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Effects of Digital Game-Based Learning on Students' Cyber Wellness Literacy, Learning Motivations, and Engagement

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Abstract: The Internet has become an essential part of our daily life, but excessive Internet use may lead to a number of risks such as Internet addiction. In order to protect teenagers from the risks, it is important to guide them to use the Internet in a safe, responsible, and ethical way. Cyber wellness literacy, as the core issue of digital citizenship, plays a vital role in the physical and mental well-being of individuals and should be given high priority. While some studies have explored the integration of digital citizenship into school education through digital game-based learning (DGBL), the influence of digital games on teenagers' learning outcomes, learning motivation, and engagement in the field of cyber wellness remains unclear. It is, therefore, a challenge to provide cyber wellness literacy learning activities that empower students to keep away from Internet addiction and maintain a happy, healthy, and safe digital life. This study addressed the issue of Internet addiction from the perspective of digital citizenship, and designed and implemented a digital game-based course in a middle school. The study then explored the potential impact of DGBL on improving students' cyber wellness literacy, motivation, and engagement. The statistical results show that DGBL not only promoted the students' cyber wellness literacy in preventing Internet addiction, but also enhanced their motivations and emotional engagement.

Keywords: digital game-based learning (DGBL); digital citizenship; cyber wellness literacy; secondary education; teaching and learning strategies

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1. Introduction

Use of the Internet has increased rapidly in recent years. According to a digital report (We Are Social (New York, NY, USA) and Hootsuite (Vancouver, BC, Canada), 2022), there are 4.9 billion Internet users worldwide, accounting for 62.5% of the total population. The 50th Statistical Report on China's Internet Development shows that by June 2022, the number of Internet users in China reached 1.051 billion. Here, Internet users refer to individuals who have used the Internet (from any location) in the last 3 months via a computer, mobile phone, digital TV, and the like [1].

The Internet has become an integral part of our daily life by revolutionizing ways of communication and access to information [2]. However, we must keep in mind that excessive Internet use may cause a number of threats. For example, long-term overuse of the Internet can lead to Internet addiction easily [3], especially among teenagers. Internet addiction is defined as "a situation characterized by physical, social and academic problems in daily life caused by one's loss of control of the Internet use" [4]. Studies conducted in different countries reported that the prevalence of Internet addiction among teenagers aged 10–18 was 27.1% in Bangladesh [5], 24.4% in China [6], 21.3% in Switzerland [7], 11.4% in Poland [8], 11.06% in America [9], 10.1% in the United Kingdom [10], and 6.3% in Jordan [11]. The negative effects of Internet addiction can include impaired mental health, reduced interaction with others, and low academic performance. In a word, Internet addiction can lead to physical, psychological, and social difficulties [2].

Therefore, it is crucial for Internet users, especially teenagers [12], to be aware of the potential dangers of Internet addiction and to take measures to prevent it. Though there are measures such as mass media publicity to raise public awareness and promote screen time control [13,14], internal factors, i.e., their cyber wellness literacy, play a vital role. That is to say, we should guide teenagers to use the Internet in a safe, responsible, and ethical way as early as possible. By integrating digital citizenship education into school curricula, students can develop the necessary knowledge and skills to protect themselves from Internet addiction.

1.1. Digital Citizenship and Cyber Wellness

Digital citizenship refers to the norms of appropriate, responsible behavior with regard to technology use [15]. Over the past two decades, studies on technology in K-12 education (typically refers to the entire education cycle from pre-kindergarten through to high school) have emphasized the importance of including digital citizenship in the school curriculum [16–19], which is congruent with several studies concluding the need to promote digital citizenship skills in students [15,20,21]. Moreover, research on digital citizenship mainly focuses on the concept and elements of digital citizenship, determining users' digital citizenship levels or perceptions, developing the curricula within the framework of digital citizenship, and conducting teaching practices [22–24].

Cyber wellness, one of the nine elements of digital citizenship, is recognized as physical and psychological well-being in a digital technology world [15]. Adolescents, in particular, are vulnerable to mental health risks and dependency behaviors due to low self-control ability and high propensity for risky behaviors [25]. As such, adults, especially teachers and parents, should train them to gain the ability to maintain a healthy balance in their digital life. Cyber wellness literacy, which encompasses the awareness, character, abilities and behaviors related to physical and psychological well-being in the digital world [26,27], is viewed as a vital component of digital citizenship. Therefore, it is imperative to prioritize the cyber wellness module as the core issue of digital citizenship education.

To implement digital citizenship and cyber wellness education, some schools and organizations have developed comprehensive digital citizenship curricula or targeted teaching resources. For instance, Common Sense Media created a six-topic digital citizenship curriculum, including media balance and well-being [28]. Some schools in Singapore integrated cyber wellness programs into their regular curriculum [29]. The University of British Columbia's Digital Emergency Medicine team developed an educator toolkit, student workbook, and interactive graphic novels that can be easily integrated into standard classroom curriculum to improve digital health literacy and promote healthy behaviors of children aged 9–14 [30]. However, in some countries, such as Turkey and China, digital citizenship education lags behind, with no systematic or dedicated teaching practices at elementary, secondary, and high school levels [27,31,32]. In China, for example, contents related to cyber wellness are traditionally mentioned in safety learning materials, ethics and the rule of law courses, or topic class meetings, leading to a fragmentary and unsystematic approach. As a result, providing cyber wellness education in these areas is challenging, making it difficult for students to stay away from Internet addiction and maintain a happy, healthy, and safe digital life [33].

1.2. Digital Game-Based Learning (DGBL)

Digital game-based learning (DGBL) refers to the use of entertaining digital games to achieve educational goals [34,35]. It has gained increasing attention in recent years as a way to engage and motivate learners, particularly in online and blended learning contexts. It enables students to engage in role playing, decision making, and problem solving by providing an immersive and interactive experience [36,37].

Research on DGBL has demonstrated numerous potential benefits, including improved motivation and engagement, optimized learning outcomes, and enhanced problem-solving skills [38]. For example, DGBL has been shown to enhance student motivation in subjects

such as math [39,40], civics and society [41], and cybersecurity training for undergraduate students [42]. It was also found that students demonstrated significantly higher intrinsic motivation and lower extrinsic motivation when learning in game-based environments [43]. Additionally, DGBL can increase student engagement in learning [40,44,45]. For instance, Huizenga et al. [46] found that students who played a game were more engaged and gained significantly more knowledge about medieval Amsterdam than those who received traditional project-based instruction. DGBL also has positive effects on learning outcomes, such as higher cognitive gains [47,48], even in the field of physical education [49].

Some studies have reported that digital games have great potential in improving teenagers' digital and information literacy [50–54] as well as digital health literacy [55–58]. Owing to the attractive gaming contexts [39], digital game-based learning connects instructional processes with digital technology to provide an effective learning environment [38,55].

1.3. Instructional Design for DGBL

The ARCS model is based on four concepts: attention, relevance, confidence, and satisfaction [59]; it offers a useful framework for designing effective DGBL experiences that engage and motivate learners [60,61]. In digital game-based learning, interactive elements, such as role playing, simulations, case studies, and problem-solving activities, can effectively capture learners' attention. In addition, connecting the instruction to students' real-life situations or interests can establish contact and encourage them to connect their present and future. Moreover, clear mission objectives, fascinating scenarios, and instant feedback are essential in designing educational games that improve students' learning achievements [62]. This study combined game design theory and the ARCS model to design and make an educational game.

1.4. Research Questions

Overall, exactly how digital games influence teenagers' learning outcomes, learning motivation, and engagement has not been fully clarified in the field of cyber wellness. This study aimed to fill in this gap by discussing the issue of Internet addiction from the perspective of digital citizenship and designing and implementing a digital game-based course in a middle school to enhance students' cyber wellness literacy to prevent Internet addiction. The research also explored the potential impact of DGBL on improving students' motivation and engagement. The following research questions (RQs) guided our study:

RQ1: Do the students who participate in game-based learning have better cyber wellness literacy than those who learn in the traditional way?

RQ2: Do the students who participate in game-based learning show higher learning motivation than those who learn in the traditional way?

RQ3: Are the students who participate in game-based learning more engaged in learning than those who learn in the traditional way?

2. Course Introduction

2.1. Design Principles

2.1.1. Course Design Principles

As digital citizenship has many connections with primary and secondary school courses in terms of pedagogical content, especially on the topic of Internet addiction, it is a good idea to integrate digital citizenship into mental health courses. However, a rigid and superimposed approach can create a sense of fragmentation among the students. To avoid this, we followed the following principles:

a. Learner-centered: Focusing on changing students' awareness, attitudes, abilities, and behaviors, this course adopted a learner-centered design model. The goal was to place learners at the center of the learning process, associating them with things around them to improve their participation in knowledge construction [63]. This learning model was achieved through active learning, which encourages learners to discuss deeply in the context of prior experience and social interaction [64–66].

b. Content-oriented: We conducted an in-depth examination of the teaching materials to explore shared contents between Internet addiction and mental health, which we combined to structure this course. The teaching contents included topics such as what Internet addiction is, the harm of Internet addiction, why people are easily addicted to the Internet, the psychological mechanism of Internet addiction, and how to prevent Internet addiction. Our purpose was to give the students a comprehensive understanding of Internet addiction and to raise their awareness on cyber wellness.
c. Diversified activity support: To ensure student engagement, we designed learning activities such as group discussion, case study, digital game playing, and after-class tasks to encourage student interaction, which helps students fully participate and apply what they learn in authentic contexts in the future [67].

2.1.2. Game Design Principles

Digital devices are restricted in our classroom, making it challenging to implement DGBL. Moreover, due to time limitations, the game should be carefully designed to match the teaching content and attract students with appropriate difficulty levels. Here are some principles we followed:

a. Goal-driven: A clear and achievable goal helps stimulate students' learning motivation, making a game more targeted. We designed a story about rescuing a friend (main character) who has been addicted to the Internet and named the game "Rescue". Players have to follow the instructions step-by-step to help their friend out [68,69].
b. Being empathic and immersive: Role substitution helps enhance students' sense of identity and experience, connecting cyberspace with the real world [70]. In our game, the main character is a middle school student who is absent in a basketball match, and the player's goal is to find and save him from gaming addiction. The associated game elements, such as the playground, classroom, basketball match, and gaming addiction, are highly authentic, making students more empathic and engaged due to their familiarity with daily life.
c. Instant feedback support: In order to improve the playability and interactivity of the game, immediate feedback should be provided in a positive and constructive way [71]. This is especially important for inexperienced players who fail to complete a task. Mission signs, position tips, leaderboards, and other examples of instant feedback can be delivered visually or audibly [72]. These features help attract players and make the story smooth, rather than frustrating them.
d. Strict time limit: According to our policy, the digital game duration in each class should not exceed 15 min, and this learning style is not recommended for frequent use in a short-term primary course. Therefore, we designed and developed a 12 min digital game named "Rescue" for students to play in class, with compact and complete plots.

2.2. Course Content

The course content is structured around four main themes, which are outlined in Table 1. Theme 1 focuses on what Internet addiction is, using case study and criteria for identifying this phenomenon. Theme 2 focuses on the risks associated with Internet addiction through group discussions and analysis of specific examples. An after-class assignment is also included in this theme. Theme 3 concentrates on why people are vulnerable to Internet addiction, analyzing possible factors and explaining the psychological mechanism behind it. Theme 4 delves into prevention strategies for Internet addiction, by sharing precautions, presenting rational use of digital devices, and informing students about relevant rules and regulations. Upon completion of these four themes, students will possess the knowledge and skills necessary to become qualified digital citizens and stay healthy against Internet addiction.

Table 1. Overview of the course content.

Themes	Content
Theme 1: What is Internet addiction	Introduction to Internet addiction. Criteria for identifying Internet addiction.
Theme 2: The risks associated with Internet addiction	Some possible risks associated with Internet addiction. Daily online hour survey (Assignment).
Theme 3: Why people are vulnerable to Internet addiction	Some possible factors for Internet addiction. Psychological mechanism behind Internet addiction.
Theme 4: How to prevent Internet addiction	Ways to prevent Internet addiction. Strategies for rational use of digital devices. Rules and regulations against Internet addiction. Rescue your friend (Gameplay).

2.3. Digital Game Design and Development

The digital game designed for this study utilized the ACRS model and educational escape room (EER) concept [73]. The game's objective is to save a friend from gaming addiction, aligning with the player's goal of being protective against Internet addiction and maintaining their physical and mental health. The story begins with a middle school student (the player) searching for a missing friend before a basketball match. The player must collect strange items related to the course's knowledge points, such as Internet addiction symptoms. Once the collection task is complete, the player will be led to his friend's bedroom, where the player needs to set the screen time limit through mobile phone simulation to free his friend. Before going back to the basketball match, they will be asked to complete a quiz to test their knowledge of the above themes.

In the game, students follow the storyline by clicking and selecting, learning while experiencing. Immediate feedback and tips are provided during game interaction, such as prompting the right answer and providing explanations. At the end of the game, a leaderboard is presented to showcase the ranking of the players.

The game was developed using Articulate Storyline3, supporting computer and mobile devices, with low teaching equipment requirements. It was released as a web-based game on Tencent Cloud Server, making it adaptable for online learning during the COVID-19 pandemic. Figure 1 shows illustrative examples of the game scenario.

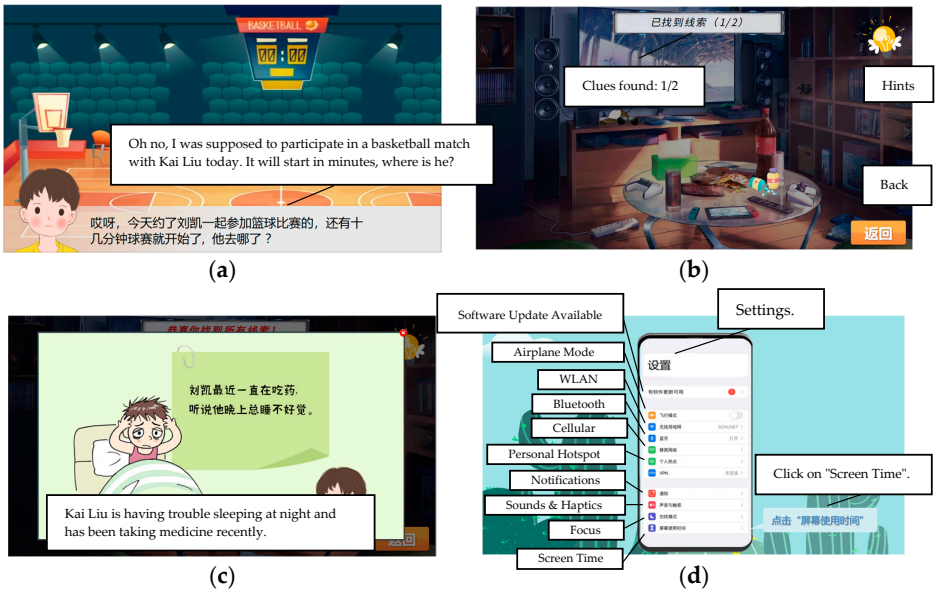

Figure 1. Screenshots of the digital game: (**a**) story background; (**b**) collection task; (**c**) feedback; (**d**) mobile phone simulation.

3. Research Methodology

In our study, we used a quasi-experimental research method to compare students' cyber wellness literacy, learning motivations, and learning engagement between the experiment and control groups.

3.1. Participants and Experimental Procedure

The experiment was conducted in the first semester of 2022–2023, with 154 seventh graders (4 classes) from Guangzhou Luoxi Xincheng Middle School recruited. As can be seen from the experimental procedure (Figure 2), the students were divided into two groups. In total, 77 students (Male = 36, Female = 41) from Class 1 and Class 2 formed the experimental group. They learned contents of cyber wellness with a digital game, and the remaining 77 students (Male = 40, Female = 37) from Class 3 and Class 4 formed the control group and learned in the traditional way. The researchers had no conflict of interest in this study. The participants were informed that their participation in this study was voluntary, they could withdraw at any time without penalty, and their personal information would be kept anonymous in all publications and presentations. By voluntarily completing the survey, all participants were considered to have given their consent to participate.

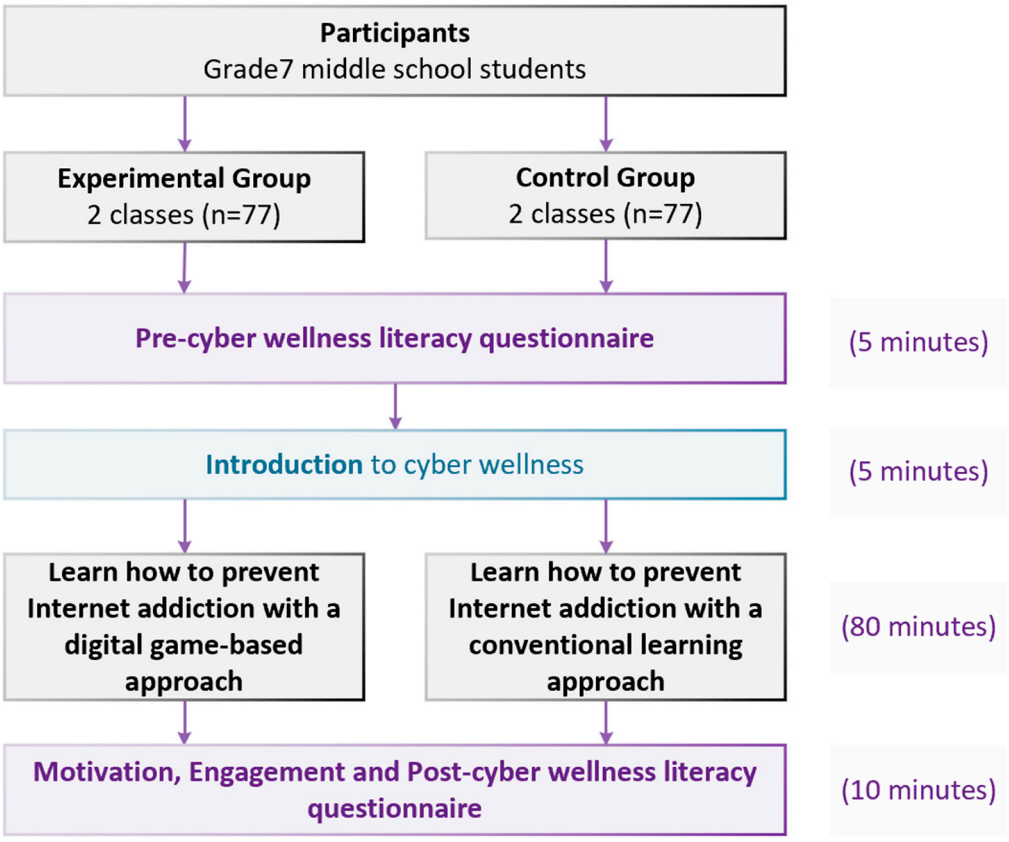

Figure 2. Experimental procedure.

At the beginning of the first lesson, the students performed a 5 min pre cyber wellness literacy questionnaire to evaluate their prior level. Then, there was an introduction to cyber wellness (from the perspective of digital citizenship) delivered by the teacher, which lasted about 5 min. Afterwards, students in the experimental group learned how to prevent Internet addiction with digital game-based approach, during which game data were gathered. Students in the control group learned the same content without digital game (in a traditional way). These lessons lasted about 4 days (total 80 min). The students then spent 10 min taking a post cyber wellness literacy questionnaire to evaluate their cyber

wellness literacy and complete the learning motivation and engagement questionnaires. Finally, the pre and post questionnaires of the two groups were compared.

3.2. Instrumentation

Pre and post cyber wellness literacy questionnaires were employed to measure the students' cyber wellness literacy. The questionnaire was modified from the Internet Addiction Test [74] and the Smartphone Addiction Proneness Scale [75]. Each questionnaire consists of 29 items with a five-point Likert scale ranging from "1: does not fit at all" to "5: fully fits" and includes three constructs. The awareness and views (AV) construct is used to explore if the students are aware of the rational use of technology and their views on technology and its impact on their health (e.g., Being addicted to the Internet may cause health problems such as vision loss). The character and ability (CA) construct refers to personal characteristics and skills related to technology use (e.g., I have got a way to control my screen time). The behavior and behavioral tendency (BT) construct asks the students to respond with rational behaviors toward technology overuse to reduce its impact on their physical and mental health (e.g., When I need to focus on learning, I will stay away from the Internet or set my phone to flight mode). The Cronbach's alpha values for these two questionnaires were 0.84 (pre) and 0.86 (post), showing good reliability in internal consistency.

The learning motivation questionnaire was revised from the Motivation Scale developed by Tüzün [43]. It consists of 6 items and all of them were measured on a five-point Likert scale. They can be divided into two dimensions. Intrinsic motivation (IM) is the drive for which students engage in an activity (e.g., I prefer courses that spark my curiosity, even if they are difficult to learn.). Extrinsic motivation (EM) is the extent to which students participate in learning under external pressures (e.g., I cannot lose to my classmates). The Cronbach's alpha value of the questionnaire was 0.80.

The learning engagement questionnaire was employed to explore the level of students' involvement, adopted from the Utrecht Work Engagement Scale—student (UWES-S) [76]. It consists of 12 items measured on a five-point Likert scale. There are three dimensions in this questionnaire. Behavioral engagement (BE) refers to the extent to which students participate in class activities and assignments (e.g., When learning something new, I can summarize it in my own words). Cognitive engagement (CE) refers to the level of students' active thinking and problem solving while participating in the course (e.g., I am very focused on my classroom study). Emotional engagement (EE) refers to students' emotional investment and attachment to the course material and the learning experience (e.g., In the process of learning, I feel happy). The Cronbach's alpha value of the questionnaire was 0.95.

The compiled questionnaire was reviewed by two experts in educational technology. Subsequently, two schoolteachers reviewed the questionnaire to ensure the content, wording, and other concerns such as its length. Before actual data collection, pilot testing was conducted with 42 randomly selected students to ensure the reliability and validity of the test items.

3.3. Data Collection and Analysis Procedure

The questionnaires were translated from English to Chinese so that the survey could be administered in the participants' native language. The survey was administered in online questionnaire during the participants' mid-class break. All responses were entered into Microsoft Excel and then imported into SPSS for statistical analysis. An independent *t*-test was conducted to investigate differences between the two groups in terms of cyber wellness literacy. Then, a paired-sample *t*-test was performed to analyze students' changes in cyber wellness literacy. Finally, a nonparametric Mann–Whitney U test was used to compare students' learning motivation and engagement between the two groups.

4. Experimental Results

4.1. Analysis of the Cyber Wellness Literacy

Before the experiment, an independent *t*-test was conducted to assess the students' pre cyber wellness literacy, and no significant differences were found between the groups (see Table 2). This indicates that all 154 students had a similar level of cyber wellness literacy before the experiment.

Table 2. The results of two groups before the experiment.

Dimension	M(SD)		t
	EG(n = 77)	CG(n = 77)	
Cyber wellness literacy	85.61(14.12)	83.90(13.40)	0.773
Awareness and Views (AV)	19.12(3.17)	18.90(2.76)	0.461
Character and Ability (CA)	37.90(6.65)	36.23(7.62)	0.144
Behavior and Behavioral tendency (BT)	28.60(5.69)	28.77(4.61)	−0.202

To address RQ1, an independent *t*-test was then used to compare students' post cyber wellness literacy in the two groups. Comparisons were made at a 95% confidence interval ($\alpha = 0.05$). The comparison of the post test scores showed a significant difference, as shown in Table 3, indicating that the students learning with the digital gaming approach in the experimental group performed better in cyber wellness literacy in terms of AV ($t = 10.91$, $p = 0.000 < 0.01$) and BT ($t = 2.10$, $p = 0.019 < 0.05$). In short, the students who participated in game-based learning had better cyber wellness literacy than those who learned in the traditional way ($t = 4.62$, $p = 0.000 < 0.01$).

Table 3. The results of the cyber wellness literacy of the two groups.

Dimension	M(SD)		t
	EG(n = 77)	CG(n = 77)	
Cyber wellness literacy	100.05(13.15)	90.92(12.23)	4.62 **
Awareness and Views (AV)	25.83(3.67)	20.16(2.71)	10.91 **
Character and Ability (CA)	41.78(6.14)	39.56(5.61)	1.93
Behavior and Behavioral tendency (BT)	32.44(4.27)	30.82(4.22)	2.10 *

* $p < 0.05$, ** $p < 0.01$.

A further independent *t*-test on gender differences within the experimental group revealed no significant difference between males and females in terms of cyber wellness literacy (see Table 4).

Table 4. The results of the cyber wellness literacy of the experimental group.

Dimension	M(SD)		t
	Male(EG)	Female(EG)	
Cyber wellness literacy	103.03(11.46)	97.44(14.09)	1.89
Awareness and Views (AV)	26.81(3.55)	24.98(3.59)	2.24 *
Character and Ability (CA)	42.78(5.80)	30.90(6.35)	1.34
Behavior and Behavioral tendency (BT)	33.44(3.75)	31.56(4.53)	1.96

* $p < 0.05$.

Finally, a paired-sample *t*-test was performed to analyze the students' changes in cyber wellness literacy (pre vs. post cyber wellness scores). Table 5 illustrates that their post cyber wellness literacy scores were significantly greater than the pre cyber wellness literacy in terms of AV ($p = 0.000 < 0.01$), CA ($p = 0.000 < 0.01$), and BT ($p = 0.000 < 0.01$). These findings demonstrate a positive learning effect of the course.

Table 5. Paired-sample *t*-test within the two groups.

Dimension	EG(n = 77)		*p*	CG(n = 77)		*p*
	Pre	Post		Pre	Post	
Awareness and Views (AV)	19.12 (3.17)	25.83 (3.67)	0.000 **	18.90 (2.76)	20.16 (2.71)	0.000 **
Character and Ability (CA)	37.90 (6.65)	41.94 (6.10)	0.000 **	36.23 (7.62)	39.95 (5.61)	0.000 **
Behavior and Behavioral tendency (BT)	28.60 (5.69)	32.44 (4.27)	0.000 **	28.77 (4.61)	30.82 (4.22)	0.000 **

** $p < 0.01$.

4.2. Analysis of Learning Motivations

As for learning motivations, the two samples were not normally distributed, so the Mann–Whitney U test, one of the most commonly used non-parametric statistical tests, was performed. It was found that the students in the experimental group were more motivated than those in the control group, as shown in Table 6. This suggests that the students who followed the DGBL were more motivated than those who learned in traditional way in terms of IM ($p = 0.001 < 0.01$) and EM ($p = 0.01 < 0.05$).

Table 6. Learning motivation of the two groups.

Dimension	EG(n = 77)	CG(n = 77)	Z	*p*
Learning Motivation	23 (21,27)	22 (19.5,25)	−2.63	0.009 **
Intrinsic Motivation (IM)	12 (10,13)	10 (7.5,12)	−3.24	0.001 **
Extrinsic Motivation (EM)	11 (8,13)	10 (7,13)	−1.75	0.01 *

* $p < 0.05$, ** $p < 0.01$.

Furthermore, a gender difference of learning motivation between the two groups was examined. Table 7 shows that learning motivation was significantly different among males ($p = 0.001 < 0.01$), while no significant difference was found among females (Table 8).

Table 7. Learning motivation of males in the two groups.

Dimension	EG(Male)	CG(Male)	Z	*p*
Learning Motivation	24 (22,27.5)	20.5 (18,24)	−3.30	0.001 **
Intrinsic Motivation (IM)	12 (11,14)	10 (9,12)	−3.36	0.001 **
Extrinsic Motivation (EM)	12 (11,14.5)	11 (9,12)	−2.81	0.005 **

** $p < 0.01$.

Table 8. Learning motivation of females in the two groups.

Dimension	EG(Female)	CG(Female)	Z	*p*
Learning Motivation	23 (20,27)	23 (20,25)	−0.236	0.813
Intrinsic Motivation (IM)	12 (11,14)	11 (10,12)	−1.01	0.311
Extrinsic Motivation (EM)	12 (10,13.5)	10 (10,13)	−0.435	0.663

4.3. Analysis of Learning Engagement

Likewise, a Mann–Whitney U test was used to compare students' engagement scores. Table 9 demonstrates that the students in the experimental group performed better than those in the control group in terms of EE ($p = 0.03 < 0.05$). However, no significant differences were found between the two groups in terms of behavior engagement (BE) and cognitive engagement (CE).

Table 9. Learning engagement of the two groups.

Dimension	EG(n = 77)	CG(n = 77)	Z	*p*
Learning Engagement	45 (37.5,52)	44 (38,50)	−0.917	0.354
Behavioral Engagement (BE)	14 (12,18)	14 (12,16)	−0.957	0.399
Cognitive Engagement (CE)	15 (12,17.5)	15 (13.5,16)	−0.468	0.640
Emotional Engagement (EE)	15 (13,18)	14 (13,18)	−1.82	0.030 *

* $p < 0.05$.

Similarly, a gender difference analysis (Tables 10 and 11) showed that emotional engagement (EE) was significantly different among males ($p = 0.048 < 0.05$) and females ($p = 0.037 < 0.05$).

Table 10. Learning engagement of males in the two groups.

Dimension	EG(Male)	CG(Male)	Z	*p*
Learning Engagement	45 (37.5,54)	45 (36,47)	−1.66	0.086
Behavioral Engagement (BE)	14.5 (12,18.75)	12.5 (11,15)	−1.08	0.551
Cognitive Engagement (CE)	15 (13,17)	14 (13.5,16)	−1.71	0.091
Emotional Engagement (EE)	15 (12.25,19)	13 (12,18)	−1.97	0.048 *

* $p < 0.05$.

Table 11. Learning engagement of females in the two groups.

Dimension	EG(Female)	CG(Female)	Z	*p*
Learning Engagement	44(37.5,51)	44(38.5,51)	−1.22	0.220
Behavioral Engagement (BE)	14(12,18)	14(13,16)	−1.38	0.167
Cognitive Engagement (CE)	15(13,17)	15(14,17)	−1.11	0.265
Emotional Engagement (EE)	15(13,17.5)	14(14,17)	−1.86	0.037 *

* $p < 0.05$.

5. Discussion

5.1. Cyber Wellness Literacy

In response to RQ1, the students who learned with a digital education game showed better cyber wellness literacy than those who learned in the traditional way, which is consistent with some existing studies [56–58,77]. Specifically, significant differences were found in constructs AV (awareness and views) and BT (behavior and behavioral tendency), which is also consistent with previous findings. For example, in terms of AV, Tim MH Li et al. found that the game was effective in raising awareness of mental health [56]; in terms of BT, Tapingkae et al. found that a contextual gaming approach can enhance students' digital citizenship behavior [54], and Maqsood et al. found that children's intended digital literacy behavior improved significantly after playing the game [50]. It is not surprising that no differences were found in CA (character and ability) as character traits are innate, and the ability to prevent Internet addiction is acquired through learning and practicing [78]; role-playing games could hardly improve learners in these two aspects. On the other hand, cyber wellness literacy in terms of AV and BT mainly relies on personal understanding and imitation of others' behavior, which could be enhanced by a well-designed role-playing game with interesting and immersive storylines. Students may learn from what they believe is valuable and change their mind or try to follow through reflection and recognition. Furthermore, there was no significant gender difference between male and female students in the experimental group, indicating that the gaming approach is an effective means of improving students' cyber wellness literacy regardless of gender, complying with earlier research [79].

5.2. Learning Motivations

Regarding RQ2, the results of this study demonstrate that compared to traditional teaching methods, the students who participated in DGBL showed a higher level of intrinsic and extrinsic motivation, which is partly consistent with previous research findings. For example, Tapingkae et al. found that DGBL significantly improved students' intrinsic motivation to learn about digital citizenship behaviors, but there was no significant difference in terms of external motivation [54]. However, in Vidergor et al.'s study (non-digital citizenship field), this gaming approach enhanced users' intrinsic and extrinsic motivation [80]. This may be due to the use of the educational escape room (EER) teaching method in our game. It provides a stronger gameful experience and gives students a sense of accomplishment in learning [73]. From the perspective of the ARCS model, the higher intrinsic motivation may result from the fascinating game scenarios that help students reflect on their behavior habits and provide them with strategies to solve real-world problems [59], which helps to change their intrinsic motivation. In addition, the higher level of extrinsic motivation may result from the use of external incentives such as scores and leaderboards [81], allowing students to assess their learning progress and feel appreciated by peers and teachers. The results have revealed a noteworthy and affirmative correlation between the scores on the leaderboard and extrinsic motivation. However, it is important to note that relying too heavily on leaderboards could have unintended consequences. For instance, students may become too focused on their rankings instead of learning, or students with lower rankings may get depressed. Meanwhile, there was a significant difference among male students in both groups in terms of learning motivation, while no significant difference was found among female students. This suggests that DGBL was more effective in improving males' learning motivation, which is consistent with previous research findings [82]. Last but not least, our findings suggest that DGBL can effectively enhance the motivation of teenagers, contrary to previous research indicating that it is more challenging to motivate adolescents than children [83].

5.3. Learning Engagement

Regarding RQ3, our results show that the students who participated in game-based learning did not show higher levels of engagement in learning than those who learned in the traditional way. Specifically, the two groups differed significantly only in terms of emotional engagement (EE), while no differences were found in terms of behavioral engagement (BE) and cognitive engagement (CE). Similarly, Yueh-Min Huang reported that the experimental group achieved higher emotional engagement [84]. It is possible that the user-friendly interface and clear navigation of our game gave the students good impressions, and its characteristics, such as the storyline and leaderboard, stimulated their interest and increased their emotional engagement [85].

In terms of behavioral engagement (BE), we reported findings inconsistent with Khan's research [86]. According to her study, students in the secondary science class admitted that DGBL kept them behaviorally and emotionally engaged. They were more involved in this learning experience and they had more fun while learning, in contrast to their previous teacher-centered learning approach [87]. One possible reason is that social interaction during gameplay could have a significant effect on behavioral engagement, as found in Eseryel's research [88]. However, in our research, due to the COVID-19 pandemic, the students played the game on their own devices at home, and there was insufficient social interaction in the game, so, it was difficult to interact with each other. In addition, technical issues, such as loss of network connection or software failure, may have negatively impacted their behavioral engagement.

Regarding cognitive engagement (CE), no significant difference was found between the two groups. According to Darr's research [89], cognitive engagement is difficult to gauge since it is purely an internal process and is not easily observable within the classroom. Additionally, self-reported questionnaires may have a subjective tendency and difficulty

in reflecting the real situation. The comparatively short duration of the game may have resulted in a lack of significant difference in terms of cognitive engagement.

6. Conclusions and Limitations

As the Internet has become an integral part of our life, there is growing concern that excessive use of the Internet may lead to Internet addiction and be harmful to people's health, particularly for teenagers who are more susceptible to mental health risks. In order to protect them from Internet addiction, adults should guide teenagers to use the Internet in a safe, responsible, and ethical way from an early age. That is what digital citizenship advocates. This study associated the issue of Internet addiction with cyber wellness literacy, which is a crucial component of digital citizenship. While previous studies have examined the integration of digital citizenship into school education through digital game-based learning (DGBL), the influence of digital games on teenagers' learning outcomes, learning motivation, and engagement in the field of cyber wellness has not been fully explored. To address this gap, this study proposed and developed a web-based game to help students understand the negative consequences of excessive Internet use and cultivate healthy online habits. Through an experiment conducted on a mental health course in a middle school from Guangzhou, we compared the effectiveness of this approach with that of the traditional teaching method. The statistical results from 154 students, who are 13 years old, show that the proposed approach did take effect in promoting cyber wellness literacy and empowering students to maintain a healthy digital life. Specifically, the students who learned with a digital educational game showed better cyber wellness literacy than those who learned in the traditional way. Significant differences were found in the constructs AV (awareness and views) and BT (behavior and behavioral tendency), but not in CA (character and ability). No significant difference was found between male and female students in the experimental group. In addition, this study explored the influence of DGBL on improving students' learning motivation and engagement. The experimental results show that compared to traditional teaching methods, the students who participated in DGBL showed a higher level of intrinsic and extrinsic motivation, and gender differences existed as male students showed a higher level than female students. Last but not least, the students who participated in DGBL were not more engaged in learning than those who learned in the traditional way. The two groups only showed significant difference in terms of emotional engagement, without gender differences. This study provides valuable insights for primary and secondary schools seeking to promote cyber wellness literacy and prevent Internet addiction.

This research has some limitations that leave room for future work. First, more experiments should be conducted to draw broader conclusions as the findings of this research came from a single school in a modernized city with high-speed Internet access, which suggests that the results may change when different schools (e.g., rural schools) are involved. On the one hand, a long-term intervention with follow-up tests would provide more insight into the effects of DGBL on students' performance, although the timetables of secondary schools are tight. Finally, third-party objective assessment of students' behavioral changes could also be attempted.

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Informed Consent Statement: The participants were informed that their participation in this study was voluntary, they could withdraw at any time without penalty, and their personal information would be kept anonymous in all publications and presentations. By voluntarily completing the survey, all participants were considered to have given their consent to participate.

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