| **RESEARCH ARTICLE**

The Influence of Smartphone Addiction, Personality Traits, Achievement Motivation on Problem-solving Ability of University Students

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| **ABSTRACT**

This study aimed to analyze the relations between smartphone addiction, personality traits, achievement motivation and problem-solving ability and explore the influence of smartphone addiction, personality traits, achievement motivation on university students' problem-solving ability. 682 students (male = 227, female = 455) from a Chinese public university participated in the research voluntarily. Data were collected by the short-version of the smartphone addiction scale, the ten-item personality inventory, the achievement motives scale, and the social problem-solving inventory. The correlations and multiple hierarchical regression analysis were used to analyze the data. The results were as follows: Firstly, it was found that there was a significant negative correlation between smartphone addiction and achievement motivation and problem-solving ability, a significant positive correlation between achievement motivation and problem-solving ability, and a significant correlation between the factors of personality traits and smartphone addiction and problem-solving ability respectively. Secondly, it was found that emotional stability of personality traits, smartphone addiction and the "fear of failure" sub-dimensions of achievement motivation significantly explained problem-solving ability. Based on these research results, some suggestions were given for the improvement of the educational field.

| **KEYWORDS**

Smartphone addiction, Personality traits, Achievement motivation, Problem-solving ability

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1. Introduction

Problem-solving is the foundation of future learning, effective social participation and personal activities and is regarded as one of the core skills in the 21st century (Partnership for 21st Century Learning, 2019). The acquisition of increased levels of problem-solving ability provides a basis for future learning, effective participation in society and for conducting personal activities.

Until now, studies on the factors influencing the development of learners' problem-solving ability have been conducted in various ways. Researchers often use personality traits and motivations to describe and explain various human behaviours (e.g. Pervin, 1989). It has become an important research method to discuss problem-solving ability from the perspective of personality traits and motivation (e.g. Arslan, 2016; D'Zurilla, Maydeu-Olivares & Gallardo-Pujol, 2011; McMurran et al., 2001). Previous studies have shown that individuals with different personality traits differ in their ability to solve problems, and motivation to solve problems is also believed to largely determine the outcome of problem-solving (D'Zurilla, Maydeu-Olivares & Gallardo-Pujol, 2011).

At the same time, with the rapid development of information technology and virtual reality technology, the integration of reality and virtual space has created a new digital living environment and has been endowed with new characteristics of problem-solving ability (Ding, 2020). Today's university students are called "Digital Natives" (Prensky, 2001). They use smartphones extensively for knowledge learning and skill development (Gerlich, Browning & Westermann, 2010; Ifeanyi & Chukwuere, 2018), including using

smartphones to access Apps to learn C#, Java, Python and other computer programming languages (Amro & Romli, 2019; Ntinda & Bidwell, 2018). Researches on smartphone use and problem-solving ability are coming into focus (Abdillah & Sulaiman, 2020; Kadry & Roufayel, 2017).

However, people are more worried about the negative impact of smartphones. China Youth Net's (2019) survey results showed that 41.94% of university students spend 4-6 hours per day on the internet by using smartphones, and even 5.66% of them spend more than 12 hours per day on the internet. The phenomenon of being engrossed in smartphone use is often regarded as smartphone addiction (Kwon et al., 2013; Samaha & Hawi, 2016). Individuals that are engrossed in their smartphones use to the extent that they neglect other areas of life, withdrawal symptoms when they can't use them or reduced productivity due to the fragmentation of daily life. Students who are at high risk of smartphone addiction are prone to academic procrastination (Li, Gao & Xu, 2020) and are less likely to achieve high grade-point averages (Samaha & Hawi, 2016).

Previous studies have shown that smartphone addiction has unique behavioural characteristics (Kwon et al., 2013; Liu et al., 2017), so people often explain the tendency of smartphone addiction in different populations from the perspective of personality traits and achievement motivation (Cocorad et al., 2018; Fu, Wu & Liu, 2021). Meanwhile, some studies have focused on the correlation between smartphone addiction and problem-solving ability (Alan & Guzel, 2020; Lee, 2014), but the influence of smartphone addiction on problem-solving ability has not been discussed in depth.

Under the social background where smartphones and study life are inseparable, in order to effectively improve the problem-solving ability of university students, it is necessary to further explore whether personality traits, achievement motivation and smartphone addiction affect problem-solving ability.

Therefore, this study aimed to analyze the correlation among smartphone addiction, personality traits, achievement motivation, and problem-solving ability, and further explore whether smartphone addiction, personality traits, achievement motivation have an impact on university students' problem-solving ability under the new social background.

To achieve the research purpose, this study attempted to address the following research questions.

1. Firstly, is there a correlation among personality traits, achievement motivation, smartphone addiction and problem-solving ability?
2. Secondly, do personality traits affect university students' problem-solving ability?
3. Thirdly, does smartphone addiction affect university students' problem-solving ability?
4. Fourthly, does achievement motivation affect university students' problem-solving ability?

2. Literature Review
2.1 Smartphone Addiction
Since Marks (1990) introduced the construct of "non-chemical addictions", the concept of addiction has been rapidly expanded to encompass the realm of non-substances, rather than just discussing the effects of alcohol, drugs and other substances on people. Corresponding to substance addiction, the concept of behavioural addiction was developed, and technological addiction (such as internet addiction, smartphone addiction) was classified as a subset of behavioural addiction.

Smartphone addiction was defined as the psychological dependence caused by the excessive use of a smartphone, which then leads to the loss of control over the use of smartphone and related services, resulting in interference in daily life and psychological or behavioural problems (Billieux, 2012; Kwon et al., 2013). Similar concepts include Problematic Smartphone Use (Elhai et al., 2018; Shin & Dey, 2013) and Smartphone Use Disorder (Marengo et al., 2020; Peng et al., 2020).

Kwon et al. (2013) suggested six factors of smartphone addiction, including daily-life distribution, positive anticipation, withdrawal, cyberspace relationship, overuse, and tolerance. These six factors are consistent with the findings of the internet addiction tool dimension (Young, 2009). Another study explored four factors in smartphone addiction, including compulsive behaviour, functional impairment, withdrawal, and tolerance (Lin et al., 2014). These factors are similar to those for substance-related and addictive disorders in the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-5).

According to previous research (Duke & Montag, 2017; Kwon et al., 2013; Liu et al., 2017), the current study summarized the following four characteristics of smartphone addiction: (1) Lose autonomous control over the use of smartphones, excessive smartphone use; compulsive smartphones use and failure in controlling the time spending on the smartphone. (2) Withdrawal symptoms developed, feelings of difficulty in coping, depression, restlessness, or moodiness when being restricted from smartphone use, intolerable without a smartphone. (3) Making more use of smartphones or the Internet for social comfort, paying

too much attention to smartphones and smartphones space, real-life interpersonal activity decreased. (4) Negative consequences related to smartphone use, such as negative outcomes in physical and mental health, study and work, interpersonal relationships from smartphone addiction.

2.2 Personality Traits

Personality is a relatively stable and enduring organization of individual character, temperament, intelligence, and physique and determines the uniqueness of individual adaptation to the environment (Eysenck, 1963). The Chinese scholar Huang (2007) further explained that personality is an individual's internal tendency in behaviour, which manifests itself in the integration of ability, emotions, needs, motivation, interests, manners, values, temperament, personality, and physique. Allport's (1937) theory of personality attributes holds that traits are the basis of personality, the basic building blocks of a psychological organization, and are some stable personality traits formed by each individual based on his or her physiology.

In the current study, personality traits are defined as the uniqueness of individual character, needs, motivation and other internal factors shown through language and behaviour in the external environment. It can be viewed as a stable feature that systematically shows individuals' commonalities and discriminations in thoughts, feelings, and actions (Maddi, 1996).

The Big Five Personality model is regarded as the most extensively used model of personality (Marengo et al., 2020; Zhao & Seibert, 2006). Existing studies (McMurran et al., 2001) show that the five dimensions of the Big Five personality model are related to problem-solving ability, so this study also adopts the Big Five personality model.

The Big Five Personality model is a hierarchical one of 30 personality traits with five broad factors, namely extraversion, agreeableness, conscientiousness, neuroticism, and openness to experience (Costa & McCrae, 1988). Specifically, extraversion is often used to assess the number and intensity of interpersonal interactions, level of activity, degree of need for stimulation, and capacity for pleasure. Agreeableness can be used to evaluate the nature of one's interpersonal orientation on the continuum from compassion to hostility in thoughts, feelings, and actions. Conscientiousness can be used to assess the extent to which individuals are organized, persistent, and dynamic in goal-oriented behaviour. Neuroticism can be used to assess compliance and emotional instability, identifying individuals who are prone to psychological distress, unrealistic thinking, overly ambitious demands, and adverse reactions. Openness to experiences can be used to evaluate the active search for and appreciation of experience itself, like to accept and explore unfamiliar experiences.

2.3 Achievement Motivation

Research on achievement motivation can be traced back to Murray (1938). He defined people's basic needs for achievement as the impulse to overcome obstacles, to build strength, and preferably to work hard at difficult tasks as fast as possible. Bigge and Hunt (1980) defined achievement motivation as the drive to work with diligence and vitality, to constantly steer toward targets, to obtain dominance in challenging and difficult tasks, and create a sense of achievement as a result. In another short definition, achievement motivation refers to the tendency to set and work toward personal goals and/or standards (Cassidy & Lynn, 1989).

In the present research, achievement motivation is defined as a relatively stable disposition to strive for achievement or success. This motivation disposition is presumed to be latent until aroused by situation cues. Achievement Motivation Theory was set forth by McClelland and his associates (McClelland et al., 1953) and further elaborated by Atkinson (1957, 1960).

In this study, achievement motivation involves two variables: the tendency to approach success and the tendency to avoid failure (Atkinson, 1960). The tendency to approach success is labelled hope of success (HS), and the tendency to avoidance failure is called fear of failure (FF) (Lang & Fries, 2006). According to Atkinson's point, individuals who hoped for more success should be more likely to perform well, be more likely to persist, be more likely to evaluate their achievements positively and be more likely to pursue higher goals. In contrast, the individuals who were more fear of failure would worry more while working on achievement-related tasks, be more negatively to evaluate themselves, be less likely to set realistic and challenging goals and have more test anxiety (Elliot & McGregor, 1999; Heckhausen & Baltes, 1991; Puca & Schmalt, 1999; Spangler, 1992).

2.4 Problem-solving Ability

Mayer (1990) defined problem-solving as cognitive processing directed at transforming a given situation into a goal situation when no obvious method of solution is available. The Framework for 21st Century Learning (P21, 2019), which was proposed by The Partnership for 21st Century Learning, defined problem solving as solving unfamiliar problems in a traditional and innovative way, identifying and asking important questions to clarify points of view and better solutions. In the Social Problem-Solving Model (D'zurilla & Goldfried, 1971; D'zurilla &Nezu, 1982), problem-solving was defined as the cognitive-affective-behavioural process by which an individual, couple, or group attempts to identify or discover effective or adaptive coping responses for specific problematic situations encountered in everyday living.

In the present study, problem-solving ability refers to the cognitive skills required to solve unfamiliar problems which are encountered in life and lie outside of the traditional curriculum domains. This ability does not refer to actual problem-solving skills but rather one's perception of one's problem-solving beliefs and style (Heppner, Witty & Dixon, 2004).

D'Zurilla and Goldfried's (1971) problem-solving five-factor theoretical model is one of the widely used models in counselling and educational settings. This model described the following five problem-solving stages: general orientation, problem definition, generation of alternatives, decision making, and evaluation. The five stages are divided into two different and albeit related problem orientation dimensions and three different problem-solving styles (D'zurilla, Nezu & Maydeu-Olivares, 2002). The two problem orientation dimensions included positive problem orientation (PPO) and negative problem orientation (NPO). Positive problem orientation involves the general disposition to (1) see a problem as a "challenge", (2) believe that problems can be solved, and (3) believe in one's personal ability to solve problems successfully (D'Zurilla, Maydeu-Olivares & Gallardo-Pujol, 2011). Negative problem orientation is on the contrary. The problem-solving styles include three factors, namely rational problem-solving style (RPS), impulsive/carelessness style (ICS), and avoidance style (AS). RPS is defined as the rational, deliberate, and systematic application of effective problem-solving skills. ICS is characterized by active attempts to apply problem-solving strategies and techniques, but these attempts are impulsive, hurried, careless, narrow, and incomplete, as is characterized by procrastination, passivity or inaction, and dependency (D'Zurilla, Maydeu-Olivares & Gallardo-Pujol, 2011).

2.5 Relations between Variables
This part summarized the relations among personality traits, achievement motivation, smartphone addiction and problem-solving ability described above by describing the ideas in previous research.

Firstly, personality traits are associated with problem-solving ability and are predictors of individual problem-solving ability (D'Zurilla, Maydeu-Olivares & Gallardo-Pujol, 2011; McMurran et al., 2001; Arslan, 2016). Neuroticism is considered the most closely related personality factor in predicting problem-solving ability (McMurran et al., 2001). In addition, conscientiousness, openness, agreeableness, and extraversion were each found to be positively related to problem-solving (Arslan, 2016).

Meanwhile, personality trait is a good predictor for smartphone addiction. Neuroticism is generally considered to be significantly positively correlated with smartphone addiction (Billieux, 2012; Cocorad et al., 2018; Demirhan, Randler & Horzum, 2016), while conscientiousness is negatively correlated with smartphone addiction (Cocorad et al., 2018; Horwood & Anglim, 2018). This conclusion has been supported by ample, up-to-date evidence (Elhai et al. 2020; Marengo et al., 2020). As regards agreeableness and openness traits, overall associations with smartphone addiction have been negative but small-sized (Cocorad et al., 2018; Demirhan, Randler & Horzum, 2016; Marengo et al., 2020). In addition, most studies have suggested that the relationship between extraversion and smartphone addiction is not obvious (Billieux, 2012; Horwood & Anglim, 2018), but others suggest that extraversion can be positively predictable to smartphone addiction (Demirhan, Randler & Horzum, 2016).

As for the correlation between smartphone addiction and problem-solving ability, a study on smartphone addiction among Korean university students showed that smartphone addiction was closely related to university students' problem-solving ability (Lee, 2014). In general, the higher the smartphone addiction tendency, the lower the problem-solving ability will be. Similar findings have shown that addiction tendencies are negatively correlated with problem-solving and critical thinking skills (İbili, 2017; Lee & Kim, 2017).

When it comes to the relationship between achievement motivation and smartphone addiction, Kim (2016) discussed the interaction between learning motivation, smartphone addiction, and self-directed learning ability of 240 pre-service early childhood teachers. It was found that the pre-service early childhood teacher who showed a high level of smartphone addiction displayed lower achievement motivation than the pre-service teachers with a low level of smartphone addiction. Another study analyzed the correlation between smartphone addiction and achievement motivation with 305 Chinese teenagers; the results showed that smartphone addiction was negatively correlated with achievement motivation (Fu, Wu & Liu, 2021).

It has also been proved that achievement motivation is relevant to problem-solving ability. In a quasi-experimental study (Yunus et al., 2021), researchers discussed the correlation between achievement motivation and the problem-solving ability of students in an online program. The results showed that the problem-solving ability was different between the students with high achievement motivation and those with low achievement motivation. Students with high achievement motivation had better problem-solving ability than those with low achievement motivation. Similar studies have also shown that problem-solving ability in students is significantly influenced by achievement motivation variables (Surur & Tartilla, 2019; Vollmer & Kaufmann, 1975).

3. Methodology
3.1Research Model and Hypothesis
This study aimed to investigate the correlation among university students' smartphone addiction, personality traits, achievement motivation and problem-solving ability and to determine the relevant factors affecting university students' problem-solving ability. To achieve the purpose, A research model was constructed (see Figure 1).
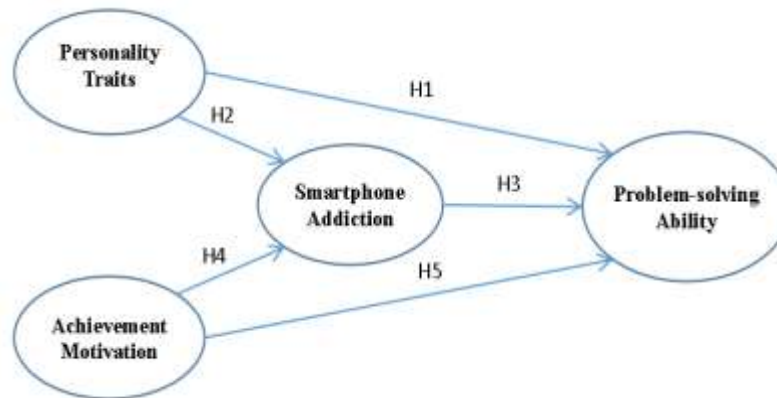
[Fig. 1] Research model

Based on the research model, the following research hypotheses are presented.

H1. Personality traits have an impact on problem-solving ability.
H2. Personality traits have an impact on smartphone addiction.
H3. Smartphone addiction has an impact on problem-solving ability.
H4. Achievement motivation has an impact on smartphone addiction.
H5. Achievement motivation has an impact on problem-solving ability.

3.2 Research Participants
In this study, 682 students from a university in southwest China participated voluntarily. Participants covered all undergraduate grades from freshman to senior, including 218 freshmen (32.0%), 209 sophomores (30.6%), 180 juniors (26.4%), and 75 seniors (11.0%). The age ranged from 19 to 24, with an average age of 21.24. Among the respondents, boys were 227 (33.3%), and girls were 455 (66.7%).

3.3 Research Tools
3.3.1 Short-version of the Smartphone Addiction Scale (SAS-SV)
The SAS-SV (Kwon et al., 2013) consists of 10 items with a six-point Likert scale (1 = strongly disagree to 6 = strongly agree). It is a simplified self-report to assess smartphone addiction, which has one factor and no subdimensions. The scale sets a cut-off value for smartphone addiction by gender, with boys > 31 and girls > 33 considered to have a high risk of smartphone addiction. The Chinese version of SAS-SV was translated and validated by Luk et al. (2018), and its structure was consistent with the original scale and had good content consistency (Cronbach's α = .84). The reliability of this study is shown in Table 1 below.

3.3.2 Ten Item Personality Inventory (TIPI)
This inventory was developed by Gosling, Rentfrow and Swann (2003) based on McCrae & Costa's Big Five personality model. The inventory consists of five subdimensions (Extraversion, Agreeableness, Conscientiousness, Emotional Stability, Openness to Experiences) and a total of 10 items. TIPI-C was translated by Chinese scholar Li (2013), and consistent with TIPI dimensions, each item using a seven-point Likert scale (1 = representing strongly disagreement to 7 = representing strongly agreement), and acceptable reliability and validity have been established for this version (Cronbach's α = .77). As a convenient and quick measurement, this questionnaire has obvious advantages in real-world research, especially in large-scale research (Wang et al., 2016).

3.3.3 Achievement Motives Scale-Revised (AMS-R)
Lang & Fries (2006) revised the original 30-item of Achievement Motives Scale (AMS; Gjesme & Nygard, 1970) and obtained the 10-item version of the AMS-R. The revised scales have the same construct as the original AMS, which have two subdimensions (hope of success, HS; fear of failure, FF), and 10 four-point Likert-type items. The scale ranges from "1: Strongly disagree" to "4: Strongly agree". In different study samples from Lang & Fries's, Cronbach's alpha of "hope of success" ranges from .71 to .80, and Cronbach's alpha of "fear of failure" ranges from .76 to .88.

3.3.4 Social Problem-Solving Inventory-Revised (SPSI-R)

This inventory was developed by D'Zurilla, Nezu and Maydeu-Olivares (2002) as a tool for measuring the problem-solving ability of respondents. The Chinese version of the SPSI-R (C-SPSI-R) was translated by Siu and Shek (2005), is a 25-item, five-point Likert-type self-report scale, consisting of five dimensions (PPO, NPO, RPS, ICS, AS). The scale ranges from "1: not at all true of me" to "5: extremely true of me". It was established good reliability and validity in Chinese university students and proved to be appropriate (Wang, 2010; Huang, 2014). The reliability of each questionnaire in this study is shown in Table 1 below.

Table 1. Internal Consistency Coefficient and KMO (N=682)

Factors of the Survey		KMO	Cronbach's α
SAS-SV	Smartphone Addiction	.865	.82
TIPI	Extraversion		.75
	Agreeableness		.68
	Conscientiousness	.762	.71
	Emotional Stability		.81
	Openness to Experiences		.84
AMS-R	Hope of Success	.845	.82
	Fear of Failure		.89
SPSI-R	Positive Problem Orientation		.83
	Negative Problem Orientation		.88
	Rational Problem-Solving Style	.830	.88
	Impulsive/Carelessness Style		.86
	Avoidance Style		.85

3.4 Data Analysis

The collected data were analyzed by using SPSS 25.0, and the model structure was validated by using AMOS 25.0. The specific methods of data parsing were as follows. Firstly, CFA was performed on all variables to test their fits to the theoretical model. Secondly, the correlation among smartphone addiction, personality traits, achievement motivation, and problem-solving ability was investigated through Pearson correlation analysis. Thirdly, multiple regression analysis was conducted to search the influencing factors of smartphone addiction and problem-solving ability.

4. Results and Discussion

The present research reported on the structural validity of the hypothetical model discussed the correlations between personality traits, achievement motivation, smartphone addiction and problem-solving ability, and analyzed the subfactors that influence smartphone addiction and problem-solving ability.

4.1 Validity of the Model

To assess the validity of the model, CFA was conducted by using maximum likelihood estimation on the full item set and by using the standardized root-mean-square residual (SRMR), the comparative fit index (CFI), the Tucker-Lewis index(TL), and the root-mean-square error of approximation (RMSEA) to detect the simple model misspecification (Hu & Bentler, 1998). In general, an adequate to a good fit is suggested by SRMR and RMSEA values approaching .05,

And by fit index values between 0.80 and 1.00. SRMR and RMSEA values between .05 and under .08 is a reasonable fit result suggested that the theoretically expected model structure fit well with the sample data, the fitting indexes were all in an acceptable range, and the standardized factor loadings range of each item ranged from .568 to .915, which indicated that the model fits well (see Table 2).

Table 2. CFA Results and Standardized Loadings (N=682)

Model	CMIN/DF	SRMR	TLI	CFI	RMSEA	Standardized loadings	
						high	low
SAS-SV	4.245	.030	.961	.971	.069	.915	.690
TIPI	4.126	.031	.944	.969	.068	.874	.662
SPSI-R	3.788	.049	.902	.913	.064	.875	.568
AMS-R	3.966	.029	.957	.967	.066	.843	.607

4.2 Correlation among variables

Table 3 shows the means, standard deviations, and inter-correlations of the variables used. Overall, there were correlations among personality traits, achievement motivation, smartphone addiction, and problem-solving ability of the participants. There was also a statistically significant correlation between the subdimensions of each variable.

According to Hemphill's (2003) definition of effect size in psychological research, $r < .20$ is "weak", .20 to .30 range is "medium", and $r > .30$ is "strong". In specific, the results showed that there was strong positive correlation between problem-solving ability and emotional stability ($r = .40$), medium positive correlation between problem-solving ability and agreeableness ($r = .22$), openness to experience ($r = .28$), and conscientiousness ($r = .29$), and weak positive correlation between problem-solving ability with extraversion ($r = .09$).

Table 3. Descriptive Statistics, Pearson Correlations among Variables (N=682)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
ES	-														
A	.35**	-													
O	.38**	.34**	-												
E	.07	.17**	.17**	-											
C	.53**	.36**	.59**	.16**	-										
AM_T	.24**	.19**	.18**	.13**	.21**	-									
AM_HS	.14**	.24**	.23**	.08*	.15**	.64**	-								
AM_FF	-.21**	-.06	-.05	-.10**	-.15**	-.80**	-.05	-							
SA_T	-.28**	-.18**	-.20**	.03	-.24**	-.35**	-.38**	.16**	-						
PSA_T	.40**	.22**	.28**	.09*	.29**	34**	.18**	-.30**	-.38**	-					
NPO	-.35**	-.16**	-.30**	-.12**	-.23**	-.30**	-.14**	.28**	.34**	-.57**	-				
ICS	-.15**	-.06	-.02	.08*	-.08*	-.16**	-.05	.17**	.07	-.49**	-.04	-			
AS	-0.07	-.04	-.03	-.16**	-0.04	-.12**	-.05	.12**	.11**	-.60**	.17**	.33**	-		
RPS	.26**	.24**	.23**	-.02	.21**	.08*	.14**	.01	-.22**	.40**	.00	.01	.04	-	
PPO	.21**	.09*	.16**	.02	.19**	.24**	.10**	-.23**	-.24**	.50**	-.37**	.11**	.00	.14**	-
M	4.67	4.72	4.40	4.16	4.28	0.46	2.96	2.50	3.09	2.37	1.48	1.67	1.37	2.09	2.27
SD	1.14	0.82	0.92	1.16	0.87	0.68	0.40	0.52	0.47	0.39	0.76	0.81	0.82	0.72	0.69

Note: **$p < .01$, *$p < .05$, ES= Emotional stability, A= Agreeableness, O= Openness to experience, E= Extraversion, C= Conscientiousness, SA_T= total Smartphone Addiction (average), AM_T= total Achievement Motivation (average), PSA_T= total Problem-solving Ability(average)

Regarding personality traits and smartphone addiction, the results showed that there was a medium negative correlation between smartphone addiction and emotional stability ($r= -.28$), Openness to experience ($r= -.20$), and conscientiousness ($r = -.24$), and a weak negative correlation between smartphone addiction and agreeableness ($r= -.18$). While no significant correlation was shown between smartphone addiction and extraversion.

Results in Table 3 showed the strong negative correlation between smartphone addiction and problem-solving ability ($r= -.38$). In specific, smartphone addiction was medium negative related with positive problem orientation ($r = -.24$) and rational problem-solving style ($r= -.22$), and strong positive related with negative problem orientation ($r = .34$) and weak positive correlation between smartphone addiction with avoidance style ($r = .11$). While no significant correlation was shown between smartphone addiction

and impulsive/carelessness style.

The results suggested that there was a strong negative correlation between smartphone addiction and achievement motivation (r= -.35), the hope of success (r= -.38), and a weak positive correlation between smartphone addiction and fear of failure (r = .16) sub-dimension.

In addition, the results suggested that the achievement motivation was strong positively related with problem-solving ability (r = .34). Specifically, there was medium to weak positive correlation between achievement motivation and positive problem orientation (r = .24), and rational problem-solving style (r = .08), there was medium to weak negative correlation between achievement motivation and negative problem orientation (r = -.30), impulsive/carelessness style (r = -.16) and avoidance style (r = -.12).

4.3 Influence factors to Smartphone Addiction and Problem-solving Ability
In order to investigate the factors influencing smartphone addiction and problem-solving ability, a stepwise multiple regression analysis was conducted in the present study, and the results are shown in Table 4. The variance inflation factor (VIF) was in a reasonable range (1.032-1.429), and there was no multicollinearity.

The results showed that the final regression model of smartphone addiction was composed of "hope of success", emotional stability, "fear of failure", openness to experiences and conscientiousness, with the explanatory power of 21.6%. The final regression model of influencing problem-solving ability was composed of emotional stability, smartphone addiction, fear of failure, openness to experiences, with the explanatory power of 28.2%.

Specifically, emotional stability (β = .235, p < .001) and openness to experience (β = .13, p < .001) explained problem-solving ability. It showed that personality traits had a significant influence on problem-solving ability, and the hypothesis of H1 was valid. In the present study, emotional stability was one factor that could better predicate problem-solving ability, which accounted for about 15.7% of the variance. In addition, emotional stability (β = -.173, p <.001), openness to experiences (β = .096, p <.01), conscientiousness (β = -.092, p < .05) well explained the smartphone addiction, which showed that personality trait had influence on smartphone addiction, and hypothesis of H2 was valid. Smartphone addiction (β = -.25, p < .001) affected problem-solving ability and the hypothesis of H3 was valid. The "hope of success" (β = -.344, p < .001) sub-dimensions of achievement motivation affected smartphone addiction and the hypothesis of H4 was valid. The "fear of failure" (β = .104, p < .01) sub-dimensions of achievement motivation significantly explained problem-solving ability, and the hypothesis of H5 was valid.

Table 4 Influence Factors to Smartphone Addiction and Problem-solving Ability (N=682)

Influence Variable	β	t	p	VIF
Dependent Variable: Smartphone Addiction				
Hope of Success	-.344	-9.978	< .001	1.032
Emotional Stability	-.173	-4.255	< .001	1.429
Fear of Failure	.104	2.973	.003	1.055
Openness to Experiences	.096	2.785	.006	1.038
Conscientiousness	-.092	-2.267	.024	1.431
F=38.442 (p<.001)				
Influence Variable	Dependent Variable: Problem-solving Ability			
Emotional Stability	.235	6.415	< .001	1.270
Smartphone Addiction	-.25	-7.291	< .001	1.113
Fear of Failure	-.209	-6.263	< .001	1.059
Openness to Experiences	.13	3.676	< .001	1.179
F=67.957 (p<.001)				

5. Conclusion

The results showed that the five hypotheses proposed in the current study were valid. According to the research results, the following discussions and conclusions can be put forward.

Firstly, the personality traits of university students affect their problem-solving ability. Among the personality traits, emotional stability and openness to experience are two of the most important factors to explain the problem-solving ability of university students. Emotional stability is usually used to identify personalities with inner steadiness, being easy to control their own emotion and not easy to generate psychological distress (Costa & McCrae, 1988). Therefore, individuals with emotional stability are considered to have more comprehensive and accurate overall cognition, be able to solve problems more rationally, and have better overall problem-solving skills when facing problems (D'Zurilla, Maydeu-Olivares & Gallardo-Pujol, 2011). Also, individuals who score high on openness to experiences are described as original, daring, imaginative, broad interests, and open to varied experiences (McCrae & Costa, 1987). Therefore, openness to experience is regarded as an important predictor of problem-solving ability (D'Zurilla, Maydeu-Olivares & Gallardo-Pujol, 2011). These results provide evidence for the prediction proposed by the previous studies (D'Zurilla, Maydeu-Olivares & Gallardo-Pujol, 2011) and contribute to a better understanding of the problem-solving activities related to personality.

It should be emphasized that extraversion was not correlated with positive problem orientation in the current study. This conclusion is different from the conclusions of previous studies that extroversion was positively correlated with positive problem orientation (D'Zurilla, Maydeu-Olivares & Gallardo-Pujol, 2011). This difference may be caused by cultural differences. For example, a study on the variability of the big Five personality traits of Chinese and American university students showed that the extroversion of American university students was significantly higher than that of Chinese university students in certain situations (Luo, 2012).

Secondly, personality traits have an impact on smartphone addiction. The result indicates that emotional stability, conscientiousness, and openness individuals are at lower risk of smartphone addiction. Individuals with lower scores on emotional stability are more likely to develop higher tendencies towards smartphone addiction due to seeking reaffirmation of being part of a social group via excessively checking social media apps (Marengo et al., 2020). This conclusion is supported by ample, up-to-date evidence (Billieux, 2012; Cocorad et al., 2018; Elhai et al., 2020). Consistent with the previous characterization of people who scored high in conscientiousness, openness to experience, and agreeableness, these individuals were not prone to a high risk of smartphone addiction. This conclusion has been widely supported (Cocorad et al., 2018; Marengo et al., 2020). Consistent with previous studies (Billieux, 2012; Horwood & Anglim, 2018), there was no significant relationship between extraversion and smartphone addiction, which means using smartphones or mobile networks to communicate with the outside world to obtain social comfort will not lead to smartphone addiction. The above conclusions suggest that administrators need to distinguish different personality traits of university students in order to provide reasonable psychological counselling and behaviour correction when intervening and adjusting university students' smartphone addiction.

Thirdly, smartphone addiction directly influences an individual's problem-solving ability. Previous studies have shown that individuals with a high level of risk in smartphone addiction had a more negative attitude towards problems and were sceptical about their own ability in solving a problem effectively, and also could not solve problems in a rational way in their daily life (Lee, 2014). This was consistent with the conclusion of this study. This conclusion suggests that administrators should take effective intervention measures for students with a high tendency of smartphone addiction to reduce the negative impact of smartphone addiction on problem-solving ability.

Fourthly, the present results showed that achievement motivation influences smartphone addiction. University students with high hope success motivation were more likely to positively pursue higher academic achievement goals and were more likely to actively accept challenges and self-evaluation (Atkinson & Feather, 1966). This means that the higher the achievement motivation is, especially the motivation to approach success, the lower the tendency to become addicted to the smartphone. However, students with high fear of failure motivation may have more risk of smartphone addiction as they are reluctant to set or accept more challenging tasks in real life as well as they might be more willing to focus on their smartphones rather than other activities and tasks as well (Bukhori et al., 2019).

Fifthly, the "fear of failure" sub-dimension of achievement motivation affected problem-solving, which indicates that motivation to fear failure may lead university students to take a more negative approach to problems encountered in daily life. Vollmer and Kaufmann (1975) reported similar results. Surprisingly, the results of regression analysis showed that the hope for success did not explain the problem-solving ability. Since hope of success has traditionally been thought of as a motivation leading to good performance (Atkinson & Feather, 1966). This result suggests that the effect of motivation for success on problem-solving orientation was not as obvious as predicted in theoretical models (Lang & Fries, 2006). This conclusion was supported by previous research (Raaheim & Kaufmann, 1972).

The present study also has the following limitations. First, since participants in the current study were from the same university and there was a significant difference in the ratio of male and female, whether the conclusion can reflect the current situation of general university students needs to be further confirmed. Secondly, this study directly used the smartphone addiction cut-off value proposed in SAS-SV (Kwon et al., 2013) as the basis for the judgment of smartphone addiction among Chinese university students. This cut-off value has been proved to be credible in Korea and other countries, but it still lacks supporting clinical data from China. Finally, the analysis data of personality traits, achievement motivation, smartphone addiction and problem-solving ability in this study were obtained from the simplified scale. Although the reliability and validity of the reduced table were not weaker than the scale with more question items (Gosling, Rentfrow & Swann, 2003), the risks of using multiple reduced scales simultaneously still need to be further evaluated.

Conflicts of Interest: The authors declare no conflict of interest.

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