



## Research article

# Construction of influencing factor segmentation and intelligent prediction model of college students' cell phone addiction model based on machine learning algorithm

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## ARTICLE INFO

## Keywords:

Machine learning  
Cell phone addiction  
Feature parameters  
Intelligent prediction model  
Questionnaire

## ABSTRACT

Mobile phone addiction among college students has emerged as a prevalent phenomenon in contemporary society, posing significant challenges to the development and well-being of these individuals. The assessment of the extent of mobile phone addiction has become an urgent concern in the present context. This study employed a sample of 3000 college students from a public university in Zhejiang Province, China, to gather questionnaire data. By utilizing a machine learning algorithm, we identified the most salient factors associated with college students' addiction, with perfectionism emerging as the primary influencer. Additionally, a machine learning-based prediction model for college students' cell phone addiction was developed, yielding a prediction accuracy of 76.68%. This intelligent model can serve as a reliable tool for subsequent evaluations of college students' cell phone addiction.

## 1. Introduction

In recent years, the usage of cell phones among Internet users in China has significantly increased. The 52<sup>st</sup> statistical report on China's Internet development states that, as of June 2023, the number of cell phone Internet users reached 1.079 billion, indicating a growth of 36.36 million users compared to December 2021. It was found that 99.8% of Internet users in China access the Internet through their cell phones, highlighting the prevalence of mobile Internet access. On average, Internet users in China spend approximately 26.7 h per week online [1]. However, it is important to note that excessive cell phone usage and dependence can have detrimental effects on mental health, potentially leading to psychological issues such as depression, anxiety, and sleep disorders [2].

In such a social context, cell phone dependence has become increasingly prevalent among Chinese college students, who spend an average of 5.2 h on their cell phones each day. Notably, they use their cell phones not only after school hours, but even in the classroom, with 79% of college students admitting to using their cell phones even during class time. Considering an average class duration of 45 min, students spend an average of 13.9 min per class engaged with their cell phones, accounting for nearly one-third of the total class time [3]. Song et al.'s research on the use of cell phones by college students yielded similar conclusions, the average daily use of cell phones by college students was 5.13 h, and the average non-study use of cell phones by students in each class was 12 min, and according to the calculation of 45 min in each class, the time utilization rate of students in each class was lower than 73.3% [4].

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College students who often use cell phones in the classroom have more serious learning burnout and more negative attitudes toward learning. College students' cell phone addiction showed a significant negative correlation with four factors: awareness of classroom discipline, attention, teacher-student interaction, and ability to think independently in class. College students addicted to cell phones ignore the requirements of classroom discipline, pay less attention to the content of the lectures, ignore the teacher's questions, and react indifferently to the teacher's classroom interaction; college students use their cell phones to search for the correct answers directly on the Internet when they encounter classroom problems, which prevents them from thinking deeply about the problems, so the more serious the addiction to cell phones among college students is, the more ineffective their classroom learning is. Cell phone addicted students play with cell phones in class, their attention is not focused on the classroom content, resulting in "hidden truancy" behavior, and they are indeed more likely to have actual truancy behavior [5,6]. The rate of cell phone addiction among Chinese college students is estimated to be approximately 36.6%, impacting their psychological well-being and overall quality of life. Research indicates a significant association between severe cell phone addiction and various psychological issues such as anxiety, depression, loneliness, social anxiety, inattention, sadness, and despair. Furthermore, cell phone addiction also manifests in physical symptoms including palpitations, nausea, and choking, as well as sleep-related problems like poor sleep quality, increased sleep latency, sleep disorders, inadequate sleep duration, and disrupted sleep patterns [7]. In Feng et al.'s study, the percentage of college students' cell phone addiction was 33%, while in Wang et al.'s study, the percentage of college students' cell phone addiction reached 37.9%, and the results of the study were similar to the above findings [8,9].

Reducing cell phone addiction among college students has emerged as a critical concern for universities and has garnered considerable attention from researchers. Previous studies have focused on identifying and controlling factors that contribute to Internet addiction. Notably, Jiang et al.'s study confirmed that the core factors of perfectionism "high doubts about actions" and "high parental expectations" on the predictive role of cell phone addiction among college students [10]. Similarly, Liu et al.'s research guided by Perfectionism Cognition Theory, established a causal relationship between perfectionism and cell phone addiction among college students [11]. Additionally, it revealed the partially mediating role of Academic Procrastination between perfectionist apprehension and cell phone addiction. Yang et al.'s study further contributed by demonstrating the predictive impact of procrastination on cell phone addiction among college students [12].

Investigations into the impact of the sense of meaning of life on cell phone addiction have been undertaken by several researchers. Liu et al.'s and Chen et al.'s studies validated the inverse predictive effect of MEANING of life on cell phone addiction and shed light on the mediating influences of coping style and subjective well-being in this relationship [13,14]. In a study conducted by Zhang et al., the concept of self-control was introduced to explore the influence of the sense of life meaning on mobile phone addiction among college students [15]. It revealed the mediating role of self-control in the relationship between the sense of life meaning and cell phone addiction. Ambiguous statements have been clarified: Two other studies have elucidated that college students' self-control is significantly negatively associated with cell phone addiction and negatively predicts cell phone addiction [16,17]. Some researchers have also considered anxiety as an intermediate variable in the relationship between self-control and mobile phone addiction, arguing that anxiety diminishes an individual's level of self-control, thereby contributing to cell phone addiction in college students [18]. Moreover, the relationship between anxiety and cell phone addiction has been emphasized. A meta-analysis conducted by Li et al. synthesized previous research findings, suggesting a bidirectional causal relationship between anxiety and cell phone addiction [19]. This reciprocal association can lead to a vicious cycle of anxiety and cell phone addiction among college students [20–22].

Machine learning, a branch of artificial intelligence, aims to simulate or implement human learning activities using computers. It has emerged as a prominent and cutting-edge research field within AI [23–26]. Over the past few decades, machine learning has garnered significant interest as a means to achieve artificial intelligence [27–31]. In recent years, research in machine learning has witnessed rapid development, becoming a crucial area of focus within artificial intelligence. Chaudhury et al. employed plain Bayesian, support vector machine, and radial basis function neural networks for data preprocessing of the Smartphone Addiction Short Version (SASV) questionnaire [32]. Zong et al. utilized SVM, C-SVM, and V-SVM for parameter optimization and classification to assess the level of Internet addiction [33]. Ioannidis et al. employed logistic regression and plain Bayes to classify and predict problematic Internet use [34]. Savić et al. employed artificial neural networks and radial basis function neural networks to predict problematic Internet use. Furthermore, Savić et al. utilized artificial neural networks and support vector set machine learning methods to model problematic social media use (PSU) [35]. Currently, deep learning techniques are rarely applied to Internet addiction prediction studies. Given that the data in question is temporal, using recurrent neural nets as a prediction model would likely yield better results. The aforementioned methods primarily encompass ordinary machine learning techniques, which may not be as effective as recurrent neural networks in capturing the sequential nature of temporal data. Therefore, this paper proposes the gd-LSTM algorithm, a deep learning technique, to predict Internet addiction risk among students and addresses the issue of overfitting.

This study employs intelligent machine learning algorithms to predict and analyze the key factors contributing to cell phone addiction among college students. The prediction accuracy of the model reaches an impressive 77%, providing valuable theoretical guidance for future intelligent assessment of cell phone addiction levels among college students and predicting the overall trend of cell phone addiction within the college community.

## 2. Materials and methods

### 2.1. Participants

The sample for this study was selected from a public university located in Zhejiang province. The participants included full-time undergraduate students, encompassing all four years of study from freshman to senior year. The total sample size consisted of 3160

individuals, with 1192 being male and 1968 being female. The detail data collection methods and original questionnaire were shown in Supporting Information.

2.2. Data processing methods

In this study, a prediction model based on a machine learning algorithm was constructed by performing weight factor analysis on eight types of datasets. These datasets include grade, gender, FMPS perfectionism total score, MLQ life meaning total score, GPS procrastination total score, SCS self-control total score, and STAI anxiety total score. The datasets were randomly divided into a training set (80%) and a prediction set (20%).

Fig. 1 provides detailed information on the process of optimizing the algorithmic model for cell phone addiction prediction. It illustrates the steps involved in developing and refining the prediction model using machine learning techniques. The model underwent iterative optimization to enhance its performance and accuracy in predicting cell phone addiction among college students.

3. Results and discussion

The results presented in Fig. 2 demonstrate that the eight independent variables, including perfectionism, sense of meaning in life, procrastination, anxiety, self-control, grade, and gender, have an impact on cell phone addiction among college students. Among these variables, grade and gender had the least influence on perfectionism and cell phone addiction.

According to Perfectionism Cognition Theory (PCT), perfectionism can result in reduced attention, persistent negative emotions, and feelings of exhaustion [36]. The underlying mechanism of perfectionism involves overthinking (rumination) and worrying. Perfectionists tend to excessively ruminate over their mistakes, worry about not doing enough, and compare themselves unfavorably to others. This overthinking process shifts their attention away from the task at hand and leads to mind wandering and difficulties in

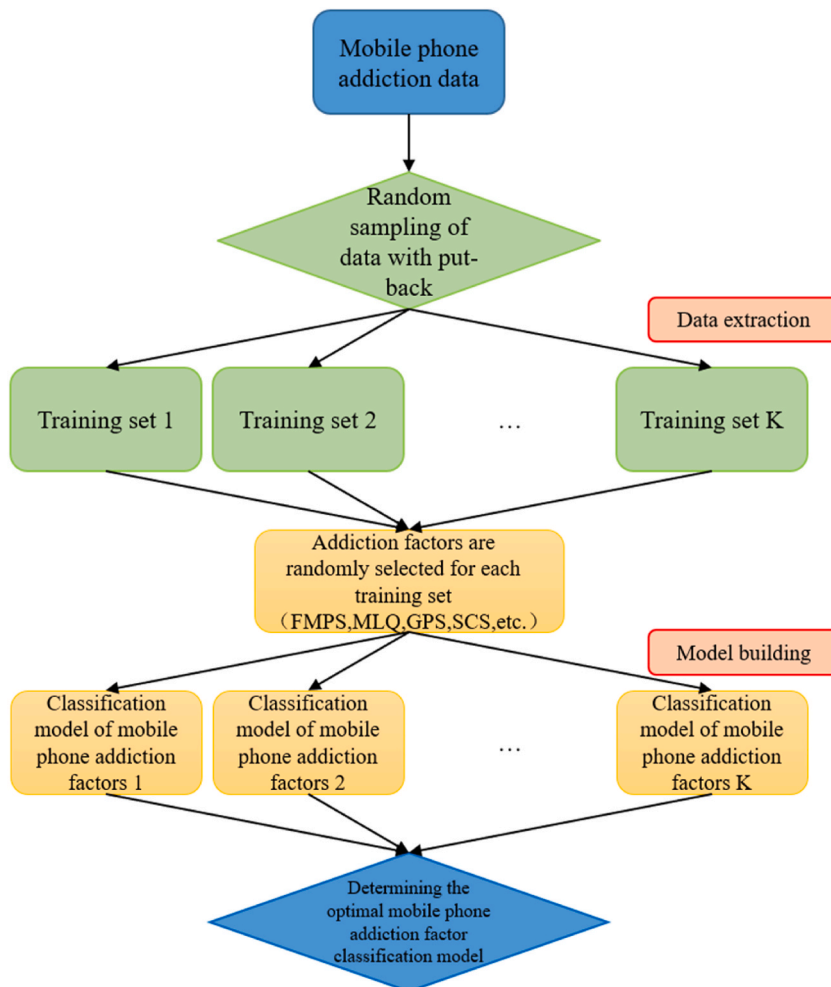


Fig. 1. Principle diagram of analysis of data.

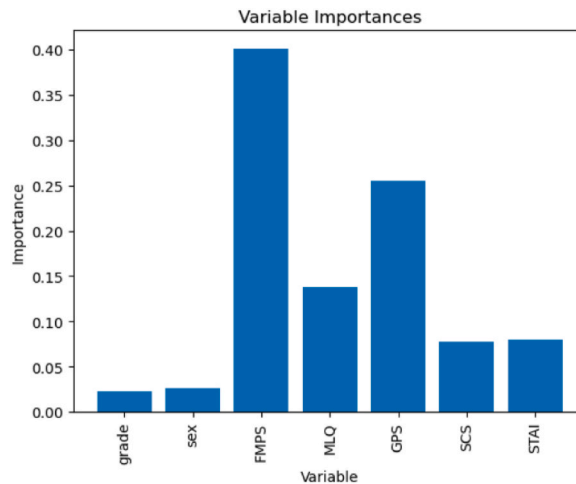


Fig. .2. Distribution of weight factors of the eight independent variables.

attentional control. These factors can contribute to the development of cell phone addiction [37].The study findings highlight the significant role of perfectionism in cell phone addiction among college students and shed light on the cognitive processes and mechanisms underlying this relationship.

Perfectionist cognitive theory posits that rumination among perfectionists leads to the generation of persistent negative emotions. Perfectionists tend to engage in prolonged contemplation of their own mistakes, which results in the intensification and prolongation of negative emotions. Moreover, perfectionists exhibit a lower inclination to express and suppress these negative emotions, further contributing to their emotional preoccupation. Consequently, perfectionists frequently find themselves immersed in negative emotions, as rumination perpetuates their persistence.

The impact of negative emotions on cell phone addiction has been investigated and confirmed by Ya Meng through the use of a validated structural equation model (SEM) [38]. This study provides empirical evidence supporting the association between negative emotions and the development of cell phone addiction. According to perfectionist cognitive theory, rumination among perfectionists leads to the emergence of enduring negative emotions. Due to their reduced tendency to express and suppress these emotions, perfectionists often find themselves entangled in negative emotional states.

Based on these findings, universities can implement strategies to address cell phone addiction among college students. One approach is to enhance the cultivation of adaptive perfectionism through educational management and psychological counseling programs. By promoting organizational behaviors and discouraging non-adaptive perfectionism tendencies, universities can effectively manage and control cell phone addiction among their students.

In the study, a random forest model was employed and evaluated by comparing it with several other machine learning algorithms. The dataset was randomly divided into a training set consisting of 2844 data samples and a prediction set consisting of 316 data samples. The performance of the random forest model was assessed by measuring its prediction accuracy.

The results, as depicted in Fig. 3, indicate that the random forest model achieved a prediction accuracy of 76.68%, which outperformed several other machine learning algorithms. This high accuracy demonstrates the effectiveness of the random forest

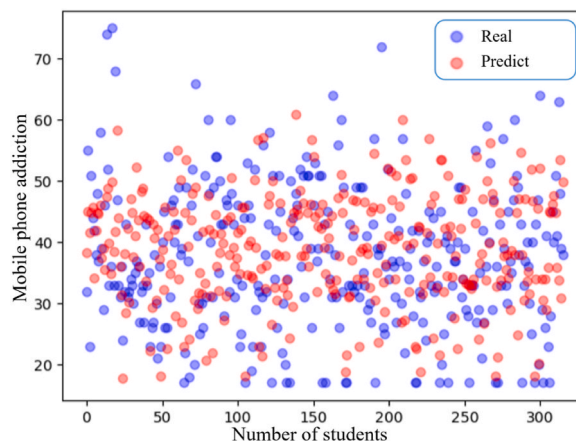


Fig. 3. Machine learning-based prediction chart of college students' cell phone addiction.

approach in predicting cell phone addiction among college students when compared to alternative algorithms.

### 3.1. Educational management recommendations for colleges and universities

This study aims to explore the main influencing factors of college students' cell phone addiction, so as to provide direction guidelines for colleges and universities to take measures to reduce college students' Internet addiction. Taking college students' perfectionism as an example, the random forest model of this study tells us that perfectionism is the most influential factor on cell phone addiction among several common factors, which provides some insights for colleges and universities to correct college students' cell phone addiction? Liu et al. 's study gives a partial answer. In this study, perfectionism is divided into adaptive perfectionism and non-adaptive perfectionism, and adaptive perfectionism corresponds to the Organization dimension of the Multidimensional Perfectionism Scale. dimension, which refers to a person's pursuit of tidiness and organization, and it can inversely predict cell phone addiction. Non-adaptive perfectionism corresponds to the Concern over Mistakes, Personal Standards, Parental Expectations, and Doubts about Actions dimensions of the Multidimensional Perfectionism Scale, and it could positively predict cell phone addiction. Therefore, colleges and universities can strengthen the cultivation of adaptive perfectionism in educational management and psychological counseling for students to enhance the rationality of students' behaviors, while suppressing students' non-adaptive perfectionism, and thus controlling college students' cell phone addiction [11].

In which way is the intervention most appropriate? Many empirical studies have proposed effective interventions for Internet addiction, the most common of which is group counseling. Qing et al. used Cognitive-Behavioral Interactive Group Therapy (CBIGT) to conduct 8 sessions of group counseling with 68 cell phone addicted college students, which effectively improved their cell phone addictive behaviors [39]. Di et al. used Solution - focused Group Counseling to reduce the degree of cell phone addiction among college students [40]. Ren et al. used narrative-oriented group counseling for a 6-week intervention, which produced a sustained improvement in college students' Internet addiction [41]. Therefore, the present study suggests the use of group counseling to reduce college students' perfectionism, anxiety, and procrastination tendencies, as well as to enhance the sense of meaning in life and self-control. For example, Liu et al. used writing expression group counseling to help college students explore their sense of meaning in life, and a 4-week intervention experiment effectively reduced college students' cell phone dependence [13]. Bian et al. conducted eight interventions with college students through mindfulness Group Counseling (MGC), which effectively reduced college students' procrastination levels and negative emotions, and in turn reduced their cell phone dependence [42]. These studies provide guidelines for clinical practice in reducing cell phone addiction among college students.

## 4. Conclusion

In this paper, we obtain the data of each scale through the questionnaire of cell phone addiction index of more than 3000 college students. By analyzing the data and learning and analyzing the data with the help of machine learning algorithms, we obtain the prediction model of college students' cell phone addiction based on machine learning, which has an accuracy of up to 76.68 %.

This study incorporates the common influencing factors of college students' Internet addiction: perfectionism, procrastination, sense of meaning in life, anxiety and self-control into the model, and not only verifies the influence of these influencing factors on Chinese college students' Internet addiction, but also distinguishes the magnitude of the influence of each influencing factor on college students' Internet addiction with the help of the machine learning model, which is an innovative result achieved in this study. This study pointed out that perfectionism, procrastination, and sense of meaning in life have a greater impact on college students' Internet addiction, while reducing anxiety and improving self-control can also assist in reducing the level of Internet addiction among college students. Comprehensive interventions on these five types of elements can be more effective in reducing the tendency of college students to become addicted to cell phones, reducing the level of students' cell phone dependence, especially reducing the behavior of using cell phones in class, and thus enhancing classroom effectiveness and academic performance.

### Research limitations and suggestions for future research

The deep learning technology used in this paper can reveal the magnitude of the effects of different independent variables on cell phone addiction, which points out the direction for colleges and universities to take targeted interventions. However, this study did not construct a model of the interrelationships between independent variables and did not explore the moderating effects and mediating effects between variables, which is not conducive to revealing the complete psychological process of cell phone addiction, and it is suggested that subsequent studies can make efforts in this regard.

In addition, this study is based on the Chinese cultural background and lacks empirical comparisons of the characteristics of cell phone addiction among college students in different cultural backgrounds. In reviewing the relevant research literature of different countries, this study found that the proportion of cell phone addiction among college students in different countries is not the same, such as Switzerland (16.9%), Denmark (23.1%), Egypt (32.5%), Brazil (33.1%), Turkey (34.6%), Malaysia (46.9%), and Jordan (62.4%), etc [43–49]. The percentage of cell phone addiction among college students in each country shows a large difference, which is related to the national conditions of each country as well as cultural differences. Individualistic/Individualistic Attitudes is one of the influencing factors of cell phone addiction, Tayana Panova believes that cultural attitudes affect the frequency and manner of interpersonal communication, and people in collectivistic cultures are more inclined to use cell phones to increase the frequency of interpersonal communication [50]. Nefretiti A. Morant further showed that the higher the level of horizontal individualism, the lower the level of Internet addiction; the higher the level of vertical individualism, the higher the level of Internet addiction; similarly,

students with higher levels of vertical collectivism showed higher levels of Internet addiction [51].

According to L. Chen et al., the level of development of network technology in each country has a greater impact on the causes of Internet addiction, for example, African countries have a lower level of development of network technology, and people's novelty and mood enhancement effect of the Internet is the main motivation for Internet addiction; China's network technology is relatively developed, so the main manifestation of Internet addiction is interpersonal communication; while in the United States, where network technology is the most developed, emotional and psychological conflicts are the main reasons for Internet addiction [52]. Addiction is mainly manifested by interpersonal communication; while in the United States, where Internet technology is the most developed, emotional and psychological conflicts are the main reasons for people's addiction to the Internet [52]. Although the above studies interpreted the influence of cultural and social factors on college students' Internet addiction from their respective perspectives, there is a lack of consensus among the studies and the cross-cultural study itself involves more elements, which can be used as further research by subsequent researchers.

## Funding

This research was funded by General project of Zhejiang Provincial Department of Education (Y201738355, Y202147215) and the Scientific Research and Developed Fund of Zhejiang A&F University (2022LFR042).

## Ethics statement

This study was approved by the Ethics Committee of Zhejiang A&F university (approval number: ZAFUAC2023033).

The study provide participants with adequate and accurate research information. Participants were consented by an informed consent process that was reviewed by the Ethics Committee of Zhejiang A&F University and certify that the study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki.

## CRedit authorship contribution statement

**Yun Hong:** Writing – original draft, Methodology, Data curation, Conceptualization. **Xing Rong:** Writing – review & editing, Investigation. **Wei Liu:** Writing – review & editing, Supervision, Methodology, Investigation, Writing – original draft.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2024.e29245>.

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