using an independent sample t test. Table 6 shows that no significant difference was found in the flow state of the CT gaming group and the CM gaming group (t = -0.59, p > .05).

Table 6. *Flow state in media and information literacy using independent sample t tests*

Groups	*N*	Mean	*SD*	*t*	*p*
CT gaming groups	16	3.64	0.71	-0.59	.559
CM gaming groups	12	3.36	0.60		

To further understand the differences in the qualitative results, the qualitative analysis presents the results based on the students' feedback. The categorized data are shown in Table 7. The data can be categorized into three main categories, namely gaming rules, learning materials and game components.

Table 7. *Student feedback*

Dimensions	Feedback
Game rules	*The game rules are too difficult and it is not clear how to play the game. A bit more diversity can be added to the characters.*
Learning materials	*Some questions are vague, while some narrative answers are ambiguous. Keywords for each question can be annotated.*
Game components	*Function cards are too many, while props are also abundant. Simplifying them would be better.*

5. Discussion and Conclusions

The purpose of this study was to investigate the difference in the learning achievement and flow state of students in the CT and CM gaming groups when playing an educational board game about media and information literacy. The research findings revealed that the educational board game designed for promoting media and information literacy had a significant impact on overall student learning achievement. This discovery aligns with the findings of Li and Hou (2022), underscoring the effectiveness of utilizing board games as educational tools in enhancing student academic performance. Compared to traditional lecture-based teaching, board games offer a more motivating and engaging learning experience. Their game mechanics, coupled with the ability to seamlessly integrate visuals and text, contribute to the establishment of effective learning pathways. The factors of rewards, tokens, and competition in gameplay increase the enjoyment of learning. In addition, this study also found that the educational board game improved students' flow experience, which is in line with Lin and Wang's (2022) finding that the integration of board game materials into academic learning activities can enhance students' flow states.

However, this study also found that collaborative-team gaming did not affect students' perceptions of flow state compared to competitive-multiplayer gaming, in contrast to Hou and Keng (2021) who found that collaborative-team gaming resulted in greater immersion in a state of flow. Our result demonstrated that the possibility of having a more knowledgeable learner who led or dominated the game play, whereas a lack of discussion of the content of the materials during gameplay prevented students from engaging in the game. In addition, no differences were found in the learning achievements of the collaborative-team gaming group and the competitive-multiplayer gaming group. The results differ from those of Azhar et al. (2022) who found that collaborative-team gaming learning was associated with better learning achievement than competitive-based learning. This may be due to the fact that the grouping in this study did not take into account the variables of students' backgrounds such as gender, personality traits, and cognitive style, which may have prevented the collaboration from being effective (Liao et al., 2019).

According to the findings of this study, it is recommended that teachers who wish to use educational board games in the future should consider the differences in the selection of teaching materials according to the students' personalities. Regarding the teaching of media and information literacy courses, teachers may consider incorporating elements of board

games into the course design. This could be used as an alternative approach for certain learning topics or as a replacement for traditional lecture-based classroom assessments. Those who develop educational board games in the future can conduct tests with similar target groups in stages and collect possible feedback so that the content and game design can be further revised according to their needs. For future educators or researchers who wish to explore the content of educational board games, the variables of students' backgrounds or other technological media, such as augmented reality, can be incorporated into the study for further discussion.

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References

Al-Azawi, R., Al-Faliti, F., & Al-Blushi, M. (2016). Educational gamification vs. game based learning: Comparative study. *International journal of innovation, management and technology*, *7*(4), 132-136.

Al-Zou'bi, R. (2021). The impact of media and information literacy on acquiring the critical thinking skill by the educational faculty's students. *Thinking Skills and Creativity*, *39*, 100782.

Alam, A. (2022). A digital game based learning approach for effective curriculum transaction for teaching-learning of artificial intelligence and machine learning. *2022 International Conference on Sustainable Computing and Data Communication Systems (ICSCDS)*, 69-74.

Alexander, F., & Galina, M. (2020). Current trends in media and information literacy in research and scientific publications of the early 21st century. *International Journal of Media and Information Literacy*, *5*(2), 153-163.

Azhar, S. A. F. J., & Jalil, H. A. (2022). Comparison of Individual and Collaborative Game-Based Learning Using Tablet In Improving Students' Knowledge In Primary Classroom Environment. *Asian Journal of University Education*, *18*(1), 205-216. https://doi.org/10.24191/ajue.v18i1.17188

BoardGeekGame. (2023). *Board game categories*. https://boardgamegeek.com/browse/boardgamecategory

Caponetto, I., Earp, J., & Ott, M. (2014). Gamification and education: A literature review. Proceedings of the European Conference on Games-based Learning, Acad Conferences Ltd.

Cardinot, A., & Fairfield, J. A. (2019). Game-based learning to engage students with physics and astronomy using a board game [Article]. *International Journal of Game-Based Learning*, *9*(1), 42-57. https://doi.org/10.4018/IJGBL.2019010104

Chan, K., Wan, K., & King, V. (2021). Performance over enjoyment? Effect of game-based learning on learning outcome and flow experience. *Frontiers in Education*, *6*, 185.

Chen, C.-Y., Huang, H.-J., Lien, C.-J., & Lu, Y.-L. (2020). Effects of multi-genre digital game-based instruction on students' conceptual understanding, argumentation skills, and learning experiences. *IEEE Access*, *8*, 110643-110655.

Costa, C., Tyner, K., Henriques, S., & Sousa, C. (2018). Game creation in youth media and information literacy education. *International Journal of Game-Based Learning (IJGBL)*, *8*(2), 1-13.

Csikszentmihalyi, M. (1991). *Flow: The Psychology of Optimal Experience*. Harper Perennial Modern Classics.

Dicheva, D., Dichev, C., Agre, G., & Angelova, G. (2015). Gamification in education: A systematic mapping study. *Journal of Educational Technology & Society*, *18*(3), 75-88.

Hou, H.-T., & Keng, S.-H. (2021). A dual-scaffolding framework integrating peer-scaffolding and cognitive-scaffolding for an augmented reality-based educational board game: An analysis of learners' collective flow state and collaborative learning behavioral patterns. *Journal of Educational Computing Research*, *59*(3), 547-573.

Isaak, J., & Hanna, M. J. (2018). User data privacy: Facebook, Cambridge Analytica, and privacy protection. *Computer*, *51*(8), 56-59.

Jackson, S. A., & Eklund, R. C. (2002). Assessing flow in physical activity: The flow state scale–2 and dispositional flow scale–2. *Journal of sport and exercise psychology*, *24*(2), 133-150.

Jackson, S. A., & Marsh, H. W. (1996). Development and validation of a scale to measure optimal experience: The Flow State Scale. *Journal of sport and exercise psychology*, *18*(1), 17-35.
Kiili, K. (2005). Digital game-based learning: Towards an experiential gaming model. *The Internet and higher education*, *8*(1), 13-24.
Kiili, K. (2006). Evaluations of an experiential gaming model. *Human Technology: An Interdisciplinary Journal on Humans in ICT Environments*, *2*(2), 187-201.
Kiili, K. J. M., Lindstedt, A., Koskinen, A., Halme, H., Ninaus, M., & McMullen, J. (2021). Flow experience and situational interest in game-based learning: Cousins or identical twins. *International Journal of Serious Games*, *8*(3), 93-114.
Kim, S.-H., & Park, S. (2021). Influence of learning flow and distance e-learning satisfaction on learning outcomes and the moderated mediation effect of social-evaluative anxiety in nursing college students during the COVID-19 pandemic: A cross-sectional study. *Nurse Education in Practice*, *56*, 103197.
Leaning, M. (2019). An approach to digital literacy through the integration of media and information literacy. *Media and Communication*, *7*(2), 4-13.
Liao, C.-W., Chen, C.-H., & Shih, S.-J. (2019). The interactivity of video and collaboration for learning achievement, intrinsic motivation, cognitive load, and behavior patterns in a digital game-based learning environment. *Computers & Education*, *133*, 43-55.
Li, C. T., Hou, H. T., & Lee, L. H. (2022). Design of a dual-hierarchy scaffolding board game-based learning activity for EFL reading comprehension. *Language Teaching Research*, https://doi.org/10.1177/1362168822112590.
Lin, Y.-T., & Wang, T.-C. (2022). A Study of Primary Students' Technology Acceptance and Flow State When Using a Technology-Enhanced Board Game in Mathematics Education. *Education Sciences*, *12*(11), 764.
Liu, Z.-Y., Shaikh, Z., & Gazizova, F. (2020). Using the concept of game-based learning in education. *International Journal of Emerging Technologies in Learning (iJET)*, *15*(14), 53-64.
Livingstone, S. (2004). Media literacy and the challenge of new information and communication technologies. *The communication review*, *7*(1), 3-14.
Mackey, T. P., & Jacobson, T. E. (2011). Reframing information literacy as a metaliteracy. *College & research libraries*, *72*(1), 62-78.
Mukhtar, S., & Putri, K. (2021). Technology integrated on media literacy in economic studies on higher education. *Journal of Social Studies Education Research*, *12*(1), 95-123.
Ofcom. (2020). *Children and Parents: Media Use and Attitudes Report.* https://www.ofcom.org.uk/research-and-data/media-literacy-research/childrens/children-and-parents-media-use-and-attitudes-report-2022
Ou, K.-L., Liu, Y.-H., & Tarng, W. (2021). Development of a virtual ecological environment for learning the Taipei tree frog. *Sustainability*, *13*(11), 5911.
Pearce, J. M., Ainley, M., & Howard, S. (2005). The ebb and flow of online learning. *Computers in human behavior*, *21*(5), 745-771.
Pinedo, R., García-Martín, N., Rascón, D., Caballero-San José, C., & Cañas, M. (2022). Reasoning and learning with board game-based learning: A case study. *Current Psychology*, *41*(3), 1603-1617.
Ryu, E. J., Jang, K. S., & Kim, E. A. (2022). Influence of Learning Presence of Non-Face-to-Face Class Experience in Nursing Students on Academic Achievement: Mediating Effect of Learning Flow and Moderated Mediation of Digital Literacy. *Journal of Korean Academy of Nursing*, *52*(3), 278-290. https://doi.org/10.4040/jkan.21241
Sailer, M., & Homner, L. (2020). The gamification of learning: A meta-analysis. *Educational Psychology Review*, *32*(1), 77-112.
Tay, J., Goh, Y. M., Safiena, S., & Bound, H. (2022). Designing digital game-based learning for professional upskilling: A systematic literature review. *Computers & Education*, 104518.
UNESCO. (2013). *Global Media and Information Literacy Assessment Framework: country readiness and competencies*. https://unesdoc.unesco.org/ark:/48223/pf0000224655.page=22
Vafeiadis, M., Bortree, D. S., Buckley, C., Diddi, P., & Xiao, A. (2019). Refuting fake news on social media: nonprofits, crisis response strategies and issue involvement. *Journal of Product & Brand Management*, *29*(2), 209-222. https://doi.org/10.1108/jpbm-12-2018-2146