An Empirical Study on the Influence of Mobile Games and Mobile Devices for Contemporary Students’ Education and Learning Behavior

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ABSTRACT

This paper aims to realize the impact of mobile educational games on contemporary students’ learning behavior. Firstly, the research status of educational games is analyzed. Secondly, an online game acceleration method is designed based on deep learning technology. Mobile games and learning behaviors are combined. College students and primary school students are selected as research samples. The main reasons for students’ usage of mobile phones are analyzed through a questionnaire survey. In addition, the impact of different social media on students’ learning behavior is analyzed. Finally, the experiment is carried out by integrating game elements into the teaching process of primary school students. The results show that about 60% of college students rarely or occasionally play mobile games. The remaining 13% never play games. It shows that many college students play games, but not many have been addicted to games for a long time.

KEYWORDS

Learning Behavior, Mobile Devices, Mobile Games, Social Media, Teaching and Education

INTRODUCTION

This paper analyzes mobile games’ impact on contemporary students’ learning behavior. With the widespread popularity of wireless networks and the expanding mobile game market, “playing games” has become a leisure choice for almost all ages. Some people use mobile games as a tool for entertainment. Some people have been addicted to games for a long time and often invest their funds in mobile games (Anwar et al., 2020). Besides leisure functions, games can also provide people with certain educational functions. Educational games help and support player learning through scaffolds. During the game, players can complete many learning behaviors according to the specific tasks in the game, such as idiom elimination games. During the game, players can complete the familiarization and use of Chinese idioms. Mobile games have many implications for learning behavior in education. Mobile devices and social media are essential educational tools (Chen et al., 2022). Educational games make it possible to “learn by playing.” Therefore, how to make mobile games a favorable “assistant” in the education process has become one of the common concerns of society.

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Maskeliunas et al. (2020) concluded that current primary school teachers lacked innovation and dynamism in the classroom. They followed the traditional “I had the final say” model and failed to inspire students to think about problems in class. There was no interaction between students and teachers. The modern classroom should be exploratory and lighthearted (Maskeliunas et al., 2020). Many studies have analyzed the use of games in education. Cheung and Ng (2021) implemented a “Comparative Media Studies Program” that attempts to make mobile game development an important part of student learning behavior. A typical student-developed game called “Revolution” has been successfully used in history classrooms in some middle schools in the United States (Cheung & Ng, 2021). Jylha and Hamari (2020) constructed an environmental model of the impact of mobile gaming applications on students’ learning behavior. They elaborated on the theory, technical methods, research directions, and resource platforms of mobile learning (Jylha & Hamari, 2020). In addition to primary and secondary school students, mobile gaming platforms for college students have also been studied. Javaid (2017) provided minority learning strategies from multiple perspectives, including curriculum design, media design, and communication design, based on the current learning behavior of college students and the context of the booming modern mobile learning. Javaid noted the platform design of mobile learning was driven by the system platform of mobile learning, including technology and application innovation (Javaid, 2017). Meishar-Tal and Ronen (2016) proposed a model structure for techniques related to the impact of modern mobile games on contemporary students’ learning behavior. They discussed and analyzed each model structure’s primary functions, key technologies, application scenarios, and related technologies (Meishar-Tal & Ronen, 2016). In addition, Izaguirre et al. (2021) created a platform for “communicating with each other and realizing desires,” which is the basic concept and core feature of “second life.”

Compared with the research theories and achievements of the above scholars, this paper uses the popular Deep Learning (DL) model and questionnaires to analyze the learning behavior of college and primary school students. The subjects are college and primary school students to explore the learning behavior of the major groups that currently use educational games. The primary research methods include the bibliographic method, questionnaire method, and comparative analysis method. In this context, the research status of educational games is first analyzed. Second, the educational game is accelerated based on DL technology. Third, through the questionnaire survey, the impact of mobile education games on the learning behavior of mobile devices by primary and college school students is comprehensively analyzed and elaborated. Finally, mobile games’ role in students’ learning behavior is explored. The ultimate goal of the research is to conclude that mobile games play an active role in future education. In addition, the research results enrich the theoretical foundation of this field and provide optimization ideas for the development of follow-up education (Najjar & Dahabiyyeh, 2021; Gu et al., 2021).

**LITERATURE REVIEW**

Since 1980, American researchers have been working on simple, stand-alone educational games. The range and speed of propagation are slow. With the rapid development of the Internet, Internet games on computers and mobile phones have gradually developed. Educational games have also changed, mainly in terms of the content, format, and audience of educational games (Rachman et al., 2019). Everyone has gradually recognized educational games and entered classroom teaching. It has laid a good foundation for the promotion of educational games in the future. Foreign countries have a long research time for educational games, and the research team is strong. The research on educational games in the United States, the United Kingdom, France, and other countries has matured and industrialized (Silveira & Villalba-Condori, 2018). In the United States, the Department of Comparative Media Studies and the Learning Science and Technology Laboratory of Microsoft Research Institute of Massachusetts Institute of Technology have jointly carried out the Games-to-Teach project. The successful development of this project has provided substantial support for future
researchers on educational games, injecting new vitality into the development of educational games (Gurbuz & Celik, 2022). Foreign countries have paid attention to primary school children’s games earlier. Enlight Entertainment, a Canadian game development company, specializes in designing and developing games for children’s education. Their games include “Monster Company” and “Winnie the Pooh.” American television production company Nickelodeon launches “Blue Educational Game Software for Primary School Students.” The American company Lidstuff has developed the Little Fingers series of software. British game development company 505 GAMES developed the game “Did it Mum” (Hewitt & White, 2021).

Domestic Chinese research on educational game theory started late in 2001. Presently, domestic companies have developed many small games aimed at preschool children. The first type is focused on supporting language skills, such as “Happy Learning English” by Shanghai Jidibao Education Software Development Co., Ltd. The second is mathematics, such as “Happy Math Garden” made by Qi Yi Technology for preschool children. The third is action-oriented, such as “Whack-a-Mole” and “Frog.” The fourth is observational, such as “Find the Difference.” The fifth is artistic expression, such as “The King of Golden Mountain Painting.” The sixth is cognitive, such as “Teletubbies.” The seventh is the comprehensive category, such as “Little Bear Family Education Learning Aid Deluxe Edition,” which is suitable for preschoolers, early childhood transition stages, and early primary school children (Zeng et al., 2020). With the rapid development of the Internet and technology, people's demand for games is also increasing, which has led to a growing team of game manufacturers (Sun et al., 2021). Most parents have gradually accepted the use of games to assist in classroom teaching. The effect of educational games on classroom teaching has gradually become prominent. Experts and scholars have also paid attention to the design and development of educational games. At present, the games developed by game manufacturers are relatively messy. Excellent educational game design can grasp the balance between education and games. It effectively combines play and learning, which is the ideal design for educational games. At present, how to find a balance between play and learning is one topic that education experts are discussing.

Currently, the research, development, and use of educational games abroad are still relatively free. Educational games are rich in resources. They have many gaming sites where most games are free to download and on a relatively open platform. This availability provides a suitable platform for learners that is worth learning in China. Although many experts and scholars currently study educational games, the positioning of games is inaccurate in most research results. Students always passively play games to complete the teaching content. Students do not play games spontaneously, which is a failure in developing educational games. Education and play are not yet fully integrated. China’s educational game research is still in a backward stage and needs to be improved. Therefore, the impact of educational games on users’ learning behavior will be discussed here to strive to provide a reference for developing educational games.

CONSTRUCTION OF MOBILE GAME MODEL IN TEACHING AND EDUCATION

Theoretical Basis of Educational Games and Learning Behaviors

Foreign studies on game theory started early. The great Greek philosopher Plato held that “a game is a conscious simulation activity generated by the jumping needs of all young animals and people’s life and ability” (Trisnadoli & Kreshna, 2021). Other scholars believed that “a game is a voluntary activity or pastime, which is a voluntary activity or career carried out within a fixed time and space. It has its own goal according to the rules consciously accepted and fully followed, accompanied by nervous and pleasant feelings and consciousness different from ordinary life” (Hernandezc & Crawford, 2021). In China’s Chinese Dictionary, the word “游” is interpreted as playing, making friends, and lobbying (Rakhmatov, 2021). The word “戏” is interpreted as playing and drama. Besides, in Cihai, the game is defined as an activity with the primary purpose of directly harvesting happiness and relaxation, and someone must participate in the whole interactive activity as a subject.
According to the literal meaning, mobile games refer to digital games that can be played on online mobile phones (Yu et al., 2021). We can divide it into text, interactive voice response, and graphic games through the game characteristics (Hu et al., 2021). Educational games refer to games for education, which are pretty common in the market, especially in primary school education. They add game elements to some teaching equipment and social media, such as roles and levels (Devraj et al., 2021). A mobile device is a small computing device that usually has a small display screen, touch input, or a small keyboard. Users can access any information they want anytime and anywhere, so it soon becomes popular in the streets (Lopez & Jaen, 2020). Social media is a platform where people can share and express their opinions and various experiences. The current representative social media includes Weibo, WeChat, blogs, and forums. Mobile Internet promotes the development of mobile games and makes social media flourish on the fertile soil of the Internet. Each coin has two sides. The information spread by social media has become essential content for people to browse the Internet. It has created new things and hot topics, one after another, exposed criminals, or unscrupulous businesses, protected consumers’ rights and interests and made society more transparent (Kusuma et al., 2021; Washington et al., 2020). People always confuse the concepts of computer games, educational software, and educational games.

Related theories in mobile educational games include mobile learning theory, gamified learning theory, and learning motivation theory. Mobile learning refers to a new learning method using wireless mobile communication network technology and network cable mobile communication equipment to obtain educational information, resources, and services. Learning convenience, personalized teaching, rich interaction, and situational relevance are characteristics of mobile learning. Mobile learning extends network learning and distributed learning. Gamified learning is about allowing learners to achieve the purpose of learning knowledge by playing games. Learners experience the fun and learn from play. It serves to improve the efficiency of classroom teaching. The great attraction of games to learners can cultivate students’ learning interests by taking their time for hobbies and helping to enhance learning efficiency. Students and parents gradually favor the concept of learning through play. Gamification learning theory is currently teaching and educational practice that has attracted much attention. It points the way for scholars studying educational games. Gamification learning theory is a fundamental theoretical foundation for educational game software development. In a virtual game environment, it is difficult for learners to escape the game’s attraction because it can make them feel the fantasy and curiosity the virtual world brings. Besides, games allow learners to experience real-life tasks that cannot be completed and gain a sense of success. Learning motivation is an intrinsic factor in students improving their academic performance.

All human activities are purposeful, and this is the motivation of human behavior. Motivation drives oneself to accomplish a set goal by stimulating the strength within one’s body. It is an explanatory concept used to explain why learners behave this way. Connectionist psychologists have proposed a theory of learning motivation. They believe that motivation is an impulse to behavior caused by external stimuli. Students are motivated to get good grades and get into a university of their choice in the future. Learning motivation is a potentially powerful internal motivation in the inner world of people. Learning motivation is extremely potent. We can stimulate learners to continuously study hard to improve learning efficiency by constantly stimulating people’s learning motivation and cultivating learners’ good learning habits (Hong & Xu, 2021).

Learners of different ages exhibit different learning behaviors. For example, primary and college school students have different ways of thinking, learning styles, and motivations for achievement. Thought will control and restrict everyone’s activities (Li & Wang, 2020). Human thought is dominant. All behaviors can be seen, tracked, and described. The learning behavior here refers to all kinds of learning-related activities and behaviors (Honebein, 2021). The subject of learning behavior is learners, and the object is the object of learning, including theoretical knowledge, relevant experience, and various skills. The learning behavior method is learning style, that is, multiple ways for learners to obtain learning information (Kwok et al., 2020). Some domestic researchers define learning behavior
as a process and activity of learning. Other scholars define learning behavior as students’ personality characteristics reflected in mastering and applying knowledge (Yadav & Oyelere, 2021). The primary factors affecting learning behavior are the teacher-student relationship, teaching behavior, learners’ characteristics, and learning style (Eutsler, 2020; Zhu, 2021).

Construction of Game Performance Improvement Model Based on DL

Machine learning technology is a technology that studies how computers simulate or realize the learning behavior of animals (Cai et al., 2021; Menezes et al., 2020; Rockstroh et al., 2020) to learn new knowledge or skills, rewrite existing data structures, and then improve program performance. Obviously, “DL” is strongly related to the “neural network” in machine learning, and “neural network” is also its main algorithm and method. “DL” is called an “improved neural network” algorithm (Kumar et al., 2020; Sedghani et al., 2021). We present the theoretical model in Figure 1.

A game acceleration framework based on DL is designed here. The framework includes four modules: input data module, game recognition module, game acceleration module, and data update module, as shown in Figure 2.

In Figure 2, after the data stream enters the device, it first enters the input data module and obtains the required information from the data stream through the module. Once the necessary information is received, it is passed as input to the game recognition module. It is determined whether the message is a game message. After that, enter the game acceleration module to complete the game acceleration. The input data module uses the Socket raw socket to obtain the required information from the data stream. This information is processed. The information is converted into the format required by the identification module. Then, this information is passed as input to the game recognition module. The primary function of the game recognition module is to implement data flow recognition. It uses the trained decision tree as the recognition model to recognize the incoming data of the input data

Figure 1. The model of DL
module. The game recognition module identifies whether the data message is an online game data message or a data message of another application. The game acceleration module uses the Quality of Service-based Weighted Round Robin scheduling strategy to achieve bandwidth allocation for online games and other applications. Low latency and high fluency of online games are guaranteed to achieve online game acceleration by allocating sufficient bandwidth to online games. The data update module first uses the multi-dimensional K-means clustering algorithm to screen the unknown data initially. After that, it picks the online game data to train a new online game recognition model. Then, the new recognition model can recognize more online games.

In the recognition algorithm in Figure 2, Back Propagation Neural Network (BPNN), Probabilistic Neural Network (PNN), Extreme Learning Machine (ELM), and wavelet neural network are selected for comparative analysis. The structure of the BPNN is shown in Figure 3.

The BP network in Figure 3 comprises three main parts: the input layer, the hidden layer, and the output layer. The algorithm has good adaptive learning ability. Moreover, it excels in dealing with various nonlinear problems. Therefore, this algorithm is well-suited for network traffic identification.

PNN is a feed-forward artificial neural network. PNNs have the advantages of simple network structure and fast network training, so they have been widely used (Mahto et al., 2020). Its main
The purpose is to solve nonlinear classification problems. It can still achieve the accuracy of nonlinear methods through linear learning methods in solving such problems, so it has significant advantages in solving classification problems. The algorithm does not have to correct the network weights to solve the need for real-time processing in training. Therefore, this method can be used for network traffic identification. PNNs comprise input, pattern, summation, and output layers. The function of the input layer is to pass feature vectors of the training data to the network. The sample vector’s dimensions determine the number of neurons in the input layer, and the number is equal to this value. The function of the pattern layer is to complete the matching of the input data feature vectors and distinct patterns to analyze and calculate. The number of types of training data will determine the number of nodes in the pattern layer. The output values of this layer are shown in Eq. (1):

\[
h(X, W) = \exp \left[ -\frac{(X - W)^T (X - W)}{2\delta^2} \right]
\]

(1)

In Eq. (1), the connection weights for the schema layer are expressed in \( W \). The smoothing factor is expressed in \( \delta \). \( X \) represents the input value, and \( h \) represents the output value. These parameters have a significant impact on the accurate implementation of the classification function of the neural network.

The function of the summation layer is to sum the probabilities of one of the classification results to find the estimated probability density function of the failure mode. The function of the output layer is to select the node with the greatest posterior probability density in different failure modes and use this node as the output of the entire probability neural network. The number of classifications of the sample data will determine the number of nodes in the output layer; the number of classification types correspond to how many neurons are used. Different neurons correspond to different classification types. When the sample data of the experiment is sufficient, the original probability density function can be continuously and smoothly approximated:

Figure 3. BP model
In Eq. (2), the $i$ training vectors of Class A failure modes are represented by $X_{ai}$. The total number of training data is expressed in $m$. Smoothing parameters are represented by $\delta$. This value determines the width of the bell curve centered on the sample point.

ELM has a similar network structure to BPNNs (Wang et al., 2021). The difference is that ELM can obtain the required optimal solution without modifying the initialization weights and thresholds given the number of nodes in the hidden layer. Therefore, the primary advantage of ELM is that there is no need to adjust the weights and thresholds of the network during training, so the training time of the network will be greatly reduced. Compared with other machine learning algorithms, this algorithm has the advantages of a fast learning rate and good generalization performance. It can be used for network traffic identification. We optimized wavelet neural networks on BPNNs. The difference between the two lies in the choice of the implied layer transfer function (Ghoushchi et al., 2021). Wavelet neural networks use wavelet basis functions as transfer functions. The entire network combines the wavelet function and the advantages of neural networks to form a new neural network. Therefore, the neural network has the characteristics of high accuracy, fast convergence, and flexible function approximation. A wavelet neural network comprises $k$ inputs and $m$ outputs. The $\omega_{ij}$ and $\omega_{jk}$ represent the connection weights of the network. The wavelet basis function is the transfer function of the network. The output of the hidden layer is $h(j)$:

$$h(j) = h\left(\sum_{i=1}^{k} \omega_{ij} x_i - b_j \right) \quad j = 1, 2, \ldots, l \quad (3)$$

In Eq. (3), $h(j)$ represents the output value corresponding to the $j$th node in the hidden layer. $h_j$ is the wavelet basis function chosen. $a_j$ and $b_j$ correspond to the scaling and translation factors of the wavelet function, respectively. The wavelet basis function here is selected, as shown in Eq. (4):

$$y = \cos(1.75x) e^{-x^2/2} \quad (4)$$

The output of the entire network is shown in Eq. (5):

$$y(k) = \sum_{i=1}^{l} \omega_{ik} h(i) k = 1, 2, \ldots, m \quad (5)$$

In Eq. (5), $h(i)$ represents the output of the $i$th hidden layer node. $l$ is the number of nodes in the hidden layer, and $m$ is the number of nodes in the output layer. Wavelet neural networks optimize the network’s structure by constantly correcting the parameters of the network. The complete process adopts the reverse gradient method, similar to the training component of the BPNN. We gradually reduced the output error through repeated training to meet the demand.
Questionnaire Design

CNKI, Google Scholar, and other channels are used to query data because of writing needs. Next, multiple studies and works from columnists and related Internet information are used. Moreover, numerous associated journals and books in the school library have also been used, such as *Research on the Development of Mobile Games* and *Gamification Thinking*. The above data collection and summary provide a favorable theoretical basis for the research ideas and methods (Abdullah et al., 2022). College and primary school students are the future of national development, and current mobile games have affected them. Hence, the corresponding questionnaire questions are set up to understand the impact of mobile games on students’ learning behavior. The questionnaire is used to investigate why college students play mobile phones, the role of browsing Weibo, WeChat, and games in learning, and the links of mobile games added to the primary school students’ education process. The purpose is to reveal the impact of mobile games on their learning behavior. The hypothesis is that mobile educational games positively impact students’ learning behavior (Li et al., 2021).

Mobile educational games have a wide audience, so the respondents of this survey include primary and college school students. Before the questionnaire, the research hypothesis that “positive mobile games will positively impact students” is proposed. China has the highest proportion of public school students. Therefore, in June 2019 and August 2020, we distributed 310 questionnaires to university students from a public university and a primary school in a public primary school in the study area. Besides, we distributed 200 questionnaires for college students and 110 questionnaires for primary school students, focusing on the impact of college students’ learning behavior. Questionnaires for university students were dispersed evenly across the four university grades as far as possible and were gender-balanced. In addition, questionnaire comprehension skills are considered. We mainly distributed questionnaires for primary school students to students in the fifth and sixth grades of primary school. In this survey, we did not consider the respondents’ usual grades.

The difference between the primary school and university student questionnaires is that the mobile games used in the experiment differ. The game combines different depth learning models to investigate whether it can improve students’ learning enthusiasm under the accelerated game speed. We discussed the questionnaire with experts of relevant disciplines before distribution. Unreasonable questions in the questionnaire are modified to the questionnaire was effective and scientifically valuable. We distributed the questionnaire face-to-face and recycled on-site to ensure the corresponding recovery rate. Additionally, 270 copies were recovered, the recovery rate is about 87.1%, 248 copies are effective, and the effective recovery rate is 91.85%. Among them, we collected 190 questionnaires from college students and 80 from primary school students. Figure 4 presents the specific investigation steps.

Figure 4 displays that the questionnaire mainly has six steps. First, research problems should be determined, and then the sampling survey should be designed. After the design was completed, specific experiments were carried out. After the experiment, the collected data are sorted, counted, and analyzed. Then, the investigation report was written. Finally, the survey is summarized and evaluated.

We introduced the validity test of systematic error variance to make the questionnaire results more accurate, as shown in equation (6):

\[
    r = \frac{\sum XY - \frac{\sum X \sum Y}{N}}{\sqrt{\sum X^2 - \frac{(\sum X)^2}{N}} \sqrt{\sum Y^2 - \frac{(\sum Y)^2}{N}}}
\] (6)
represents the reliability coefficient, \( X \) is the dependent variable, \( Y \) represents the independent variable, and \( N \) represents the quantity.

Equation (6) can get the score difference of actual numbers. Equation (7) displays the details:

\[
\alpha = \frac{K}{K-1} \left( 1 - \frac{\sum_{i=1}^{K} \sigma_{Y_i}^2}{\sigma_X^2} \right)
\]  

In (7), \( \alpha \) means coefficient, and \( K \) means quantity. The meaning of other letters is the same as in the previous equation. The higher the reliability coefficient is, the higher the reliability between the variables is, and the higher the degree of internal consistency between the variables is. \( \alpha \leq 0.3 \) indicates that the variable is not credible. When \( \alpha \) is between 0.3 and 0.4, it indicates that the variable is initially credible. When \( \alpha \) is between 0.4 and 0.5, it indicates that the variables are slightly conceivable. When \( \alpha \) is between 0.5 and 0.7, it indicates that the variables are credible. When \( \alpha \) is between 0.7 and 0.9, the variables are relatively credible. When \( \alpha > 0.9 \), it indicates that the variable is very reasonable. Equation (8) is used to test the reliability of the internal consistency of the questionnaire response, and the result is 0.86, indicating that the reliability of the questionnaire is relatively high.

In addition, the questionnaire is used to study the following questions, as shown in Table 1.

<table>
<thead>
<tr>
<th>Type</th>
<th>Primary coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>For College Students</td>
<td>The main intention of college students playing mobile phones</td>
</tr>
<tr>
<td></td>
<td>The specific situation of college students playing mobile games</td>
</tr>
<tr>
<td>For primary school students</td>
<td>Students’ attention after adding the DL model</td>
</tr>
<tr>
<td></td>
<td>Changes in students’ homework submission efficiency before and after the experiment</td>
</tr>
<tr>
<td></td>
<td>Changes in students’ academic performance before and after the experiment</td>
</tr>
<tr>
<td></td>
<td>Student satisfaction survey</td>
</tr>
</tbody>
</table>
The research topics in Table 1 differ for different subjects. The idiom game is used as an example. We measured the idiom mastery level of primary school students before and after the experiment and evaluated their language homework submission efficiency. During the application, teachers will introduce mobile games to primary school students for part of the class. Teachers prefer a combination of mobile games and classrooms.

Figure 5 shows the suggestions for follow-up work based on the current research content.

Figure 5 shows that the problem generated by the learning module is the only way to improve the power of players’ bullets. It is also the foothold of the combination of this game and education. During the game, the learning module reads the word data from the database according to the specified range. Then, the question-making module processes the obtained data to provide learning questions and answers for the game logic module. This design can trigger students’ thirst for knowledge and increase their interest in learning.

THE RESULTS AND ANALYSIS OF THE INFLUENCE OF MOBILE GAMES ON LEARNING BEHAVIORS IN THE EDUCATION PROCESS

Comparison of Game Recognition Accuracy Results of Different Algorithms

For different games, we counted the recognition accuracy ten times. The comparative analysis of the recognition accuracy results of BPNN, PNN, ELM, and wavelet neural networks is revealed in Figure 6.

Figure 6 shows that the accuracy of the BPNN and PNN curves is relatively stable. The average recognition accuracy is sorted from largest to smallest: PNN > BPNN > ELM > wavelet neural network. It indicates that the average recognition accuracy of PNN is better than the other three
algorithms. Therefore, the PNN algorithm is selected here for the recognition algorithm in online game acceleration. Subsequent studies will also be carried out based on this.

The Status Quo of the Influence of Mobile Games on Learning Behavior

Mobile phones have multiple advantages. They are convenient to carry and meet the needs of human beings. College students are one of the main users of mobile phones, and mobile games will affect their learning behavior. The main purposes of their mobile phone use can be understood through the questionnaire. Figure 7 presents the results.

Figure 7 reveals that only 10% of college students use mobile phones to make calls and send text messages. No one uses mobile phones to send emails, few students use them for shopping, and only 4.4% use them for learning. Students mainly use mobile phones for Internet access, WeChat,
entertainment, and playing games, accounting for 27%, 44%, and 12%, respectively. The reason is that they have gradually replaced the functions of making phone calls and sending text messages with WeChat software and the rapid spread of wireless networks. As for sending emails, there may be little or no content involved because students have no work at present, so no student takes email as the primary intention of playing mobile phone. Besides, the tasks related to sending emails are more inclined to be sent using the computer.

With the rapid progress of the mobile Internet, the popularization of smartphones, and the promotion of mobile games by various mobile applications, games continue to shift from the computer side to the mobile phone segment. Therefore, we used the questionnaire results to generate descriptive statistics to evaluate the situation of modern college students playing mobile games (Figure 8).

Figure 8 clearly shows that about 25% of college students often or always play mobile games, which is relatively frequent. About 60% of college students seldom or occasionally play mobile games. The remaining 13% of college students never play games. It shows that while many college students play games, few have been addicted to them for a long time.

College students mainly use mobile phones for entertainment and chatting. The bivariate correlation analysis method in Statistical Product and Service Solutions (SPSS)25 is used to make a correlation analysis on the two variables “browsing Weibo” and “learning behavior by browsing Weibo.” Table 2 presents the results.

Figure 8. Modern college students playing mobile games. (a) number of people; (b) proportions.

<table>
<thead>
<tr>
<th>Type</th>
<th>Parameter</th>
<th>Browse Weibo</th>
<th>Learning behavior by browsing Weibo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Browse Weibo</td>
<td>correlation coefficient</td>
<td>1</td>
<td>0.712</td>
</tr>
<tr>
<td></td>
<td>Sig.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>α</td>
<td>0.486</td>
<td>0.486</td>
</tr>
<tr>
<td>Learning behavior by browsing Weibo</td>
<td>correlation coefficient</td>
<td>0.712</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sig.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>α</td>
<td>0.581</td>
<td>0.586</td>
</tr>
</tbody>
</table>
Table 2 shows that the correlation coefficient $\alpha = 0.486 < 0.5$, indicating a low correlation between “browsing Weibo” and “learning behavior by browsing Weibo,” and this correlation is positive. The value of Sig. (two-sided) is 0, which means that the hypothesis that the two are not correlated is rejected at the significance level of 0.01. Therefore, a significant positive correlation exists between college students’ browsing Weibo and their learning behavior. It means that in their daily life, college students’ browsing behaviors on Weibo have a specific promotion for their use of this channel to assist their learning.

Next, the bivariate correlation analysis function in SPSS25 is adopted to make a correlation analysis of the two variables of “Browsing WeChat” and “Learning Behavior by Browsing WeChat.” Table 3 displays the analysis results.

Table 3 shows that the correlation coefficient $\alpha = 0.712 < 0.8$, showing a moderate correlation between “browsing WeChat” and “learning behavior by browsing WeChat,” and this correlation is positive. The value of Sig. (two-sided) is 0. It suggests rejection of the hypothesis that the two are not correlated, at the significance level of 0.01. Therefore, there is a significant positive correlation between college students’ browsing WeChat and their learning behavior. In their daily life, college students’ behavior of browsing mobile WeChat can promote their use of this channel to assist their learning to a certain extent.

The mobile game should also be verified. Next, the two variables of “mobile game” and “learning behavior based on the mobile game” are analyzed using the bivariate correlation analysis function in SPSS25. Table 4 shows the analysis results.

### Table 3. Correlation coefficient between college students’ browsing mobile WeChat and assisted learning

<table>
<thead>
<tr>
<th>Type</th>
<th>Parameter</th>
<th>Browse WeChat</th>
<th>Learning behavior by browsing WeChat</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Browse WeChat</strong></td>
<td>correlation coefficient</td>
<td>1</td>
<td>0.712</td>
</tr>
<tr>
<td></td>
<td>Sig.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>$\alpha$</td>
<td>0.581</td>
<td>0.586</td>
</tr>
<tr>
<td><strong>Learning behavior by browsing WeChat</strong></td>
<td>correlation coefficient</td>
<td>0.712</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sig.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>$\alpha$</td>
<td>0.581</td>
<td>0.586</td>
</tr>
</tbody>
</table>

### Table 4. Correlation coefficient between college students’ mobile games and their assisted learning

<table>
<thead>
<tr>
<th>Type</th>
<th>Parameter</th>
<th>Browse WeChat</th>
<th>Learning behavior by browsing WeChat</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Browse WeChat</strong></td>
<td>correlation coefficient</td>
<td>1</td>
<td>0.712</td>
</tr>
<tr>
<td></td>
<td>Sig.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>$\alpha$</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Learning behavior by browsing WeChat</strong></td>
<td>correlation coefficient</td>
<td>-0.15</td>
<td>-0.21</td>
</tr>
<tr>
<td></td>
<td>Sig.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>$\alpha$</td>
<td>0.581</td>
<td>0.586</td>
</tr>
</tbody>
</table>
Table 4 shows that the value of the correlation coefficient $\alpha$ is -0.15, less than 0, showing a negative correlation between “mobile game” and “learning behavior based on the mobile game.” It means that college students’ mobile game behavior in their daily life does not promote their use of this channel to assist in learning. On the contrary, if overused, it will also pose a threat to learning behavior. Therefore, every college student should pay attention to the rational use of mobile phones.

To sum up, after analyzing the impact of browsing Weibo, browsing WeChat, and playing mobile games on learning behavior, we found that browsing Weibo and WeChat positively affect learning behavior to a certain extent. Students can exercise their social skills and improve their ability to obtain relevant information by browsing Weibo and WeChat on mobile phones. However, playing games does not promote learning behavior. If they have low self-control, they will certainly indulge in it.

**The Influence of Mobile Games by DL on Learning Behavior**

By analyzing the impact of mobile games on learning behavior in the education process, we found mobile games do more harm than good to learning behavior. Students use mobile phones more for playing games than for learning. With the continuous development of science and technology, mobile games are also indirectly bringing benefits to learning behaviors.

The learning behavior of college students has been analyzed, and mobile games have increasingly affected primary school students. Since the games for college and primary school students are different here, we do not compare the results of the two. Next, the influence of mobile games on primary school students’ learning behavior under the DL method is studied. Now, the popular “learn Chinese from me” Chinese character mobile game on the Internet has designed six game modules: learning, writing, recognizing, flipping, pointing, and connecting Chinese characters. Students can learn while playing games. It is not dull. Students are vivid to learning knowledge. This learning method can achieve twice the result with half the effort. In addition, different game categories also correspond to different competition mechanisms. Table 5 displays the details.

Table 5 shows that this software divides knowledge and games. Each knowledge type and game type have a corresponding competition mechanism. These competition mechanisms can arouse students’ enthusiasm and make them more attentive in class, and it is difficult to skip thinking. In addition, the competition mechanism can also cultivate children’s teamwork and communication skills.

In the practical application process, teachers will decide when to conduct these experiments in the classroom. After traditional classroom education, teachers introduce students to educational games

<table>
<thead>
<tr>
<th>Knowledge type</th>
<th>Game type</th>
<th>Competition mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factual knowledge</td>
<td>Interest classification</td>
<td>Each class has two games, and each group selects a team leader to participate. Students can work in pairs to complete the classification task. Each team member can prompt the team leader. The two groups with a short time will win, and the points of each winning group will be + 1 during the game.</td>
</tr>
<tr>
<td>Conceptual knowledge</td>
<td>Judge right and wrong</td>
<td>There are two games in each class. Each group selects one person from each group to participate in the game. One group carries out PK, the group with high accuracy wins, and the group wins each game. Integral + 1.</td>
</tr>
<tr>
<td>Program knowledge</td>
<td>Banked Cloze</td>
<td>There are two games in each class. Each group selects one person from each group to participate in the game. One group completes the blank filling in cooperation, and the two groups with a short time in two games win. Winning group points + 1.</td>
</tr>
</tbody>
</table>
and guide students through learning. When students master the knowledge points in the educational game in the classroom, the efficiency of homework completion will also be affected.

We randomly divided these students into two groups, and Table 6 displays the specific results. Among them, the first group is the experimental group, and the second group is the control group.

We conducted a questionnaire on the effect of adding the DL model to the “learn Chinese with me” game. Figure 9 shows the results.

Figure 9 shows that fact knowledge is concentrated in about 30.4 minutes on average, conceptual knowledge is concentrated in about 33 minutes, and program knowledge is concentrated in about 30.3 minutes on average. Among the knowledge of facts, concepts, and procedures, conceptual students have the longest attention time, indicating that they are more willing to make judgments about right and wrong questions, which attracts their attention more.

Before and after nine experiments, the students’ homework is investigated to test this mobile game’s effect on multiple aspects. First, the teacher evaluates learning efficiency to evaluate the students’ knowledge acquisition to obtain the learning efficiency parameters. Figures 10 and 11 display the results.

The efficiency of students’ homework is compared before and after the experiment. We found that the change in the good students’ work efficiency is not very obvious but is stable, and there is no apparent fluctuation. It shows that the change before and after the experiment still has little impact on the work efficiency of the good students. On the other hand, the work efficiency of secondary students has changed to some extent. Notably, the work efficiency of the third middle school student has changed significantly, gradually approaching the good students. It shows that the adjustment of

Table 6. Number and proportion of primary school students

<table>
<thead>
<tr>
<th>Group</th>
<th>People number</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group one (experimental)</td>
<td>20</td>
<td>50%</td>
</tr>
<tr>
<td>Group two (control)</td>
<td>20</td>
<td>50%</td>
</tr>
</tbody>
</table>

Figure 9. Different types of student concentration time
game titles has further improved the impact on secondary students. Although the work efficiency of the three students with weak foundations still lags that of the secondary students, the fluctuation between them after the experiment has gradually narrowed. It shows that the students’ learning attitude with weak foundations is better than before. It also shows that adjusting game titles and strategies positively affect students with weak foundations.

Meanwhile, a survey is conducted on the user experience of these students. Figure 12 displays the results.
Figure 12 shows that about 72% of the total number of students like very much and like this way of learning. On the other hand, 13% of students dislike this model, and 15% of students sometimes like and sometimes dislike this model. Besides, about 68% of students feel this model has improved their confidence in learning. About 25% believe that their learning confidence has hardly improved, and 7% believe that their confidence has been reduced. This method is conducive to class enthusiasm or learning confidence, and the experience is better. A few students believe their failure to improve their enthusiasm and learning confidence is because of their receptive ability. Moreover, this model needs to be perfected in some aspects.

Academic performance is very critical for every student. Tables 7 and 8 present the comparison results of the two types of student performance.

By comparing Tables 7 and 8, Sig.<0.05, suggesting a significant difference between the experimental and control classes. The introduction of educational games has significantly improved student achievement. However, it is found that the performance of good students and students with weak foundations is not apparent after analyzing the performance of 20 students in the experimental class.

<table>
<thead>
<tr>
<th>Class</th>
<th>N</th>
<th>Mean Value</th>
<th>Standard Deviation</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>20</td>
<td>87.26</td>
<td>14.698</td>
<td>0.854</td>
</tr>
<tr>
<td>Two</td>
<td>20</td>
<td>91.45</td>
<td>11.368</td>
<td>0.806</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class</th>
<th>N</th>
<th>Mean Value</th>
<th>Standard Deviation</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>20</td>
<td>98.23</td>
<td>9.456</td>
<td>0.025</td>
</tr>
<tr>
<td>Two</td>
<td>20</td>
<td>88.25</td>
<td>12.361</td>
<td>0.0289</td>
</tr>
</tbody>
</table>
group. This result suggests that mobile educational games should be redesigned, reformed, and researched to meet students’ needs at different stages.

DISCUSSION

Primary and college school students are the sample for the study where a questionnaire was used as the research method. The main reasons for college students to use mobile phones, the impact of different social media on students’ learning behavior, and the impact of integrating game elements into the teaching process of primary school students on students’ learning status were analyzed. Finally, we found that adding mobile games to the education process will improve students’ learning interests and academic performance to a certain extent. In addition, the use of social software can also cultivate students’ learning behavior. However, there are still some research deficiencies, such as using the situation created by the game to develop students’ abstract thinking ability and metacognitive ability and improving the relevant functions of the game existing to continue to improve the gameplay. Furthermore, a study of the group of middle school students can be carried out in the future. Yang et al. (2021) studied the impact of mobile games on students’ learning behavior from the perspective of middle school students. They proposed that middle school students were in adolescence. Teachers’ teaching methods at this stage should attract students’ attention (Yang et al., 2021). Anitha and Padma (2021) detailed the ideas and theories of digital game learning, the concept of game learning, ways to conduct play learning, and the specific applications of game learning in education, business, military, and training (Anitha & Padma, 2021). Compared with the above research theory, this paper comprehensively analyzes and studies the impact of mobile device-assisted mobile education games on students’ learning behavior from the perspective of the overall macro situation. The results combined with theoretical and experimental data are convincing. Besides, studying the impact of mobile educational games on contemporary students’ learning behavior can update parents’ real-life stereotypes.

CONCLUSION

The progress of modern Internet technology and the continuous improvement of people’s living standards have brought a broad space for developing mobile games in education and have also derived multiple problems. From the perspective of education and teaching, we used primary and college school students in the research sample. The DL algorithm / Learn Chinese with Me and questionnaire survey are used to analyze the impact of mobile games on learning behavior in the educational process. The main conclusions are as follows. Contemporary college students mainly use mobile phones to surf the Internet, WeChat, and entertainment. The analysis of the impact of browsing Weibo, WeChat, and mobile games on learning behavior shows that browsing Weibo and WeChat positively correlates with learning behavior. These methods can cultivate sentiment, broaden horizons, and improve the ability to obtain relevant information and communicate skills. However, if the mobile phone is not used properly and reasonably, the user will be addicted to the mobile phone for a long time. The impact of mobile games on the learning behavior of primary school students in the teaching process is analyzed. The results show that the correct use of mobile phones and integrating games into learning can improve students’ homework submission efficiency and academic performance. It can also give most students the confidence to learn and learn actively. Studying the influence of mobile educational games, mobile devices, and social media on contemporary learning behavior can enrich the academic theory in this field and provide a good reference value for promoting contemporary students’ learning behavior and improving academic performance. Additionally, it can correct the one-sided view that “mobile games are not conducive to education” in parents’ eyes to a certain extent. There are certain limitations in data collection due to limited energy, resulting in certain deviations in examining relevant data. The combination of DL and this paper is also not deep enough.
In addition, the economic investment of mobile games in learning behavior in the educational process is not discussed. The concept of learning behavior has not been deepened and refined. Therefore, in the future, it is possible to deepen the research on online game acceleration and evaluate the benefits according to the specific situation. Learning behavior will be explored deeply so that suggestions and opinions can promote mobile games’ long-term and stable development in the educational process.
REFERENCES


APPENDIX

A Questionnaire Survey on the Impact of Mobile Educational Games on Students’ Learning Behavior

Hello everyone. We are conducting a “questionnaire on the impact of mobile educational games on students’ learning”. This questionnaire is anonymous; we hope you can fill it out truthfully. Thank you for taking the time to complete this questionnaire:

1. Your gender _______
2. Your grade _______
3. What do you mainly do with your mobile phone? (multiple choice)
   A. WeChat, QQ chat
   B. Sending emails
   C. Entertainment, playing games
   D. Making phone calls
   E. Online class
   F. Shopping
   G. Others

4. How long do you spend on the game in a week?
   A. 0
   B. 1-14h
   C. 15-28h
   D. Over 28h

5. How many games are there on your phone?
   A. 0
   B. 1-3
   C. 4-5
   D. Over 5

6. Do you play mobile games in class?
   A. Never
   B. Occasionally
   C. It depends

7. What do you think of the overall relationship between playing mobile games and learning? ()
   A. Affect learning
   B. Promote learning
   C. No impact
   D. Not clear

8. What is your current view on mobile games? ()
   A. People can get something that they can’t get in reality.
   B. It can relax life and make people more engaged in learning.
   C. People can broaden their horizons and make many new friends
   D. It affects learning. You regret playing games.
   E. It’s just entertainment

9. How fast will your homework be submitted after adding the DL algorithm / learning Chinese with me to the current class?
   A. No change
   B. Increasing submission speed by about 5%~10%
   C. Increasing submission speed by about 11%~15%
   D. Increasing submission speed by more than 16%
10. What is the change in your grades after adding the DL-based algorithm / learning Chinese with me to the current class?
   A. No change
   B. Performance improved by about 5%~10%
   C. Performance improved by about 11%~15%
   D. Performance improved by more than 16%

11. Would you like to add the DL algorithm / learn Chinese with me (a mobile educational game) to other subjects?
   A. I do
   B. I don’t want to.

12. How do you feel about joining DL / learning Chinese with me (a mobile educational game)?
   A. Extremely satisfied. It improves learning interest and liking.
   B. General
   C. Dissatisfied

13. Do you have any good suggestions for adding DL/learning meaning with me (a mobile educational game) to the classroom?