

An Empirical Study on the Influencing Factors of Education for Sustainable Development Competencies of Pre-Service Teachers in Yunnan Province: A Mediated Model Analysis of Sustainable Leadership, ESD Holism, and ESD Pluralism*



¹Zhicheng Zhang, Ekapum Jiwmittayanukul and Kusuma Yamgate

Faculty of Education, Srinakharinwirot University, Thailand.

¹Corresponding Author's Email: zhangzhicheng0827@gmail.com

Abstract

Amid the escalating challenges of global climate change and sustainable development, education is considered the core force in promoting a sustainable future. Cultivating pre-service teachers with professional action competence in education for sustainable development (ESD) is of enormous strategic significance for achieving educational reform and social sustainable development. However, the current systematic empirical quantitative research on pre-service teachers' ESD competence is still relatively limited. To this end, the specific research objectives are as follows: 1) To study the levels of sustainable leadership, ESD holism, ESD pluralism, and professional action competence in ESD among pre-service teachers. 2) To examine the direct causal relationship between the variables, including the direct impact of sustainable leadership on ESD holism, ESD pluralism, and professional action competence in ESD, as well as the direct impact of ESD holism and ESD pluralism on professional action competence in ESD. 3) To test the mediating effect of ESD holism and ESD pluralism in the path of sustainable leadership on professional action competence in ESD. The research target sample is pre-service teachers from normal colleges in Yunnan Province. A total of 527 valid questionnaire data were collected through offline questionnaire surveys, and path analysis was performed using PLS-SEM (partial least squares structural equation modeling).

The research results are as follows: 1) The mean scores of pre-service teachers on all major variables were at a high level. 2) The results of PLS-SEM revealed that sustainable leadership has a significant positive impact on ESD holism, ESD pluralism, and professional action competence in ESD. Additionally, ESD holism and ESD pluralism also significantly predict professional action competence in ESD. 3) The mediation effect analysis found that ESD holism and ESD pluralism play a partial mediating role in the path of sustainable leadership affecting professional action competence in ESD.

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Introduction

At present, the world is facing unprecedented sustainability challenges. Climate change, environmental degradation, and socio-economic imbalance are becoming increasingly serious, posing a severe test to the development models and education systems of various countries. UNESCO (2024) pointed out that education for sustainable development (ESD) should be used to systematically cultivate talents with the knowledge, skills, and values required to deal with sustainability issues in order to achieve sustainable transformation of society. As an important path of interdisciplinary education, ESD emphasizes the organic integration of environment, society, and economy, aiming to promote learners to form critical thinking, systematic understanding, and positive action capabilities (Raman, Hutagalung, and Rahman, 2022; Nousheen, Zai, Waseem, and Khan, 2020). In this context, teacher training, especially pre-service teacher education, has become a key link in implementing the goals of ESD, and plays a decisive role in whether future educators can effectively convey the concept of sustainable development.

Although some scholars have paid attention to the integration of ESD in pre-service teacher education, there is still a lack of in-depth empirical quantitative research on the factors that affect pre-service teachers' ESD competence, especially the mechanism of sustainable leadership, ESD holism, and pluralism. Existing literature shows that although pre-service teachers have demonstrated high professional ability in multiple teaching areas (Rubio and Saenz, 2023), there are still obvious deficiencies in teaching confidence and practical application related to sustainability (Ammoneit, Turek, and Peter, 2022). In addition, although teachers generally have a positive attitude towards self-efficacy in ESD courses, the pertinence and systematization of related training still need to be strengthened (Avsec and Ferk Savec, 2021). How to effectively bridge the gap between theory and practice is still a core issue in current teacher training.

As the trend of global warming intensifies (Kabir et al., 2023), the education system urgently needs to take on the mission of shaping a sustainable society in the future. Kabir et al. (2023) pointed out that since 1880, global temperatures have shown a significant upward trend. If timely intervention is not made, the global average temperature may rise by about 2.5°C, which will trigger an irreversible ecological crisis. In the face of this grim reality, the sustainable leadership of educators is particularly important. Hargreaves and Fink (2004) proposed that sustainable leadership is not only related to the long-term development of educational organizations, but also emphasizes fairness, diversity, and resource protection, and emphasizes the dynamic balance between tradition and innovation (Hargreaves, 2007; Ferdig, 2007). In teacher education institutions, the sustainable leadership behavior of leaders



will profoundly affect pre-service teachers' understanding and practice tendencies of ESD (Lambert, 2011; Raman et al., 2022).

In recent years, more and more educational reforms and national policies have included ESD in the priority agenda. China's Education Modernization 2035 clearly proposes to accelerate the realization of a sustainable education system, actively connect with the United Nations 2030 Agenda for Sustainable Development, and make quality education and lifelong learning a strategic priority. China's education development path is highly consistent with the Incheon Declaration and the Education 2030 Framework for Action issued by the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 2015, demonstrating China's firm commitment to achieving the global Sustainable Development Goals (SDGs), especially SDG 4 (quality education).

However, existing ESD research is mainly concentrated in Europe, America, and developed coastal areas. For southwest China, especially Yunnan Province, which has rich ecological diversity and cultural specificity, relevant empirical research is extremely scarce. As an important ecological barrier in China, Yunnan's unique natural environment and significant climate change pressure make it an ideal place to study ESD and sustainable education practices. Take Lijiang Yulong Snow Mountain as an example. From 1982 to 2009, the glacier area has dropped sharply by 61.9%, from 11.61 square kilometers to 4.42 square kilometers. During the same period, the average annual temperature in Lijiang continued to rise (Zhang and Lian, 2014). Such ecological crises have had a profound impact on water resources, agriculture, tourism, and social structure in Yunnan. The education system is in urgent need of cultivating a new generation of teachers with sustainable action capabilities.

Based on this, this study responds to three core research gaps in the current academic and practical fields: (1) There is still a lack of research on how sustainable leadership affects pre-service teachers' professional action competence of ESD through ESD holism and pluralism; (2) In the existing literature, the mediating role of ESD holism and pluralism between sustainable leadership and pre-service teachers' competence has not been systematically tested; (3) The empirical research on the current status of pre-service teachers' SD competence and its influencing path in Yunnan Province are extremely limited, and there is an urgent need to fill the evidence base for regional education policy and teacher training reform.

This study aims to provide a theoretical basis and practical path for teacher training in Yunnan Province and even in China by constructing a mediating model between sustainable leadership, ESD holism, ESD pluralism, and pre-service teachers' ESD professional action competence, and to contribute academic results with local characteristics and practical significance to the development of the global ESD education system.



Objectives of the Research

1. To study the levels of sustainable leadership, ESD holism, ESD pluralism, and professional action competence in ESD among pre-service teachers.
2. To examine the direct causal relationship between the variables, including the direct impact of sustainable leadership on ESD holism, ESD pluralism, and professional action competence in ESD, as well as the direct impact of ESD holism and ESD pluralism on professional action competence in ESD.
3. To test the mediating effect of ESD holism and ESD pluralism in the path of sustainable leadership on professional action competence in ESD.

Research Methodology

This study adopts an empirical research design to systematically explore the impact mechanism of sustainable leadership, ESD Holism, and ESD Pluralism on the professional action competence regarding ESD of pre-service teachers in Yunnan Province, China. The research process is divided into seven steps, as follows:

1st Step: This study first extensively reviews relevant literature regarding education for sustainable development (ESD), sustainable leadership, ESD holism, ESD pluralism, and professional action competence regarding ESD of teachers to establish a solid theoretical foundation. Through literature review, the definition, measurement dimension and potential relationship of each variable are clarified, and then the theoretical model and hypothesis path of this study are constructed.

2nd step: Based on the extensive literature review, this study proposes a structural equation model containing four core variables: sustainable leadership, ESD holism, ESD pluralism, and professional action competence regarding ESD. It is proposed that sustainable leadership has direct and indirect effects on the professional action competence regarding ESD of pre-service teacher, and ESD holism and ESD pluralism play a mediating role in it. The research model systematically presents the causal relationship between the variables through a path diagram.

3rd step: Key informants are

3.1 Target Population

The target population of this study is the normal students or pre-service teachers majoring in normal education in six universities in Yunnan Province, China. The six universities selected are: Yunnan Normal University, Kunming University, Qujing Normal University, Chuxiong Normal University, Zhaotong University, and Honghe University. These six universities are the core institutions for teacher training in Yunnan Province, covering the southern (Honghe University), western (Chuxiong Normal University), northern (Zhaotong University), and central regions (Yunnan Normal University, Kunming University) of Yunnan Province, with good regional representativeness and a broad source of students.

3.2 Target Sample

This study takes the pre-service teachers majoring in normal education in six universities in Yunnan Province, China as the main research target sample. Specifically, they include Yunnan Normal University (about 8,000 people), Kunming University (about 5,000 people), Chuxiong Normal University (about 3,000 people), Qujing Normal University (about 2,500 people), Zhaotong University (about 2,500 people), and Honghe University (about 2,500 people). The total size of the overall target group is about 23,500 people, covering the central, southern, northern, and western regions of Yunnan Province. The sample area distribution is reasonable, which can fully represent the overall characteristics and regional differences of the normal student population in Yunnan Province.

In order to ensure that the sample size is statistically representative and meets the requirements of inferential validity, this study uses Cochran (1977) sample size formula for calculation, and determines the minimum sample size to be 385. After considering the non-response rate of about 32.5%, the actual number of questionnaires distributed was 570 to ensure that the effective sample recovery volume meets the statistical requirements. The sample allocation adopts a stratified allocation sampling method based on the proportion of pre-service teachers in each university to ensure that the sample proportion of each school is consistent with its proportion in the overall group, thereby improving the representativeness of the sample structure and the wide applicability of the data.

4th step: Tools and methods used in the study

Based on the previous literature review and relevant mature measurement scales, this study designed a structured questionnaire that includes core measurement dimensions such as Sustainable Leadership, ESD Holism, ESD Pluralism, and Professional Action Competence in ESD. During the questionnaire design process, we fully referred to authoritative research tools in high-quality journals, and appropriately adjusted the content of the items based on the educational background of pre-service teachers in Yunnan Province to ensure the contextual adaptation and measurement accuracy of the questionnaire. The questionnaire was scored using a Likert five-point scale (1 = strongly disagree, 5 = strongly agree) to ensure the continuity of the data and the applicability of statistical analysis. To ensure the content validity of the scale, the first draft of the questionnaire was reviewed and revised by 5 experts in the fields of education, sustainable development, and psychometrics. The results of the IOC revealed that the IOC values of all questions are between 0.8 and 1. Among them, 51 questions scored 1, and only 1 question scored 0.8. All of them are significantly higher than the standard of 0.5, indicating that all questions have good content validity. In addition, a small sample ($N = 100$) was selected for pre-testing to test the internal consistency and construct validity of the questionnaire. The pre-test results show that the Cronbach's Alpha coefficients of each scale are higher than 0.80, indicating that the questionnaire has good internal consistency reliability.



In the formal survey stage, paper questionnaires were distributed to collect data to improve the recovery rate and filling quality. The questionnaire mainly includes the following four parts: Sustainable Leadership Scale, ESD Holistic Scale, ESD Pluralism Scale, and ESD Professional Action Competence Scale.

5th step: Data Collection

This study applied an offline questionnaire survey method to collect data. The researchers recruited two pre-service teachers from each of the six normal universities in Yunnan Province (Yunnan Normal University, Kunming University, Qujing Normal University, Chuxiong Normal University, Zhaotong University, and Honghe University) through their connections to assist in the distribution of questionnaires, for a total of 12 people. In order to ensure that the sample distribution is consistent with the scale of pre-service teachers in each university, the questionnaires were distributed in proportion: 195 copies for Yunnan Normal University, 120 copies for Kunming University, 60 copies for Qujing Normal University, 75 copies for Chuxiong Normal University, 60 copies for Zhaotong University, and 60 copies for Honghe University. During the data collection process, the convenience sampling method was first used to invite pre-service teachers who participated in school activities and classroom learning to fill out the questionnaires, and further through the snowball sampling method, the first batch of participants recommended eligible students to participate in the survey. This double sampling strategy effectively overcomes the practical limitations in the data collection process while ensuring the diversity and representativeness of the sample.

6th step: Data analysis

This study applies the PLS-SEM (partial least squares structural equation modeling) for data analysis, which mainly includes the following steps: (1) Measurement model verification: test the reliability, convergent validity and discriminant validity of each latent variable. (2) Structural model verification: analyze the path coefficient, determination coefficient (R^2), prediction correlation (Q^2), and model fit goodness. (3) Mediation effect test: The Bootstrap method is used to test the significance of the mediation effect of ESD Holism and ESD Pluralism. PLS-SEM analysis is performed using SmartPLS software to ensure the scientific and rigor of the analysis results.

7th step: Summary and presentation of the research results

Finally, this study systematically organizes and presents the results of various analyses, including path analysis results, model fit indicators, and mediation effect test results. The research results will be compared and discussed with existing literature, deeply explain the relationship and influence mechanism among various variables, and put forward suggestions for educational practice and future research directions.



Research Results

From the 1st objective, the research result was found that the levels of each variable were at a high level. Specifically, sustainable leadership (Mean = 3.726, SD = 0.755), ESD holism (Mean = 3.782, SD = 0.888), ESD pluralism (Mean = 3.588, SD = 0.756), and ESD professional action competence (Mean = 3.777, SD = 0.616) all reached a high level, indicating that the tested pre-service teachers generally have a positive understanding of education for sustainable development and a good practice foundation. Further analysis revealed that among the three components of ESD professional action competence, pre-service teachers performed well in ESD self-efficacy (Mean = 3.810, SD = 0.771) and perceived pedagogical content knowledge about ESD (Mean = 3.843, SD = 0.762), indicating that they have strong confidence in their own teaching ability and related knowledge; they also reached a high level in the willingness to implement ESD (Mean = 3.671, SD = 0.809), reflecting that they have strong motivation for ESD practice.

From the 2nd objective, the research result was found that sustainable leadership had a significant positive impact on ESD holism ($\beta = 0.573$, $t = 13.264$, $p < 0.001$), ESD pluralism ($\beta = 0.485$, $t = 10.559$, $p < 0.001$), and ESD professional action competence ($\beta = 0.227$, $t = 4.527$, $p < 0.001$). Further analysis found that ESD holism ($\beta = 0.303$, $t = 5.912$, $p < 0.001$) and ESD pluralism ($\beta = 0.093$, $t = 1.960$, $p = 0.050$) both have a significant positive impact on ESD professional action competence. From the perspective of model explanatory power, the PLS-SEM (partial least squares structural equation modeling) has a good explanatory and predictive effect on each endogenous variable. Specific data reveal that sustainable leadership has an explanatory power of 33% ($R^2 = 0.33$) for ESD holism and 24% ($R^2 = 0.24$) for ESD pluralism, while sustainable leadership, ESD holism and ESD pluralism together have an explanatory power of 43% ($R^2 = 0.43$) for ESD professional action competence, all reaching above medium level. In addition, the predictive correlation (Q^2) of the model also shows good predictive ability, with Q^2 of ESD holism, ESD pluralism, and ESD professional action competence being 0.28, 0.19 and 0.32, respectively. Path effect size analysis further confirmed that sustainable leadership has a large effect size on ESD holism ($f^2 = 0.489$) and a medium effect size on ESD pluralism ($f^2 = 0.308$), indicating the core role of sustainable leadership in shaping the key elements of sustainable education in real world practice. The overall model goodness of fit (GoF) is 0.469, which is at a high level, indicating that the research model has good adaptability and robustness in terms of explanatory power and predictive power. These results fully verify the research hypothesis and further support the causal path structure between sustainable leadership, ESD holism, ESD pluralism, and pre-service teachers ESD professional action competence.

From the 3rd objective, the research result was found that sustainable leadership had a significant direct impact on ESD professional action competence ($\beta = 0.594$, $t = 15.046$, $p < 0.001$). Further mediation effect analysis showed that ESD holism played a partial mediating

role between sustainable leadership and ESD professional action competence (beta = 0.174, $t = 5.160$, $p < 0.001$). ESD pluralism also showed a partial mediating effect on ESD professional action competence (beta = 0.045, $t = 1.894$, $p < 0.1$).

The New Body of Knowledge

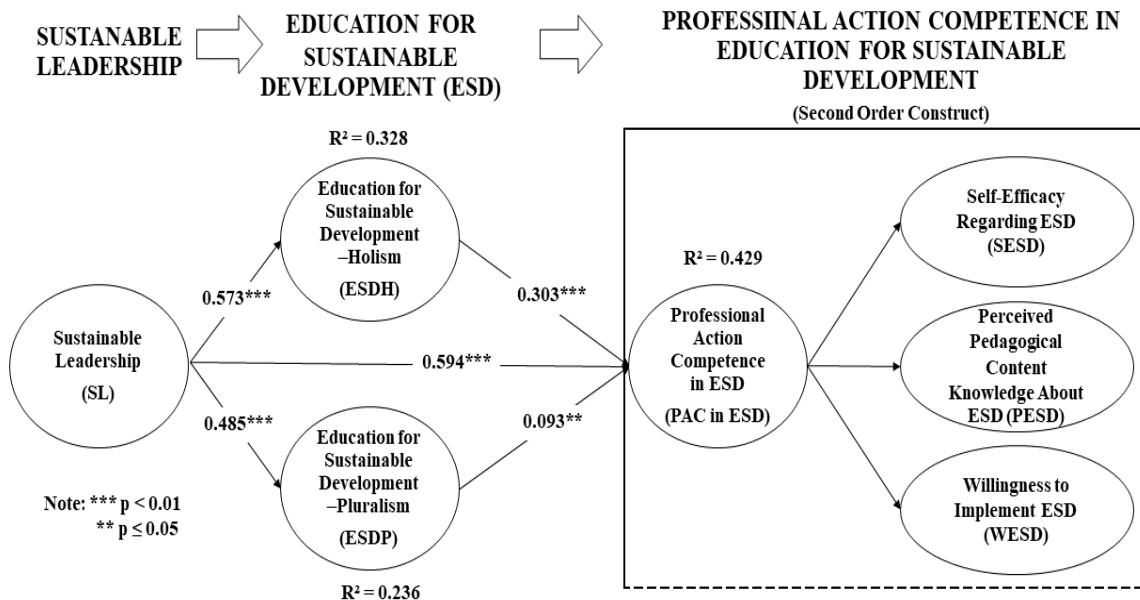


Figure 1: Structural Model to Improve Professional Action Competence in ESD

Based on the empirical results of this study, the new knowledge system constructed is integrated into the “Mediating Path Model of Sustainable Leadership Promoting Pre-service Teachers’ Professional Action Competence in Education for Sustainable Development”, as shown in figure 1. This model reveals that sustainable leadership not only directly promotes pre-service teachers’ professional action competence in ESD, but also indirectly improves their professional action competence in ESD by enhancing their learning experience in ESD holism and ESD pluralism. The study adopts PLS-SEM (partial least squares structural equation modeling) as the core method, and through scale evaluation, path analysis and mediation effect test, it ensures that the process is scientific and rigorous and the data is valid. The application paths include: 1. Strengthen the sustainable leadership of school leaders, guide the positive transformation of educational organizations through vision shaping, innovative practice, effectively allocate school resource, set clear ESD requirement for teaching staff, ethical care and student-oriented strategies; 2. Incorporate ESD holistic content into curriculum design and teaching implementation, covering the three dimensions of



environment, society, and economy, and encourage students to think from the perspectives of time (past, present, future) and space (local, regional, global); 3. Create a teaching environment that supports multiple perspectives, critical thinking and participatory learning, and inspire students to deeply participate in sustainable issues in real world. This new knowledge system has significant value and social benefits. It not only provides pre-service teacher training institutions with an operational education model and practice path, but also injects theoretical support and practical guidance into promoting individual literacy, promoting school organizational culture innovation and supporting social sustainable development. In the future, schools can systematically carry out teacher education reform based on this model, comprehensively improve the education for sustainable development professional action competence of the teaching staff, and help cultivate a new generation of citizens with a sense of global responsibility.

Discussion of Research Results

From the research result of the 1st objective, it was found that pre-service teachers in Yunnan Province showed high levels in all major latent variables, including sustainable leadership, ESD holism, ESD pluralism, and professional action competence in ESD. This is because the current teacher education has integrated the concept of sustainable development into the teacher training system to a certain extent, so that pre-service teachers have a positive understanding of sustainable development in education and have a good practical foundation. The mean analysis revealed that pre-service teachers had reached a high level in ESD self-efficacy, perceived pedagogical content knowledge about ESD, and the willingness to implement ESD, indicating that they have strong confidence and motivation to be competent and promote education for sustainable development practice. This result further verifies the multidimensional structural theory of ESD professional action competence.

From the research result of the 2nd objective, it was found that sustainable leadership has a significant direct positive impact on ESD holism, ESD pluralism, and professional action competence in ESD, as well as the significant direct impact of ESD holism and ESD pluralism on professional action competence in ESD. This is because school leaders play a vital role in promoting education for sustainable development, and can deeply embed the concept of sustainability into educational practice through systematic management, value construction, and resource allocation support (Kadji-Beltran, Zachariou, and Stevenson, 2013). If school leaders can create an open and inclusive campus culture and a participatory governance atmosphere, they will effectively motivate teachers to adopt multiple teaching strategies and enhance students' critical thinking and negotiation skills on sustainable issues (Boeve-de Pauw, Gericke, Olsson, and Berglund, 2015; Verhelst et al., 2023). When the education process systematically integrates ESD holistic and pluralistic elements, the self-efficacy, pedagogical ability, and willingness to act on sustainable issues of pre-service teachers are significantly

enhanced, indicating a comprehensive improvement in professional action competence. This finding is consistent with the research results of Abidin, Mokhtar and Arsat (2023) and Verhelst, Vanhoof and Van Petegem (2023), all of which emphasize the key position of school leaders in promoting education for sustainable development. This finding is also consistent with social influence theory (Kelman, 1974), to be more specific, this study further uses the perspective of social influence theory (Kelman, 1974) to verify that sustainable leaders can significantly reduce teachers' psychological resistance to multiple value conflicts by shaping school group norms and value internalization mechanisms, which in turn making ESD holism and ESD pluralism a part of their teaching consciousness and professional identity.

From the research result of the 3rd objective, it was found that ESD holism and ESD pluralism plays a partial mediating role in the path of sustainable leadership affecting professional action competence in ESD. This is because if school leaders have sustainable development-oriented leadership traits, they can often create a more inclusive and innovative teaching environment, so that pre-service teachers can be more exposed to interdisciplinary integration, system thinking, participatory discussion, multi-perspective inquiry and other teaching practices in the teaching process, which are the key teaching characteristics reflected by ESD holism and ESD pluralism. The increase in the frequency of contact means that pre-service teachers have more opportunities to observe, participate in and learn such teaching methods, which in turn forming a professional action competence in ESD structure in a subtle way. This finding is consistent with Kelman's (1974) social influence theory, which states that changes in individual behavior in an organization depend not only on value identification, but also on the behavioral patterns they are exposed to in their environment.

Conclusion

The results of this study show that sustainable leadership has a significant positive impact on ESD holism and ESD pluralism. Additionally, ESD holism and ESD pluralism both significantly and positively affect the professional action competence in ESD of pre-service teachers. Sustainable leadership also directly promotes professional action competence in ESD of pre-service teachers. Furthermore, ESD holism and ESD pluralism play a partial mediating role between sustainable leadership and professional action competence in ESD of pre-service teachers. In sum, all 7 research hypotheses are supported.

Suggestions

1. The suggestions from the research

Based on the results of the 1st objective, the results found that the tested pre-service teachers have reached a high level in all research variables. Therefore, higher normal colleges and teacher education-related institutes should actively integrate the core concepts of ESD into the teacher training curriculum in a systematic way, especially strengthening the training



model combining classroom teaching design, case teaching, and field experience, and further improve the practical operation ability and self-efficacy of pre-service teachers in sustainable development education.

Based on the results of the 2nd objective, the results found that sustainable leadership has a significant positive impact on ESD holism, ESD pluralism, and pre-service teachers' professional action competence in ESD, and ESD holism and ESD pluralism also play a positive promoting role in pre-service teachers' professional action competence in ESD. Therefore, education administrative departments at all levels, normal colleges, and internship guidance institutes should focus on cultivating the sustainable leadership literacy of school leaders and teachers and deepen the ESD holism and ESD pluralism education practice by building a supportive campus culture, promoting interdisciplinary teaching, and providing an open and diverse learning environment to systematically improve the pre-service teachers' professional action competence in ESD.

Based on the results of the 3rd objective, the results found that both ESD holism and ESD pluralism have partial mediating effects between sustainable leadership and professional action competence in ESD. Therefore, it is recommended that education authorities and normal colleges should focus on designing immersive learning programs with the core of improving ESD holism and pluralism in the teacher training system, such as project-based learning, community service learning, and cross-cultural communication courses that integrate sustainable development issues.

2. The suggestions for future research

The future research is recommended to involve the following issues:

2.1 To conduct repeated verification in different geographical regions and multicultural contexts to further test the generalizability and applicability of the study's findings.

2.2 To supplement and validate existing self-report survey data by introducing more objective and diverse measurement tools, such as classroom observation, teaching practice evaluation, and student learning achievement tracking.

2.3 To explore other potential mediating and moderating factors affecting ESD integration in teacher training, including institutional support, teachers' intrinsic motivation, policy environment, and school culture.

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