Research Article

Self-Regulated Learning and Mental Health of Teacher Trainees: Mediating Roles of Basic Psychological Needs

Qiying Gan* , Hong Wang

Faculty of Teacher Education, Wenshan University, Wenshan, Yunnan 663099, China

Health Psychology Research

Background

Self-regulated learning is important for the mental health of teacher trainees. Based on the self-determination theory, an analytical framework of "self-regulated learning–internal psychological needs" was constructed to promote the mental health of teacher-training students.

Objective

This study aimed to investigate the effects of self-regulated learning on the mental health of teacher trainees and examine the multiple mediating roles of autonomy, competence, and relatedness needs.

Methods

A questionnaire assessing self-regulated learning, the Chinese version of the Self-Determination Theory Basic Psychological Need Satisfaction Scale, and a self-assessed health scale were used to investigate the effects of self-regulated learning on the mental health of 528 teacher trainees from three teacher training schools.

Results

Self-regulated learning positively predicted mental health through autonomy, competence, and relational needs. The mechanisms of action of self-regulated learning, basic psychological needs, and psychological well-being were found to be informative for the development of teacher trainees.

Conclusion

Self-regulated learning ability is a crucial factor in promoting the mental health of teacher trainees, and meeting their basic psychological needs has a unique functional value for their well-being. Group intervention programs can be designed based on the need satisfaction model to enhance teacher trainees' self-regulated learning abilities and improve their mental well-being.

1. INTRODUCTION

The COVID-19 pandemic has led to stress, anxiety, and mental health problems among learners worldwide,[1] and university students, as a special group, have experienced dramatic changes in their learning styles and living conditions[2], posing new challenges for schools in mental health education. During the COVID-19 pandemic, online teaching has become a popular mode of instruction. In the post-epidemic era, as students return to school and resume intensive studies under school supervision, the continued use of online teaching and learning requires teachers to shift their instructional design to facilitate online learning and foster students' self-regulated learning (SRL) skills[3].

Self-regulated learning is an important skill for teacher

*Corresponding author:
Qiying Gan
Faculty of Teacher Education, Wenshan University, Wenshan, Yunnan 663099, China.
Email: 10044@em.wsu.edu.cn

trainees, and it is challenging for them to develop SRL in the classroom if they lack confidence in managing their own learning. SRL should be an essential skill for teachers, enabling every teacher to foster and promote SRL among their students[4,5]. SRL positively impacts academic achievement[5-7] and mental health[8], with research showing that SRL can contribute to improving students' mental health levels.

Self-regulated learning leads to better time management, mastery of study skills and programs, increased self-efficacy, and a reduction in study stress and anxiety. Research has also found a bidirectional relationship between levels of psychological well-being and the extent of SRL, with students who are mentally healthy being more likely to acquire SRL skills and vice versa[9,10].

In the self-determination theory (SDT), the satisfaction of basic psychological needs is considered a central element in protecting an individual's psychological well-being and can influence the role that environmental factors play in an individual's developmental process[11]. It is hypothesized that basic psychological needs may mediate the impact of SRL on psychological well-being.

Despite the apparent importance of SRL for teacher trainees, relatively few studies have examined SRL with teacher trainees as the target population[12]. Moreover, existing research has largely overlooked the role of SRL as a positive psychological resource that can effectively contribute to mental health education. Thus, the present study recruits teacher trainees to examine the mechanisms linking SRL, basic psychological needs, and mental health, to explore how SRL functions as a positive psychological resource, evaluate its practical significance for promoting mental health education, and provide insights for teacher training aimed at enhancing the development of pre-service teachers.

The theoretical rationale for this mediation pathway can be articulated as follows. First, SRL represents an active, self-directed process in which learners exercise autonomy by setting their own goals and selecting learning strategies. Second, the successful implementation of SRL strategies leads to competence satisfaction as learners experience a sense of mastery and progress. Third, when learners seek help or engage in collaborative learning, they fulfil their need for relatedness. According to the SDT, these need satisfactions are the proximal mechanisms through which contextual factors influence psychological well-being[13]. Recent empirical research supports this pathway, as studies have demonstrated that need satisfaction mediates the relationship between learning environment characteristics and student well-being outcomes[14,15].

It is important to note that in this study, the terms "mental health" and "psychological well-being" are used in close conceptual proximity. Psychological well-being is generally considered a core component of mental health, encompassing positive emotional states, life satisfaction, and optimal psychological functioning[16,17]. Following the World Health Organization (WHO)'s definition, mental health is not merely the absence of mental disorders but represents a state of well-being in which individuals realize their own potential, can cope with normal life stresses, work productively, and contribute to their community[18]. In this context, psychological well-being serves as a positive indicator of mental health status, and the two constructs share substantial conceptual overlap[19,20]. Therefore, consistent with previous research in educational psychology[8,21], this study treats these terms as closely related constructs that reflect the positive dimensions of students' mental health.

In addition, it is critical to note that SRL is not merely a learning strategy but rather a multidimensional construct. According to Zimmerman[22] and Panadero[23], SRL encompasses cognitive strategies (e.g., rehearsal, elaboration), metacognitive processes (e.g., planning, monitoring, evaluation), behavioral regulation (e.g., effort management, help-seeking), motivational components (e.g., self-efficacy, goal orientation), and emotional/affective dimensions (e.g., anxiety control, interest maintenance). This comprehensive conceptualization is essential for understanding how SRL influences psychological well-being through multiple pathways.

Additionally, according to Karlen et al.[24], teacher trainees hold a dual role: they must develop competencies both as self-regulated learners themselves and as future agents who will promote SRL among their students. This dual perspective underscores the particular importance of investigating SRL among teacher trainees.

2. THEORY AND HYPOTHESES

2.1. SELF-REGULATED LEARNING AND MENTAL HEALTH

Self-regulated learning is the process by which learners actively activate and maintain their thoughts, feelings, and behaviors, and systematically direct them toward achieving learning goals[8]. Following Bandura's[25] concept of "self-regulation," researchers have found that self-regulation is an important predictor of mental health[9,26]. For university students, learning is the primary activity, and SRL not only affects student's academic status but is also strongly associated with psychological well-being. Research has shown that SRL negatively predicts test anxiety[27], and SRL strategies have a positive impact on students' psychological well-being or mental health status[21]. Individuals with SRL set their own learning goals, monitor and regulate their achievement, and provide evaluation and feedback to further regulate their learning[28]. SRL significantly impacts an individual's psychological development through the interaction between the individual, the environment, and behavior, and higher SRL ability is associated with higher levels of psychological well-being. Based on the close relationship between SRL and psychological well-being, it is hypothesized that SRL positively influences the psychological well-being of teacher trainees (Hc0).

The theoretical foundation for this relationship between SRL and psychological well-being is well-established in the educational psychology literature. Zimmerman and Schunk[20] demonstrated that SRL serves as a mediating mechanism between environmental factors and academic outcomes. Furthermore, the broaden-and-build theory[29] suggests that positive psychological states facilitate the development of personal resources, including learning strategies, while effective learning behaviors, in turn, promote positive emotional experiences. This reciprocal relationship has been empirically supported in multiple studies examining student populations[30,31].

The post-epidemic educational context, characterized by the widespread adoption of online and blended learning modalities, provides a unique and particularly relevant setting for examining SRL among teacher trainees. During and after the COVID-19 pandemic, students experienced a significant shift from traditional face-to-face instruction to online learning environments[31-33], placing greater demands on their self-regulation capabilities. Research has consistently shown that online learning success is particularly

dependent on students' ability to self-regulate their learning behaviors, emotions, and cognitions[5,7]. Therefore, this study situates the investigation within the post-epidemic era to examine how SRL skills relate to the mental health outcomes of teacher trainees in this transitional educational context.

2.2. THE MEDIATING ROLE OF BASIC PSYCHOLOGICAL NEEDS

Self-determination theory[34,35] is a macro-theory of human motivation, development, and well-being. At its core, SDT proposes that humans have three innate, universal basic psychological needs that are essential for psychological growth, integrity, and well-being. According to Ryan and Deci[35], these needs function as "essential nutrients" for psychological health—similar to how plants require water and sunlight for growth, humans require the satisfaction of autonomy, competence, and relatedness for optimal psychological functioning and well-being. SDT posits a dynamic relationship between need satisfaction and self-regulation—when basic psychological needs are satisfied, individuals are more likely to develop autonomous motivation and effective self-regulatory capacities. Conversely, engaging in self-determined behaviors such as SRL can contribute to need satisfaction. This bidirectional relationship has been supported in recent studies[36,37].

Basic psychological needs are derived from the SDT proposed by Deci and Ryan[34]. These needs include competence, autonomy, and relatedness, which are essential for personal growth, integration, social development, and psychological development[38]. Competence refers to individuals experiencing their behavior as effective, for example, when students meet their learning requirements and feel capable. Autonomy refers to experiencing one's behavior as voluntary and self-endorsed. For example, students experience autonomy satisfaction when they can choose learning topics, methods, or schedules, and perceive their learning activities as aligned with their values and interests. Relatedness refers to feeling connected to significant others and experiencing mutual support[39].

According to SDT, effective self-regulation relies on the satisfaction of basic psychological needs[34]. The psychological needs and motivation model proposed by Deci and Ryan[34] asserts that the satisfaction of these needs is a prerequisite for effective self-regulation and subjective well-being. The theory suggests that fulfillment of the three basic psychological needs is necessary for autonomous regulation of behavior[11]. SRL is a comprehensive process encompassing cognitive, metacognitive, behavioral, motivational, and emotional aspects of learning[22,23], which plays a critical role in online learning success; students' achievement in online learning environments largely depends on their ability to self-regulate, significantly affecting learning satisfaction[7]. Based on this analysis, the following hypotheses are proposed:

(i) Ha1: SRL positively influences teacher trainees' need for autonomy.
(ii) Ha2: SRL positively influences teacher trainees' relational needs.
(iii) Ha3: SRL positively influences teacher trainees' competency needs.

The satisfaction of basic psychological needs promotes psychological well-being. Previous studies have found that basic psychological needs are associated with the ability to adapt, overcome difficulties, face challenges, and activate

resources[40]. Moreover, basic psychological needs are essential psychological nutrients for individual regulation, self-improvement, and growth. When basic psychological needs are met, it enhances well-being and psychological health; conversely, when basic psychological needs are not met, it increases the risk of individual negativity, defensiveness, and unhappiness.

In addition, the satisfaction of basic psychological needs can enhance individuals' resilience, buffer the impact of stress, reduce stress appraisal[13,41], and play an important role in psychological well-being. Based on this analysis, exploring the impact of the three dimensions of basic psychological needs (autonomy, competence, and relatedness) on psychological well-being led to the following hypotheses:

(i) Hb1: The need for autonomy positively influences the mental health of teacher trainees.
(ii) Hb2: Relatedness needs positively influence teacher trainees' mental health.
(iii) Hb3: Competence needs positively influence teacher trainees' mental health.

Self-regulated learning has been shown to positively influence psychological well-being and the satisfaction of basic psychological needs. Although basic psychological needs also influence individuals' psychological well-being, few studies have examined the interaction mechanisms among SRL, basic psychological needs, and psychological well-being simultaneously. Therefore, drawing on prior theoretical and empirical evidence, this study proposes that basic psychological needs (autonomy, competence, and relatedness) mediate the relationship between SRL and mental health. The conceptual model is shown in Figure 1, and the following hypothesis is proposed: autonomy, competence, and relatedness needs partially mediate the relationship between SRL and teacher trainees' mental health (Hd).

3. METHODOLOGY

3.1. SAMPLE SELECTION AND DATA COLLECTION

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Education Research Ethics Committee of Wenshan University (WSU-EDU-2022-044). Informed consent was obtained from all participants prior to their participation in the study. The purpose of the study was clearly explained at the time of the survey, and participants were assured that the questionnaire was strictly confidential, used solely for academic research purposes, and was completed anonymously, to minimize concerns and enhance the authenticity of responses.

Between December 2022 and February 2023, a total of 528 teacher trainees from three universities in Yunnan were recruited for the study, and a randomized online survey was administered using Questionnaire Star. Among the participants, 124 were male, and 404 were female. Regarding the academic year level (hereafter referred to as "grade"), there were 129 freshmen, 140 sophomores, 202 juniors, and 57 seniors. Additionally, 182 participants were enrolled in science-related majors, while 346 were enrolled in arts-related majors.

Regarding demographic characteristics, the participants' ages ranged from 18 to 24 years (mean [M] = 20.36, standard deviation [SD] = 1.42). The sample distribution across semesters was as follows: first semester (n = 65), second semester (n = 64), third semester (n = 72), fourth semester
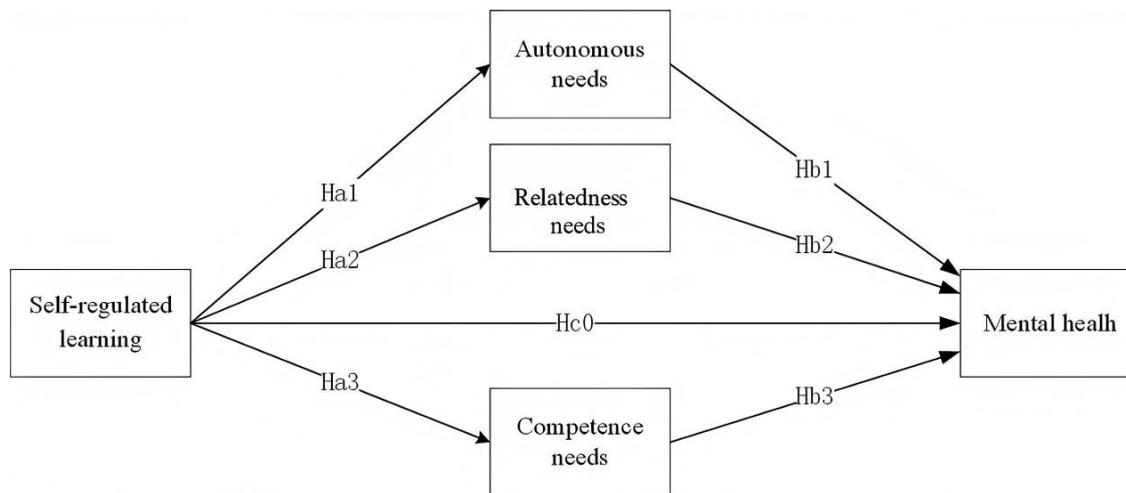
Figure 1. Conceptual model diagram

(n = 68), fifth semester (n = 98), sixth semester (n = 104), and seventh–eighth semesters (n = 57). One-way analysis of variance was conducted to examine whether there were systematic differences among the three universities.

Results indicated no significant differences in SRL ($F_{(2, 525)}$ = 1.87, p = 0.155), basic psychological need satisfaction ($F_{(2, 525)}$ = 0.94, p = 0.391), or mental health scores ($F_{(2, 525)}$ = 1.23, p = 0.293) across universities. Similarly, no significant differences were found between science and arts students for the main study variables (p > 0.05). The inclusion of both science and arts students was intended to enhance the generalizability of findings across different academic disciplines within teacher education programs. All three universities were comprehensive normal universities and shared similar teacher training curricula, ensuring comparability of the educational context.

3.2. INSTRUMENTS

3.2.1. BASIC PSYCHOLOGICAL NEED SATISFACTION SCALE

The Chinese version of the SDT Basic Psychological Need Satisfaction Scale, adapted from the nine-item scale developed by Sheldon and Niemiec's[42] nine items, was translated and validated by Du et al.[43], and administered using a seven-point Likert scale. The original scale was developed based on SDT[11,44] and has been widely used in educational research[44]. The Chinese version demonstrated satisfactory psychometric properties in prior validation studies[45]. Sample items include:

(i) Autonomy: "I feel free to express my ideas and opinions" and "I feel that my choices reflect what I really want."
(ii) Competence: "I feel confident that I can accomplish my tasks well" and "I feel capable of achieving my goals."
(iii) Relatedness: "I feel connected to people who care about me" and "I experience a warm feeling with the people I spend time with."

In the present study, the Cronbach's α coefficients were 0.84 for autonomy, 0.87 for competence, and 0.82 for relatedness, indicating good internal consistency. These three dimensions correspond directly to the theoretical conceptualization of basic psychological needs as defined in SDT[35], ensuring conceptual and measurement alignment.

3.2.2. SELF-ASSESSMENT HEALTH RATING SCALE

The Self-Test Health Rating Scale (SRHMS) developed by Xu et al.[46] was used in this study. The scale consists of six dimensions, namely positive emotions, social resources and social contact, cognitive functioning, social support, role activities and social adjustment, and psychological symptoms and negative emotions. The scale contains 29 items and is rated on a five-point Likert scale, with higher scores indicating higher levels of psychological well-being. By assessing both psychological and social dimensions of health, the SRHMS has been widely used among Chinese populations and validated for use with university students.

The SRHMS was developed and validated by Xu et al.[46] based on the WHO's conceptualization of health and has been extensively used in Chinese university student populations[15]. Sample items include:

(i) Positive emotions: "I often feel happy and satisfied" and "I feel optimistic about the future."
(ii) Psychological symptoms and negative emotions: "I rarely feel depressed or anxious" (reverse scored).
(iii) Social support: "I can get help from others when I need it."

It is important to note that although the scale measures multiple dimensions of health and well-being, the present study focuses specifically on psychological well-being—including positive emotions, cognitive functioning, and psychological symptoms—which align with the theoretical conceptualization of psychological well-being discussed in the literature review[11,16,17]. In the present study, the Cronbach's α coefficient for the total scale was 0.91, and the coefficients for the psychological well-being subscales ranged from 0.78 to 0.85, indicating good reliability.

3.2.3. SELF-REGULATED LEARNING ABILITY QUESTIONNAIRE

The Self-Regulated Learning Ability Questionnaire, developed by Schunk and Ertmer[47] and translated and adapted by Zhang[48], consists of four dimensions: motivation (e.g., self-efficacy, attribution, expectancy, & interest), approach and strategy, behavioral performance, and use of social and environmental resources. The final score is calculated as the sum of all item scores, with higher scores indicating higher levels of SRL ability.

The original questionnaire was developed by Schunk

and Ertmer[47] based on social cognitive theory and Zimmerman's[22] cyclical model of SRL. The Chinese version was translated and validated by Zhang[48] and demonstrated good psychometric properties in Chinese student samples. Sample items include:

(i) Motivation: "I believe I can master the knowledge taught in class" (self-efficacy) and "I find learning interesting and engaging" (interest).

(ii) Approach and strategy: "I set specific goals before studying" and "I use different learning strategies depending on the task."

(iii) Behavioral performance: "I can concentrate on learning without being distracted" and "I manage my study time effectively."

(iv) Social and environmental resources: "I seek help from teachers or classmates when I encounter difficulties."

This multidimensional measure aligns with the theoretical conceptualization of SRL, which encompasses cognitive, metacognitive, behavioral, and motivational components[22,23], as described in our literature review. In the present study, the Cronbach's α coefficients were 0.85 for motivation, 0.82 for approach and strategy, 0.79 for behavioral performance, and 0.81 for social and environmental resources. The overall Cronbach's α for the scale was 0.92, indicating excellent internal consistency.

3.3. STATISTICAL ANALYSIS

This study used Stata 15.0 (StataCorp LLC, College Station, USA) for descriptive statistics, correlation analysis, regression analysis, and bootstrap mediation analysis. To test mediation effects, we followed the recommendations of Yzerbyt *et al.*[49], who addressed issues related to replication and false positive findings in mediation analysis. They argued that the component (stepwise) approach has the advantage of low Type I error rates but suffers from low statistical power, whereas commonly used exponential test methods (e.g., the Sobel test and the bootstrap method) may increase Type I error rates.

Therefore, mediation testing was conducted in two steps: (i) examining the components of the indirect effect using hierarchical regression to establish the presence of an indirect effect; and (ii) estimating the magnitude and significance of the indirect effect using the bootstrap method (1,000 resamples).

3.4. COMMON METHOD BIAS CONTROL

As all data in this study were collected through self-report questionnaires, several procedural and statistical remedies were employed to minimize potential common method bias[47].

Procedurally, the following measures were taken: (i) participants were assured of complete anonymity to reduce evaluation apprehension and promote honest responses; (ii) the questionnaire was designed to be of moderate length (58 items) to prevent respondent fatigue; and (iii) items measuring different constructs were presented in varied formats and response scales (five- and seven-point Likert scales) to reduce method effects.

Statistically, Harman's single-factor test was conducted by including all variables in an exploratory factor analysis. The results indicated that the first unrotated factor explained 29.75% of the total variance, which was below the critical threshold of 40%[50], suggesting that common method bias was not a significant concern in this study.

4. RESULTS

4.1. CORRELATION ANALYSIS

Pearson's correlation coefficients were calculated to examine the bivariate relationships among all study variables. Although these correlations provided preliminary support for the hypothesized relationships, it is important to note that statistically tested correlations constitute inferential statistics rather than purely descriptive analyses. Formal hypothesis testing was subsequently conducted using hierarchical regression analyses (Section 4.2), which allowed for examination of the unique contribution of each predictor while controlling for other variables.

The results of the correlation analysis are presented in Table 1. The findings revealed that SRL was significantly and positively correlated with psychological well-being (r = 0.511, $p < 0.001$), providing initial support for hypothesis Hc0. Additionally, SRL showed significant positive correlations with autonomy needs ($r = 0.365$, $p < 0.001$), competence needs ($r = 0.412$, $p < 0.001$), and relatedness needs ($r = 0.313$, $p < 0.001$), offering preliminary support for hypotheses Ha1, Ha2, and Ha3. Moreover, autonomy needs and psychological well-being ($r = 0.412$, $p < 0.001$), competence needs and psychological well-being ($r = 0.413$, $p < 0.001$), and relatedness needs and psychological well-being ($r = 0.387$, $p < 0.001$) were also significantly positively correlated, providing initial evidence for hypotheses Hb1, Hb2, and Hb3.

Descriptive statistics for each variable are presented as M and SD. The study variables were measured using different response ranges. SRL was assessed using a questionnaire with scores ranging from 0 to 80 (M = 55.47, SD = 10.21), indicating moderate to high levels of SRL. Psychological well-being was measured on a five-point Likert scale, with total scores ranging from 29 to 145 (M = 78.85, SD = 14.79), indicating above-average mental health. Basic psychological needs (autonomy, competence, & relatedness needs) were measured using seven-point Likert scales, with scores for each dimension ranging from 3 to 21 (M = 13.52, 13.28, and 13.30, respectively), indicating moderate levels of need satisfaction. Higher scores on all measures indicate higher levels of the respective construct.

4.2. ANALYSIS OF THE MEDIATING ROLE OF AUTONOMY NEEDS, COMPETENCE NEEDS, AND RELATEDNESS NEEDS

In this study, a hierarchical regression model was employed to examine the relationships between SRL and psychological well-being, as well as autonomy, competence, and relatedness needs. The results are presented in Table 2 Based on prior research indicating that gender, grade, and major significantly affect college students' mental health, these variables were included as control variables. Wen's[51] three-step mediation regression analysis was used to examine the mediating role of autonomy needs, competence needs, and relatedness needs in the relationship between SRL and mental health.

As shown in Model 1, SRL had a significant positive effect on psychological well-being (β = 0.52, $p < 0.001$). After controlling for gender, grade, and major, SRL accounted for 27.2% of the variance in psychological well-being, indicating that higher SRL ability was associated with higher

Table 1. Results of the correlation analysis of each variable

Variable	Mean	Standard deviation	Self-regulated learning	Psychological well-being	Autonomous needs	Competence needs	Relatedness needs
Self-regulated learning	55.470	10.21	-	-	-	-	-
Psychological well-being	78.847	14.788	0.511***	-	-	-	-
Autonomous needs	13.521	3.809	0.365***	0.412***	-	-	-
Competence needs	13.278	4.051	0.412***	0.413***	0.492***	-	-
Relatedness needs	13.295	4.041	0.313***	0.387***	0.359***	0.547***	-

Note: ***$p < 0.001$.

psychological well-being. These empirical results support hypothesis Hc0.

As shown in Models 2, 3, and 4, SRL significantly and positively predicted autonomy needs ($\beta = 0.36$, $p < 0.001$), competence needs ($\beta = 0.29$, $p < 0.001$), and relatedness needs ($\beta = 0.31$, $p < 0.001$). After controlling for gender, grade, and major, SRL explained 13.2%, 8.8%, and 9.1% of the variance in autonomy, competence, and relatedness needs, respectively, indicating that higher SRL ability was associated with greater satisfaction of these basic psychological needs. These empirical results support hypotheses Ha1, Ha2, and Ha3.

As shown in Models 5, 6, and 7, SRL had a significant positive effect on autonomy needs ($\beta = 0.42$, $p < 0.001$), competence needs ($\beta = 0.42$, $p < 0.001$), and relatedness needs ($\beta = 0.39$, $p < 0.001$) in predicting psychological well-being. After controlling for gender, grade, and major, autonomy, competence, and relatedness needs accounted for 17.5%, 17.8%, and 15.3% of the variance in psychological well-being, respectively. This indicates that the satisfaction of basic psychological needs effectively contributes to psychological well-being. These findings support hypotheses Hb1, Hb2, and Hb3.

As shown in Model 8, the regression coefficients of autonomy needs ($\beta = 0.16$, $p < 0.001$), competence needs ($\beta = 0.16$, $p < 0.001$), and relatedness needs ($\beta = 0.13$, $p < 0.001$) were included simultaneously in the regression model of SRL and psychological well-being. The coefficients of all three variables on psychological well-being remained significant, while the regression coefficient β for SRL decreased from 0.52 to 0.38. The explained variance increased from 27.2% to 37.9%, suggesting a partial mediating effect of autonomy, competence, and relatedness need in the relationship between SRL and psychological well-being.

The mediating effects were further tested using the bootstrap method (with 1,000 resamples), and the results are presented in Table 3. The 95% confidence intervals for the indirect effects of autonomy, competence, and relatedness needs, as well as the total indirect effect, did not include zero, indicating that the mediating effects are significant and supporting hypothesis Hd.

5. DISCUSSION

5.1. THE SIGNIFICANT INFLUENCE OF SELF-REGULATED

LEARNING ON THE MENTAL HEALTH OF TEACHER TRAINEES

The findings revealed that SRL significantly predicts teacher trainees' mental health ($\beta = 0.52$, $p < 0.001$), explaining 27.2% of the variance in psychological well-being (Model 1; Table 2). This substantial effect size indicates that SRL is a powerful predictor of mental health outcomes in this population. These findings align with and extend previous research by Mega et al.[6], Vansteenkiste and Ryan[13], and Riggenbach et al.[40], providing quantitative evidence for the critical role of self-regulation in promoting psychological well-being among teacher trainees.

The strong predictive relationship found in this study ($\beta = 0.52$, $R^2 = 27.2\%$) has important theoretical and practical implications. In the post-epidemic era, teacher trainees face novel challenges and must actively regulate their learning to achieve a dynamic balance between the internal and external learning environments. Self-regulated learners actively motivate themselves and use appropriate learning strategies by evaluating a learning task in light of their prior knowledge and beliefs, setting goals, planning specific strategies to achieve them, and monitoring their progress by assessing the likelihood of success and deviations from expected outcomes. In the SRL process, learners are actively engaged, managing and directing their own learning activities through conscious effort.

Research has found that self-regulated learners achieve higher levels of attainment regardless of the course[20,48]. Teacher trainees with high levels of control, self-regulation, and initiative are better equipped to adapt to post-epidemic conditions and exhibit enhanced learning outcomes. SRL not only directly impacts students' academic performance but also supports their psychological development and well-being[52]. The findings of this study confirm that SRL meets the basic psychological needs of teacher trainees, is a strong predictor of their psychological well-being, and serves as a significant determinant of their psychological well-being.

5.2. INFLUENCE OF SELF-REGULATED LEARNING ON THE MENTAL HEALTH OF TEACHER TRAINEES THROUGH THE NEED FOR AUTONOMY, COMPETENCE, AND RELATEDNESS

The mediation analysis (Models 2–8; Table 2) revealed the

Table 2. Regression models for self-regulated learning, psychological well-being, autonomy needs, competency needs, and relatedness needs

Dependent variable	Independent variable							
	Psychological well-being	Autonomous needs	Relatedness needs	Competence needs	Psychological well-being			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Self-regulated learning	0.52***	0.36***	0.29***	0.31***	-	-	-	0.38***
Gender	−0.08**	−0.04	0.03	0.01	−0.07	−0.10**	−0.09**	−0.08**
Specialties	−0.01	0.02	0.04	0.02	0.01	0.00	0.01	−0.02
Grade	−0.08**	0.07	0.03	-0.01	−0.07	−0.05	−0.03	−0.10***
Autonomous needs	-	-	-	-	0.42***	-	-	0.16***
Competence needs	-	-	-	-	-	0.42***	-	0.16***
Relatedness needs	-	-	-	-	-	-	0.39***	0.13***
N	528	528	528	528	528	528	528	528
Adjusted R^2	0.272	0.132	0.088	0.091	0.175	0.178	0.153	0.379

Note: ** $p < 0.05$ and *** $p < 0.001$.

Table 3. Analysis of the mediating effect using the bootstrap method

Effect	Coefficient	Bootstrap SE	z	p	95% CI
Mediating effects of autonomy needs	0.081	0.025	3.3	0.001	[0.033, 0.129]
Mediating effects of relatedness needs	0.057	0.017	2.8	0.005	[0.021, 0.098]
Mediating effect of competence needs	0.07	0.026	2.64	0.008	[0.018, 0.122]
Total indirect effect	0.208	0.033	6.25	<0.001	[0.143, 0.273]

mechanisms through which SRL influences mental health. SRL significantly predicted all three basic psychological needs: autonomy needs (β = 0.36; $p < 0.001$; explaining 13.2% of the variance), competence needs (β = 0.29; $p < 0.001$; explaining 8.8% of the variance), and relatedness needs (β = 0.31; $p < 0.001$; explaining 9.1% of the variance). Each of these needs, in turn, significantly predicted mental health: autonomy needs (β = 0.42, $p < 0.001$), competence needs (β = 0.42, $p < 0.001$), and relatedness needs (β = 0.39, $p < 0.001$). When all three mediators were included simultaneously (Model 8), the direct effect of SRL on mental health decreased from β = 0.52 to β = 0.38, while the explained variance increased from 27.2% to 37.9%, confirming partial mediation.

Bootstrap analysis (95% confidence interval; 1,000 iterations) verified the significance of these indirect effects. These quantitative findings suggest that basic psychological needs serve as crucial pathways through which SRL promotes mental health. Our findings provide quantitative support for SDT in the context of teacher trainees' mental health. SDT states that the satisfaction of basic psychological needs—such as autonomy, competence, and relatedness—is the basis of psychological well-being. According

to SDT[34], individuals possess innate psychological needs that are essential for self-motivation and personality integration[50,37]. When individuals' needs are met, they are more likely to engage in positive developmental processes, including personal growth and self-regulation. However, the satisfaction of these needs does not occur automatically and requires support from the external environment[38]. Several researchers argue that a direct correlation between basic psychological needs and other variables is insufficient to highlight the importance of basic psychological needs, and that conceptualizing basic psychological needs as a mediating or moderating variable between other variables more effectively highlights their role in individual development[53].

Self-regulated learning positively predicts basic psychological needs, as demonstrated by the significant regression coefficients (autonomy: β = 0.36; competence: β = 0.29; relatedness: β = 0.31; all $p < 0.001$). Distance learning promotes autonomy by providing learners with opportunities to practice and apply what they have learned at their own pace. Personalized, autonomous learning environments create optimal conditions for learners to experience a sense of competence.

Autonomous learning environments are valued in the

post-epidemic period, requiring that learners engage in SRL, which fosters a sense of control[54] and supports the satisfaction of students' autonomy needs. Self-directed support can go a long way in meeting an individual's need for autonomy, and the satisfaction of this basic psychological need is crucial for enhancing psychological well-being. In the post-epidemic era, students need to learn more autonomously, and through self-monitoring and self-regulation of their learning mindset, behavior, emotions, and cognition, their basic psychological needs for autonomy, competence, and relatedness are satisfied.

A unique contribution of this study is the quantitative comparison of the effects of these needs. Autonomy needs demonstrated the strongest predictive power for psychological well-being ($\beta = 0.42$, explaining 17.5% of the variance), followed by competence needs ($\beta = 0.42$, explaining 17.8% of the variance), with relatedness needs showing somewhat weaker effects ($\beta = 0.39$, explaining 15.3% of the variance). This differential pattern suggests that for teacher trainees in the post-epidemic era, autonomy and competence needs may be particularly critical for mental health.

Drawing on the self-determination and satisfaction model as an intervention rationale for designing a basic psychological needs group intervention program, basic psychological need satisfaction plays an important role in influencing mental health and is highly valued by mental health practitioners[53,55]. Therefore, the mechanisms of SRL and the role of basic psychological needs in influencing mental health identified in this study can provide a useful reference for teacher trainees.

Notably, our study contributes three key scientific insights: (i) the effect size of SRL on mental health ($\beta = 0.52$) is larger than previously reported in general student populations, suggesting that teacher trainees may particularly benefit from self-regulation interventions; (ii) the partial mediation model with 37.9% explained variance indicates that while basic psychological needs are important mediators, other pathways may also exist; and (iii) the relatively equal importance of autonomy and competence needs (both $\beta = 0.42$), compared to relatedness needs ($\beta = 0.39$), suggests that interventions should prioritize fostering independence and mastery experiences.

Although this study yielded several findings, some limitations remain. First, although the hypotheses of this study are supported by the empirical data, the data are cross-sectional, and the sampling area is limited to Yunnan; thus, the reproducibility and generalizability of the findings are constrained. Therefore, future studies should expand the sampling scope and collect longitudinal data to validate these findings. Second, this study relied primarily on self-reports from university students. Future research could incorporate additional data collection methods to enhance objectivity and reduce potential bias.

Despite the study's limitations, the results have both theoretical significance and practical value. They contribute to SRL research by exploring the mechanisms through which SRL influences psychological health in relation to basic psychological needs, and highlight the important role of SRL in teacher trainee development. Additionally, they provide a reference for promoting the psychological health of teacher trainees in the post-epidemic era. SRL can be used as a positive psychological resource. Based on the SDT's basic psychological need satisfaction model, intervention programs can be designed to enhance teacher trainees' SRL ability, enabling them to set goals and proactively deploy resources to improve their psychological health through satisfying basic psychological needs in novel learning environments and during challenging periods.

6. CONCLUSION

Self-regulated learning has a significant positive impact on the psychological well-being of teacher trainees, and higher SRL ability is associated with higher levels of psychological well-being. SRL not only directly enhances teacher trainees' psychological well-being but also indirectly influences it through the satisfaction of their autonomy, competence, and relatedness needs.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest related to the subject matter or materials discussed in this manuscript.

AUTHOR CONTRIBUTIONS

Conceptualization: Qiying Gan
Data curation: Qiying Gan
Formal analysis: All authors
Writing–original draft: All authors
Writing–review & editing: All authors

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was conducted in accordance with the Declaration of Helsinki and was approved by the Education Research Ethics Committee of Wenshan University (protocol code: WSU-EDU-2022-044; approval date: February 1, 2022). Informed consent was obtained from all participants.

CONSENT FOR PUBLICATION

Informed consent was obtained from all participants prior to their inclusion in the study. Written consent forms were signed by all participants.

DATA AVAILABILITY STATEMENT

The data supporting the findings of this study are available from the corresponding author upon reasonable request, due to participant privacy.

ADDITIONAL DISCLOSURE

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