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Education and Sustainable Development Goals

Edited by

Yuzhuo Cai and Lili-Ann Wolff

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Cover image courtesy of Yuzhuo Cai

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About the Editors

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Yuzhuo Cai (PhD in Administrative Sciences) is a Senior Lecturer and Adjunct Professor at the Higher Education Group (HEG), Faculty of Management and Business, Tampere University, Finland. He has been with HEG for 20 years and was the Acting Professor of the unit from August 2013 to July 2014. He is the Director of the Sino-Finnish Education Research Centre, a network organisation involving over 20 Chinese and Finnish universities, and the Deputy Director of the Research Centre on Transnationalism and Transformation (TRANSIT), an interdisciplinary research centre spanning three faculties at Tampere University. He is also in the coordination group of the Science, Technology and Innovation (STI) Research Tampere Network and the coordination group of Think Tank for China, SGroup Universities in Europe. He is Editor-in-Chief of *Triple Helix* and a Co-Editor of the *Journal of Studies in International Education*. His main interests are in higher education research and innovation studies, focusing on interactions between higher education and society including an international dimension. He has published more than 130 academic publications in these fields, including those in prestigious journals, such as *Higher Education, Studies in Higher Education, International Journal of Management Reviews, Technovation, Minerva, Science and Public Policy, and European Planning Studies and Scientometrics*.

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Lili-Ann Wolff (Doctor of Education) is a Senior Lecturer and Associate Professor in environmental education at the Faculty of Educational Sciences, University of Helsinki, and a member of the Helsinki Institute of Sustainability Science (HELSUS). Besides holding a master and doctorate in education, she also graduated with degrees in *science* and in *philosophy*. She has been involved in the development of environmental and sustainability education and in sustainability education research in various contexts. Accordingly, she has extensive experience with international cooperation and networking as a member of many strategic working groups, and she has been engaged in politics on many levels. In several decades, she has been a member of the International Union for Conservation of Nature's (IUCN) Commission on Education and Communication (CEC), in many Nordic expert groups, which include the current Nordic Expert Group on Education for Sustainable Development. At the European level, she is currently a Finnish Management Committee member in the EU Cost Action PHOENIX—Protection, Resilience, Rehabilitation of Damaged Environment. Within her own faculty, she leads the research project Sustainable World Heritage Learning through a Phenomenon-based Approach (SveaSus), the Sustainability Education Research Group (SusEdu), and the working group on Equality and Non-discrimination. Her research interests include sustainability education from transdisciplinary and critical views combining education, philosophy and history of science, natural sciences, and arts. Among her research topics are education in the Anthropocene, transformative learning, transdisciplinary education, worldview education, sustainability management, and phenomenon-based learning. She has written books and numerous articles and book chapters, both scientific papers and popular science. She has authored more than 240 publications in total, and some of her publishers are Oxford University Press, Springer Nature, Edward Elgar, and Routledge.

Preface to "Education and Sustainable Development Goals"

This eBook is a collection of the articles in the Special Issue entitled Education and Sustainable Development Goals. Although our Special Issue primarily targeted papers presented at the 6th Sino-Finnish Joint Learning Innovation Institute (JoLii) Annual Conference on 15-17 November 2021, we also received many manuscripts beyond the conference. The 11 published papers, contributed by 39 authors from six countries (China, Finland, Japan, Denmark, the Netherlands, and the UK), are generally divided into five categories: (1) quality of education, (2) SDG policy and implementation, (3) education and societal development, (4) students' learning, and (5) global experience. We believe that the book benefits a wide array of readers, such as educational researchers, policymakers, administrators, and professionals interested or engaged in education and the United Nations' Sustainable Development Goals (SDGs). We thank all the authors and reviewers for their valuable contributions. We also acknowledge Tampere University's financial support for publishing this Special Issue via the GINTL project.

Yuzhuo Cai and Lili-Ann Wolff
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Editorial

Education and Sustainable Development Goals

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1. Introduction

Sustainability and sustainable development have been on the global political agenda since the end of the 1980s. Already before that, environmental crises were increasingly being recognized around the world. In 2015, the United Nations (UN) adopted the 2030 Agenda for Sustainable Development, providing a blueprint for peace and prosperity 'for people and for the planet'. The agenda includes 17 Sustainable Development Goals (SDGs) and 169 sub-targets, which are all integrated. This development dynamic means that what takes place in one field affects the outcomes in the other. It also implies that local as well as global development must strive towards ecological, social, and economic sustainability. The implementation of the blueprint is equivalent to achieving the 17 SDGs.

One of the most severe sustainability problems facing the world today is climate change. For decades, climate experts and researchers have tried to raise the climate issue on the daily political agenda. Since the 1990s, international conferences have taken place acknowledging how to mitigate climate change politically. However, even if the consequences of climate change are obvious and visible on a daily basis as ecological and social disasters, these political negotiations tend to fail because of strong economic interests hindering any essential progress. In addition, these challenges steadily increase since in both policy discourses and academic research, sustainability concerns not only ecological but also social and economic matters [1].

In this unsustainable situation, education has been appointed the role of facilitator. However, even this instrument is steered by strong economic interests making accountability a cornerstone of contemporary education policy [2]. There is still a lot to do before education becomes fairer and more democratic and broadly promotes global sustainability aims. In this process, education research, policy, as well as practice need improvement. Evidently, the entire Agenda and its goals and sub-targets have significant educational implications. In addition to SDG 4, Quality Education is also recognized as the key to the success of the remaining SDGs [3]. However, even if the important relations between education and the SDGs are widely acknowledged, there remains ambiguity on how education can effectively contribute to the SDGs [4] as well as how education and educational institutions can be transformed to better adapt to the SDGs [5]. Thus, when announcing this Special Issue, we searched for transformative approaches to learning, education, and institutional performance in accordance with the SDGs, global and comparative perspectives on education and the SDGs, but also specific learning and teaching approaches related to the SDGs.

The aim of this Special Issue is to address the role of sustainability in educational contexts. It is based on the theme of the 6th annual conference of the *Sino-Finnish Joint Learning Innovation Institute* (JoLii). The conference was hosted by Tampere University. JoLii, involving more than 20 Chinese and Finnish universities, aims to enhance high-quality Sino-Finnish education cooperation and exchange through joint research, collaborative programs and experience sharing. The institute is also committed to developing innovative solutions for education and learning, as well as policy, in both countries, and it is committed

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to addressing global challenges. The 6th JoLii conference invited education researchers from China and Finland, two countries with unique education systems. China has the largest, while Finland has one of the internationally best-performing education systems in the world. Our interest with this Special Issue was not to exclusively inspire the JoLii conference participants but also many other researchers. We want to stimulate a discussion on the relations between education and sustainable development in a broad sense, as well as on the roles of education and educational institutions in the implementation of the SDGs.

2. Articles

The eleven articles collected in the Special Issue are diverse, and their view of sustainability are far from similar. However, we have grouped their topics into four categories: (1) quality of education, (2) SDG policy and implementation, (3) education and societal development, (4) students' learning and (5) global experience.

2.1. Quality of Education

In their article "Factors impacting the sustainable development of professional learning communities in interdisciplinary subjects in Chinese K-12 schools: A case study" [6], Yiyun Hu, Xiaoli Jing, and Yaqing Yang claim that Chinese schools have made great efforts to improve the teachers' professional development by the establishment of professional learning communities. These authors see the establishment of professional learning communities as one of the most effective approaches for promoting professional teacher development. Their research shows the role of interdisciplinary subjects in K-12 schools' professional learning communities and how interdisciplinarity relates to school structures and policies, school leadership, and teachers' professionalism. In addition, professional learning communities draw attention to three community features: (1) a conflict-inclusive atmosphere, (2) the coexistence of individual and shared visions, and (3) an emotional bonding identity.

The article "A sustainability lens on the paradox of Chinese learners: Four studies on Chinese students' learning concepts under Li's "virtue–mind" framework" [7] is written by ten authors: Ruixiang Gao, Jiayin Zhang, Yirao Liu, Jielin Zeng, Danying Wu, Xiaoxiao Huang, Xiaoqing Liu, Lei Mo, Zehui Zhan, and Huang Zuo. It is based on four empirical studies investigating how Chinese students' learning concepts relate to Jin Li's "virtue–mind" framework. This theoretical framework provides a broad view of the advantages and disadvantages of Chinese education and of how to make it more sustainable. The authors want to make new modifications and enrich Li's theory through this study. By comparisons, they found interesting regional differences. They also proved Li's basic hypothesis that culture has significance for people's fundamental learning beliefs.

2.2. SDG Policy and Implementation

In "The reception of education for sustainable development (ESD) in China: A Historical review" [8], Ronghui (Kevin) Zhou and Nick Lee present a study about the discourse on ESD in China over a period of three decades. The focus in this study is especially on the reception of ESD in Chinese education policies. Their results show that in recent Chinese policies, the 'ecological civilization' concept is replacing traditional definitions of ESD. The authors argue that China's domestic discourse thus weakens the relation between ESD and sustainable development, turning the UNESCO definition of ESD into environmental protection education based on domestic interests.

The article "How urban residents perceive nature education: A survey from eight metropolises in China" [9], by Yu Huang, Rui Shi, Jin Zhou, Zhiqiang Chen, and Peng Liang, investigated how Chinese urban residents' perceptions of "nature education" contributes to the success of specific nature education. In this study, the respondents did not consider the emotional benefits and the development of social and functional skills as essential outcomes of nature education. However, the research shows the positive effects of nature education, and the authors emphasize that the SDGs and other international as well as Chinese

sustainability-related plans provide a solid foundation for promoting nature education and for transforming education and society towards ecological civilization.

2.3. Education and Societal Development

In their article "Sustaining higher education quality by building an educational innovation ecosystem in China: Policies, implementations and effects" [10], Tengteng Zhuang and Baocun Liu examined quality in higher education from the stakeholders' perspectives. The stakeholders include not only various actors within higher education but also people from the government and industry sectors. They applied the sustainable entrepreneurial university concept [11] and conducted policy analysis to approach their research inquiry about developing a sustainable higher education sector in China. Their study shows that China has launched a series of policies to build a higher education innovation ecosystem in which multiple stakeholders co-work in a synergistic approach to fueling higher education quality at various levels. However, there is an imbalance and unevenness in implementation, particularly concerning the participation of higher education institutions and enterprises.

Ruichang Ding and Zheng You's article "Education partnership assistance to promote the balanced and sustainable development of higher education: Lessons from China" [12] investigated the partnership between higher education institutions in economically advanced regions and in less developed areas. Education Partnership Assistance is a national strategy for bridging the development gaps across the country. By conducting a policy analysis, they found that the Education Partnership Assistance program, based on the Communist Party of China's ideological cornerstones of "common prosperity", cannot continue indefinitely. They argued that true sustainability is contingent on the capacity building of the recipient higher education institutions rather than the endless assistance from supporting universities.

2.4. Students' Learning

The three articles on students' learning do not explicitly address SDGs but provide a solid foundation to further explore education and SDGs with respect to skills and learning.

The article "What characterizes an effective mindset intervention in enhancing students' learning? A systematic literature review" [13], by Junfeng Zhang, systematically explores the efficacy of mindset interventions for adolescents of school age from the perspective of teaching and learning. She found three pedagogical characteristics that ensure successful interventions: (1) Mutual interaction among the person, the context, and the theory to generate the message; (2) Iterative processes to ensure the message is delivered; (3) A persuasive yet stealthy approach to facilitating its internalization.

In their article "Supporting K-12 students to learn social-emotional and self-management skills for their sustainable growth with the Solution-Focused Kids' Skills Method" [14], Shuanghong Niu, Hannele Niemi, and Ben Furman explored how Kids' Skills (KS), a method based on solution-focused psychology, can be used to help students overcome emotional or behavioral problems through learning relevant skills. By analyzing 23 case descriptions from KS practitioners, they identified four key components of the KS method critical for producing desired changes in children. They were: (1) helping students to identify specific social-emotional and/or self-management skills, so they learn to overcome their difficulties; (2) supporting students in learning their identified skills by helping them understand what the skill entails and become aware of their strengths and resources; (3) assisting students in acquiring their identified skills; and (4) reinforcing the learned skills to ensure sustainable effects.

In their article "Higher education to support sustainable development: The influence of information literacy and online learning process on Chinese postgraduates' innovation performance" [15], Chiyao Sun, Ji'an Liu, Liana Razmerita, Yanru Xu and Jia Qi probed how information literacy affects postgraduates' innovation performance. Based on Biggs' Presage–Process–Product model, they developed and verified several hypotheses by ana-

lyzing a survey of 501 Chinese university graduates. Based on their findings, the author argues that improving postgraduates' sustainable-development capabilities in the digital age can foster an inclusive learning environment and high-quality learning outcomes.

2.5. Global Perspective

In the article "Education for sustainable development in higher education rankings: Challenges and opportunities for developing internationally comparable indicators" [16], Anete Veidemane approaches the sustainability issue from a broad international perspective. She discusses the ranking of higher education institutions according to how successful they are in embedding sustainable development principles into their teaching. With this study, she contributes to the discussion on both how to identify criteria for ESD indicators and how to use them in international rankings. She also critically states that it is not enough to simply see these criteria as useful, but potential users of the indicators also need to consider "for what purpose are indicators relevant?" and "for whom are these indicators relevant?" (p. 20).

In their article "Bridging academics' roles in knowledge diffusion in sustainability-driven public–private partnerships: A case study of the SDGs workshop in central Japan" [17], Hoe Chin Goi, Muhammad Mohsin Hakeem, and Frendy offer insight from a case study. This study focuses on the role of academics in knowledge diffusion in a Japanese sustainability-oriented workshop including several stakeholders. Their results highlight the challenge of finding knowledge gaps, fostering effective communication, enabling knowledge extension, and creating shared values. The study reveals the role of academics in collaborative sustainability-related settings and in bringing fundamental knowledge to academic institutions, industry partners, and policymakers. Expectantly, this knowledge can support the development of sustainability-based regional development.

3. Concluding Remarks

This Special Issue contributes to varying aspects of research on education and SDGs by posing new research inquiries, taking stock of current research knowledge and providing fresh empirical findings. In addition, interesting theoretical issues are discussed. Aggregately, the published articles show that education and the SDGs compose a broad research field requiring multidisciplinary approaches and deeper investigations in diverse empirical settings. In our role as the Special Issue's guest editors, we are grateful to all the contributors, and we expect more education scholars and researchers in other related fields to explore this research area. Finally, we acknowledge the support of the Finnish project of the Global Innovation Network for Teaching and Learning (GINTL) for the 6th JoLii conference and the Special Issue.

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Article

Factors Impacting the Sustainable Development of Professional Learning Communities in Interdisciplinary Subjects in Chinese K-12 Schools: A Case Study

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Abstract: Professional learning communities are recognized as one of the most effective approaches for promoting the professional development of teachers. In the current complex and rapidly changing era, to facilitate the implementation of interdisciplinary curricula, Chinese schools have made tremendous efforts to enhance teacher professional development, particularly by establishing professional learning communities. Aiming to understand the operation of professional learning communities in interdisciplinary subjects in Chinese K-12 schools and to examine factors impacting the sustainable development of these professional learning communities, we conducted a case study on professional learning communities in the interdisciplinary subject of Education for International Understanding in Chengdu Horsens Primary School. As part of this study, we interviewed the principal, course director, seed teachers and teachers participating in the selected case. The research results demonstrated that the major factors impacting the sustainable development of professional learning communities in interdisciplinary subjects in Chinese K-12 schools include school structures and policies, school leadership, teachers' professionalism and learning capacity and their sense of community. In addition, compared to traditional subject-based professional learning communities in China, professional learning communities in interdisciplinary subjects highlight a sense of community, which presents three distinctive features: a conflict-inclusive atmosphere, the coexistence of individual and shared visions and an emotional bonding identity. These three features also have a considerable impact on the sustainable development of professional learning communities in interdisciplinary subjects in Chinese K-12 schools.

Keywords: professional learning communities in interdisciplinary subjects; teachers' professional development; teacher learning; sustainable development; China

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1. Introduction

Teachers are one of the most influential and powerful forces for promoting educational equity and high-quality educational development. They are also one of the key factors in advancing sustainable development. In Sustainable Development Goal 4, which aims to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all", the United Nations states that one of its targets is to "increase the supply of qualified teachers in developing countries" [1]. Likewise, the United Nations Educational, Scientific and Cultural Organization has made the supply of well-trained, supported and qualified teachers one of its top priorities [2]. Nowadays, learning has been widely recognized as an indispensable approach for improving teacher quality and promoting teacher professional development. According to Andreas Schleicher [3], Director for the Directorate of Education and Skills at the Organisation for Economic Co-operation and Development, in the globalized era and the knowledge-based economy, approaches for promoting teacher learning have undergone radical changes with the conceptual shift from individual learning to professional community learning [4]. In the last three decades, professional learning

communities (hereafter PLCs) have been developed as one of the most effective approaches for promoting teacher professional development. By improving peer-to-peer communication, facilitating collaborative learning and building shared responsibilities, PLCs have a systematic and positive impact on teacher professional development [5].

1.1. Literature Review

Our literature review revealed that educational researchers have examined several issues related to PLCs, which can be roughly classified into two categories. The first category is the definition, attributes and functions of PLCs. PLCs are defined differently due to the varying social, cultural and educational backgrounds in different countries [6]. The most prevalent definition of PLCs is that proposed by Hord [5], who describes the PLC as a professional community of learners in which the teachers in a school, along with its administrators, continuously seek and share learning, as well as acting on their learning. The goal of their actions is to enhance their effectiveness as professionals for the benefit of students. Regarding the attributes of PLCs, Hord and Sommers [7] identify PLCs as having five characteristics: shared values, visions and goals, collective learning and application, shared individual practice, shared and supportive leadership and supportive conditions. Studies on the functions of PLCs highlight that well-established PLCs can help teachers increase disciplinary knowledge, enhance teaching skills and develop professional identity [8–10]. The second category includes the factors contributing to the operation of PLCs. For example, according to Hord et al. [11], teachers' availability is a key factor in ensuring the regular organization of PLCs. Mulford [12] and Robison et al. [13] identify that PLC leadership is essential for the effective implementation of PLC activities. Hall and Hord [14] argue that supportive policies outside the schools are also important for the organization of PLCs.

PLCs also exist in China, although there are some variations in their naming and implementation. The PLCs organized for teachers in Chinese K-12 schools are called *jiaoyanzu* (Teacher Research Groups in English, hereafter TRGs). Rooted in China's collectivist culture, which emphasizes harmony, authority and unity [15], TRGs have distinctive Chinese characteristics in terms of their organization and function. In terms of organization, they are grassroots teaching research units that are established according to the different subjects in schools [16]. With regard to function, TRGs focus on "teaching", whereas PLCs in Western countries are more concerned with "learning" [16]. Despite their distinctive Chinese characteristics, TRGs have many similarities to PLCs in Western countries [17]. For example, they both emphasize the importance of shared vision, collective responsibility for improving student learning outcomes and collaborative culture among teachers [18]. Similar to PLCs in form, TRG activities involve joint lesson planning, sharing of materials and ideas, peer observation and mentoring, collective interrogation of open lessons and conducting collaborative research [16,19,20]; in function, TRGs contribute significantly to teacher learning and professional development [21], while serving as a crucial platform for teachers to collaborate with each other to tackle the common problems encountered in classroom teaching [22,23]. Therefore, TRGs are regarded as the Chinese model of PLCs. When Shanghai topped the Programme for International Student Assessment, many scholars attributed its success to the implementation of TRGs in China. The Chinese model of PLCs, represented by TRGs, has thus been attracting increasing attention from international scholars. A brief literature review on the Chinese model of PLCs revealed that the existing research focuses on their historical development [24], organizational form [25] and function with respect to teacher professional development [26]. Overall, previous studies of the operation of PLCs have primarily been conducted in Western countries, whereas those in the Chinese context are limited [24]. Moreover, research on PLCs in the Chinese context is often based on single subjects, as PLCs have traditionally been established according to the different subjects in schools [27–29].

1.2. The Chinese Context

Over the past few decades, educational philosophy has undergone a radical change around the world, shifting from disciplinary learning to interdisciplinary learning [30]. Accordingly, enhancing students' interdisciplinary competences to succeed in an uncertain and constantly changing era has become the primary mission of schools, colleges and universities worldwide. In response to this challenge, in 2014, the Ministry of Education of China issued Opinions on Comprehensively Deepening Curriculum Reform and Implementing the Fundamental Tasks of Moral Education, highlighting the importance of interdisciplinary cooperation [31]. In 2019, the Central Committee of the Communist Party of China and the State Council of China released China's Education Modernization Plan Towards 2035 to guide the education development in the country. According to this plan, the Chinese government will "promote the interdisciplinary integration in primary and secondary schools and explore the development of interdisciplinary curricula focusing on cultivating students' comprehensive quality" [32]. To facilitate the development of interdisciplinary curricula and enhance teachers' capacity to deliver interdisciplinary curricula, Chinese K-12 schools have been enthusiastic about establishing PLCs in interdisciplinary subjects.

Although many PLCs in interdisciplinary subjects have been established in China, only a few articles have been published about them. These articles illustrate what PLCs in interdisciplinary subjects are in the Chinese context and how PLCs in interdisciplinary subjects benefit teacher professional development in China. According to Chen [33], PLCs in interdisciplinary subjects in China refer to teaching and research teams composed of teachers from different subjects and grades. Tang [34] and Zhao and Chen [35] reveal that PLCs in interdisciplinary subjects provide support for cooperation between teachers from different subjects, broaden teachers' horizons and improve the development of professional learning. It is notable that all these articles are written in Chinese and are inaccessible to the wider international research community. Moreover, little has been mentioned about the factors impacting the sustainable operation of the PLCs in interdisciplinary subjects, although this emerging model of PLCs is considered to be an important platform for teacher professional development in China. Questions such as what factors impact the sustainable development of PLCs in interdisciplinary subjects, how they promote teacher professional development and what the differences in factors impacting PLCs in interdisciplinary subjects are, as well as those impacting the traditional subject based PLCs, remain unanswered. In this context, to fill this research gap, we attempt to answer the following research questions in this study: (1) What factors are impacting the sustainable development of PLCs in interdisciplinary subjects in Chinese K-12 Schools? (2) How are the factors impacting the development of PLCs in interdisciplinary subjects different from those impacting the development of traditional subject-based PLCs? By answering these two research questions, we can understand the systematic and positive effect of PLCs in interdisciplinary subjects on teacher professional development, which further influences student achievement and school improvement.

The paper is organized as follows. It starts with a description of the analytical framework and then sets out the research methodology. The research findings are subsequently presented and discussed on the basis of the data collected. The conclusion summarizes the significance of this study and provides directions for future research.

2. Analytical Framework

This study adopted the Global PLC conceptual framework as the analytical framework. The Global PLC conceptual framework was constructed by a research team led by Huffman [36] on the basis of Senge's [37] five disciplines of learning organizations and Hord's [5] model of PLCs. In the 1970s, in the face of the fiercely competitive market, the concept of "organizational learning" [38] was introduced to describe a situation wherein companies could only maintain their competitive advantage through continuous learning. As the pioneer of research on organizational learning, the Massachusetts Institute of Tech-

nology established the Center for Organizational Learning in 1990. While working at the Centre for Organizational Learning, Senge developed five disciplines of learning organizations: systems thinking, personal mastery, mental models, building a shared vision and team learning [37]. Later, Hord, an educational researcher working on school leadership and school improvement, had the opportunity to work in a "learning organization" to investigate how a school improved through PLC activities. Inspired by Senge's five disciplines of learning organizations, in 1997, Hord [5] proposed a model of PLCs in education, which was composed of shared values, vision and goals, collective learning and application, shared individual practice, shared and supportive leadership and supportive conditions. Hord argued that this model could contribute to school improvement and education reform. Since it was proposed, Hord's model of PLCs has been very well received by educational researchers in the Western world and has been validated and revised to adapt it to different cultural contexts.

Based on Hord's model of PLCs, Huffman et al. [36] developed the Global PLC conceptual framework in 2009 by conducting a literature review of PLC actions in schools in mainland China, Hong Kong, Taiwan, Singapore and the United States and interviewing principals and teachers in these five countries and regions. Having noticed common practices among school improvement initiatives, Huffman and her colleagues identified five constructs impacting PLC actions: organizational structure, policies and procedures; leadership; professionalism; learning capacity; and sense of community. Organization structures, policies and procedures are considered to be structures which constitute an important form of support for teacher learning in PLCs. The other four constructs are considered as actions and refer to behaviors, relationships and interactions among teachers. Leadership can be considered to be both a structure and an action within schools. These five constructs are considered as important internal factors for teachers in carrying out PLC actions, but given the cultural contexts of different countries and regions, external factors, such as the central office, state/province/city and parents/family, have also been identified as influencing PLC actions [36].

The first construct, organizational structures, policies and procedures, provides supportive conditions in the development of PLCs. The key descriptors include time, scheduling, space, staffing, funding, equipment/technology, policies at the national, local and school levels and monitoring and assessment practices that impact PLC development. The second construct is leadership, which refers to the key strategies school leaders adopt to model, facilitate, develop responsibility for and foster shared values, visions and decision making among teachers in the school. The key descriptors of this construct are modeling learning practices, facilitating learning for all, sharing a vision, broad-based decision making, moral purpose and responsibility. The third construct is professionalism, which represents actions related to excellence in which teachers act responsibly and are committed to colleagues and students, to adopting best practices and to demonstrating ethical behavior and good judgment. The key descriptors involve teachers' commitment, identity, ethics, professional judgement and self-efficacy. The fourth construct is learning capacity, which emphasizes teachers' openness and capacity to learn new strategies, to use data and to adjust to changes in practice. The key descriptors include teachers' openness to learn collaboratively, their ability to learn through collective inquiry, to use multiple sources of data, to give supportive feedback to colleagues, to reflect on their colleagues' feedback, to improve teaching styles and collective efficacy. The fifth construct is the sense of community, which refers to a school culture and atmosphere focusing on the relational aspect of the community to ensure high levels of learning for teachers and students. The key descriptors cover shared values and norms, mutual trust and respect, collegial influence, group membership, emotional bonding and recognition and celebration.

The Global PLC conceptual framework identifies several factors impacting PLC actions in five countries and regions with different cultural backgrounds. The identified factors provide essential support for the sustainable development of PLC actions. Therefore, this study will adopt the Global PLC conceptual framework to explore the factors impacting

the sustainable development of PLCs in interdisciplinary subjects such as Education for International Understanding in Chinese K-12 schools. The empirical investigation will test this conceptual framework's applicability in PLCs in interdisciplinary subjects and modify it if needed.

3. Research Methodology

To obtain an in-depth understanding of the factors impacting the sustainable development of PLCs in interdisciplinary subjects in Chinese K-12 schools, this study used the Global PLCs conceptual framework proposed by Huffman et al. [36] as the analytical framework and adopted a case study as the research methodology. According to Yin [39], a case study should be performed when the research purpose is to "investigate a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident". In this section, we give a brief introduction of the selected case and the data collection, analysis and validation procedures.

3.1. Case Selection

This study selected Chengdu Horsens Primary School as the case. Chengdu Horsens Primary School is a public elementary school founded by the Chengdu Government in China in cooperation with the Government of Horsens in Denmark in 2018. It is a member of Chengdu's Education for International Understanding (hereafter EIU) Studio. The subject of EIU in Chengdu Horsens Primary School is mainly composed of interdisciplinary knowledge aiming to promote cross-cultural exchange and the understanding of different countries and is complemented by other subjects and theme activities infused with relevant knowledge and skills. The interdisciplinary EIU subject in this school is run for students at all grade levels and is taught by both full-time EIU teachers and English teachers. Teachers of other subjects, such as Chinese, Mathematics and Fine Arts, are encouraged to infuse knowledge on international understanding into their subjects and to offer inquiry-based theme activities. Moreover, the principal has established the EIU Curriculum Studio to promote curriculum development and teacher training in this school and beyond. To engage more teachers in the curriculum development of EIU, Chengdu Horsens Primary School has established the "1 + 3 + N" PLC model, which is characterized by interdisciplinarity. In this model, 1 refers to a seed teacher responsible for the development of each EIU course; 3 represents three teachers of any subject, such as Chinese, English, mathematics, fine arts, physical education and moral education; and N is any teacher who is willing to participate in the curriculum development. The one seed teacher and three teachers of any subject are key members of the PLCs. The PLC model implemented in Chengdu Horsens Primary School is designed to stimulate teachers to demonstrate their teaching in PLCs and therefore facilitate the curriculum development of EIU. As of now, this school has established six "1 + 3 + N" PLCs.

The reason for selecting Chengdu Horsens Elementary School's PLCs in EIU as the case is because this school has developed an exemplary PLC model in interdisciplinary subjects. Through participating in the PLC activities, teachers of other subjects accumulate plenty of knowledge and experience in the curriculum development and teaching practices of EIU. They also improve their interdisciplinary competences and enhance their teaching capacity in their own subjects. Therefore, Chengdu Horsens Elementary School's experiences are worth exploration and dissemination.

3.2. Data Collection

As part of this study, semi-structured interviews were conducted to explore factors impacting the sustainable development of PLCs in interdisciplinary subjects in Chinese K-12 schools. In total, we recruited one principal, one course director, five seed teachers and 13 teachers involved in the PLCs to participate in this study. Table 1 presents the profile of the participants and our coding system. Participants in different positions were interviewed in order to be able to draw a complete picture of how PLCs in EIU operate in Chengdu

Horsens Elementary School. Our interview questions mainly involved three aspects. The first set of questions was asked to obtain the participants' background information, such as their motivation in teaching EIU and basic information on the course they were teaching. The second set of questions was designed according to the Global PLC conceptual framework constructed by Huffman and her colleagues. The questions focused on the five constructs of organizational structure, policies and procedures; leadership; professionalism; learning capacity; and sense of community. The third set of questions was proposed in order to understand the similarities and differences between PLCs in EIU and PLCs in other subjects. Examples of the interview questions are presented below.

- What is your motivation for teaching for EIU? Please introduce basic information on the course you are teaching.
- What do you think are the main factors impacting the implementation of PLC activities for the subject of EIU in your school? (Hints: time, space, staffing, funding, equipment and other resources).
- What learning capacities do you think are essential for facilitating PLC activities in EIU? (Hints: openness to learn collaboratively, ability to inquire collectively, ability to use multiple sources of data, ability to provide feedback, ability to reflect on and change practices and sense of collective efficacy).
- What are the similarities and differences between PLCs in EIU and PLCs in other subjects?
- How have the PLC activities in EIU changed your teaching of the subject and of your own subject (Chinese, English, Mathematics, etc.)?

Table 1. Numbers and coding system of participants by position.

Positions in the Case School	Number of Interviewees	Coding System
Principal	1	A1
Administrator	1	B1
Seed teacher of the PLCs *	5	C1–C5
Teacher participating in the PLCs **	13	D1–D13
Total	20	

* Seed teachers of the PLCs are composed of two full-time EIU teachers and three teachers teaching the subjects of Chinese, English and Fine Arts. ** Teachers included one teacher of Chinese, one teacher of Physical Education, one teacher of Moral Education, two teachers of Mathematics, two teachers of Fine Arts and three teachers of English.

In addition to the questions listed above, the interviewer also asked some follow-up questions wherever appropriate. For example, when the participants mentioned that the PLCs in EIU had a positive impact on their teaching in their own subject, the interviewer asked about the specific aspects of the positive impact. The interviews were conducted individually. Each interview lasted about 40 min and was recorded. We also observed the operation of the PLCs in EIU and recorded the teachers' emotional responses and body language while participating in the PLC activities. The observations were performed three times for a total of 10 h. Additionally, we collected teachers' journal entries about their teaching reflections.

3.3. Analysis and Validation

Upon data collection, the first author and the third author transcribed the data and conducted a thematic analysis by following Braun and Clarke's [40] six-phase guide. The themes were identified through a combination of inductive and deductive approaches. The preliminary coding scheme was first designed through a deductive approach according to the Global PLC conceptual framework. The five constructs in the Global PLC conceptual framework, i.e., organizational structure, policies and procedures, leadership, professionalism, learning capacity and sense of community, were identified as parent nodes. The key descriptors in each of the five constructs, such as group membership, collegial influ-

ence and emotional bonding in the construct of sense of community, were coded as child nodes. Later, the first author and the third author revised the preliminary coding scheme through an inductive approach. They repeatedly read the transcriptions and formulated a formal coding scheme based on the data collected (see details in Figure 1). For example, when constructing the Global PLC conceptual framework, Huffman et al. [36] identified professionalism and learning capacity as two separate constructs. According to their interpretation, professionalism is concerned with teachers' professional competence, whereas learning capacity stresses teachers' lifelong learning and self-improvement. In this study, however, the first author and the third author found it difficult to distinguish these two constructs, so they put them together in one parent node in the data analysis process.

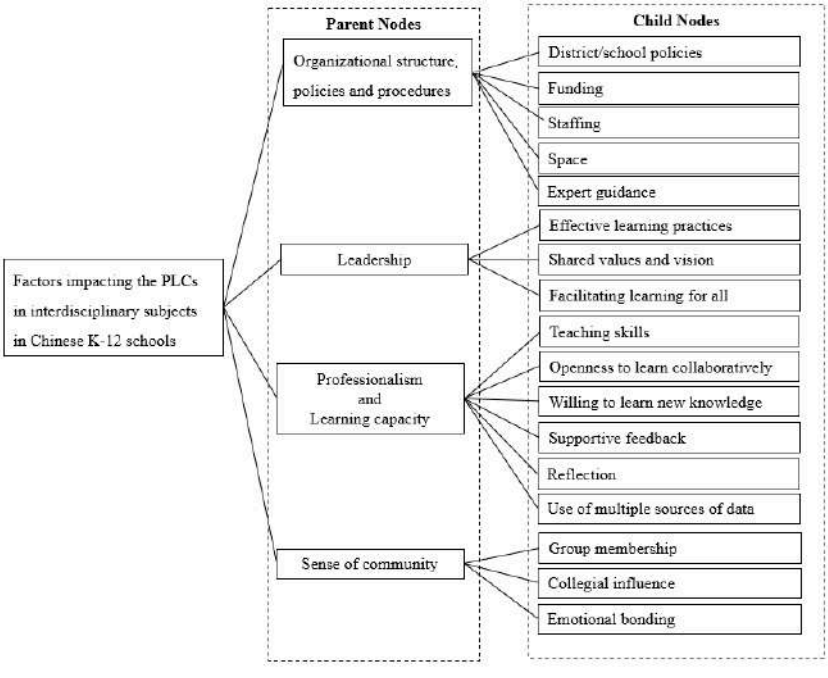

Figure 1. The coding scheme of factors impacting the sustainable development of PLCs in interdisciplinary subjects in Chinese K-12 schools.

After the formal coding scheme was formulated, the first author and the third author coded the data independently in a qualitative data analysis software tool N-vivo 12.0. When all the transcriptions had been coded, they conducted a coding comparison query in NVivo to assess the inter-rater reliability. The Kappa coefficient across all nodes was reported to be 0.76, indicating a substantial agreement between the two authors. In the end, the two authors discussed the disagreements and revised the discrepancy codes until consensus was reached. To examine the validity and reliability of the coding, the first author and the third author triangulated the data collected from different participants and from different data sources to ensure that they did not conflict with each other. In addition, the paper was shared with interviewees to allow them to clarify or change the data interpretations.

4. Results

In this section, we present our analysis of the factors impacting the sustainable development of PLCs in interdisciplinary subjects in Chinese K-12 schools. Our analysis was guided by the Global PLC conceptual framework. Since both professionalism and learning

capacity in the Global PLC conceptual framework point to teacher capacity development and they cannot be completely differentiated, we present them together below.

4.1. Organizational Structure, Policies and Procedures

The interviews demonstrate that the PLCs in EIU in Chengdu Horsens Primary School have been strongly supported by the local government and the school. In 2019, the Education Development Centre of Chengdu High-Tech Industrial Development Zone (hereafter the Zone), where Chengdu Horsens Primary School is located, signed a cooperative agreement with a university in Beijing to develop the project "Joint Construction of National Demonstration Pilot Zone for the Internationalization of Basic Education". As a part of this project, the Zone selected several pilot schools within the jurisdiction to offer the interdisciplinary subject of EIU. Chengdu Horsens Primary School was selected as a pilot school in 2020 and has received consistent support from the Zone and the school in funding, staffing, space and expert guidance since then. These supports provide a solid foundation for the sustainable development of the PLCs.

> *The Chengdu High-Tech Industrial Development Zone has provided strong support for the pilot schools. Our school has not only received generous funding from the Zone to establish the PLCs in EIU, to develop EIU curriculum and to construct relevant facilities, but also received guidance from experts in Beijing. Through the cooperation with a university in Beijing, the Zone invites educational experts to provide guidance to each pilot school, including providing advice on the PLCs' organization.* (A1)

Thanks to the policy and funding support from the Zone and the school, PLCs in EIU were very quickly established in Chengdu Horsens Primary School. Unlike the traditional subject-based PLCs in China, which are composed of teachers in the same grade and the same subject [18], PLCs in EIU prioritize interdisciplinarity. Chengdu Horsens Primary School has thus established the "1 + 3 + N" PLC model, engaging teachers from many different subjects. This new PLC model provides institutional support for teachers to exchange experiences and promote mutual learning in EIU. These PLCs are nonmandatory and open to every teacher in the school.

> *Each semester, the school establishes three PLCs in EIU, composed of both designated teachers and voluntary teachers. Teachers are also encouraged to establish PLCs by themselves and to submit lesson plans for the school to select.* (B1)

In addition to the support in policy, funding, staffing and expert guidance, Chengdu Horsens Primary School provides a meeting room for PLCs in EIU, ensuring that the teachers have the space to discuss and learn in groups.

> *Our school has built a meeting room specialized for the PLCs in EIU and built a cultural wall in the room to promote EIU. EIU has been identified as a featured subject in our school, so we can apply for funding for this subject more easily. Our group usually meets once a week to develop the curriculum. But we meet more often when there is a teaching competition on EIU at the school or the Zone level. The number of our meeting also increases when experts from the university in Beijing come to provide guidance.* (C1)

4.2. Leadership

Leadership is crucial to the successful implementation of a school project [41]. In the Global PLC conceptual framework, leadership is considered to be both a structure and an action [36]. Resonating with this argument, the principal of Chengdu Horsens Primary School is both an important leader and a significant actor in the PLCs in EIU. The principal has not only been leading the development of EIU, including the operation of PLCs, but has also been working as a full-time EIU teacher in the school. Owing to her previous work experience in foreign exchange and cooperation in basic education in government, she prioritized the cultivation of students' cross-cultural competence and encouraged teachers to participate in PLCs in EIU.

> *We were anticipating the outlook of the school when it was founded. Considering the long-lasting cooperation between Chengdu and Horsens, we decided to connect the international resources of both cities and develop the curriculum for EIU. Before heading this school, I worked at the Department of Education on foreign exchange and cooperation for a long period. The previous work experience cultivated in me a keen sense of internationalization. Once the school was founded, we applied for the EIU program launched by the Chengdu High-Tech Industrial Development Zone in cooperation with a university in Beijing, but we failed to be included in the first batch of the pilot schools due to an insufficient number of teachers and students. Fortunately, we participated in the construction of the first batch of pilot schools as an observer and were selected as part of the second batch of polit schools a year later.* (A1)

The principal's focus on the PLCs in EIU has impacted every teacher in Chengdu Horsens Primary School. Her impact has been mainly exerted in three ways. First, the principal established the "1 + 3 + N" PLC model to stimulate teachers' interests in teaching the interdisciplinary of EIU and provide a platform for effective learning practices. Second, the principal developed the EIU database together with colleagues to offer teaching materials in EIU, so that other teachers participating in the PLCs are able to update and expand the database. In this way, she has helped construct the school culture promoting EIU and established shared values and vision among teachers. Third, the principal established an EIU Curriculum Studio, which, as a form of PLC, provides a platform for exchanges and mutual learning to teachers in the school and beyond, thus facilitating teachers' learning.

> *In PLC activities, the most important things for us are to polish the lesson plans and develop the teaching materials. The school has built an EIU database, which includes teaching materials developed by three full-time EIU teachers in our school. As a growing number of teachers become involved in the PLCs in EIU, the teachers can improve their courses on the basis of the teaching materials provided in the EIU database. They can also upload their courses to provide teaching materials to other teachers. In addition, many teachers have developed new EIU courses and PLC activities and uploaded them to this database for other teachers in this school to learn from and improve.* (D5)

> *The studio has a three-year plan. The task for the first year, which is 2021, is to complete the organization of the studio and formulate relevant regulations. The studio has 29 teachers, including 18 from the Zone and 11 from outside the Zone and this number is expected to increase in the coming years. In the second year, we will strengthen the training of EIU teachers, attempting to promote the development of EIU in other schools. In the third year, we will promote our EIU curricula in rural schools.* (A1)

4.3. Professionalism and Learning Capacity

When constructing the Global PLC conceptual framework, Huffman et al. [36] identified professionalism and learning capacity as two constructs. According to their interpretation, professionalism is concerned with teachers' professional competence, whereas learning capacity stresses teachers' lifelong learning and self-improvement. This study finds it difficult to distinguish these two constructs, so we present findings related to them together in this subsection. The interviews demonstrate that, compared to traditional subjects, the interdisciplinary subject of EIU sets higher requirements on teachers, requiring them to be open, collaborative and reflective, to have interdisciplinary competences, to have the willingness and ability to learn new knowledge and to be able to improve their teaching based on their colleagues' feedback. Since EIU is an emerging subject in China, there is no programs or schools specialized for the cultivation and training of EIU teachers. Currently, teachers teaching EIU courses in China are those teaching traditional subjects such as Chinese, English and Mathematics. During the interviews, the participants repeatedly mentioned the criteria for selecting EIU teachers. First, the teachers should possess proficient teaching skills.

> *We pay particular attention to teaching skills when selecting teachers for the subject of EIU. We find that teachers with proficient teaching skills in their own subjects are likely to teach EIU with ease.* (B1)

Second, the teachers must have interdisciplinary competences and openness to learn collaboratively. EIU is not confined to a single subject, so the teachers' ability to integrate different subjects is essential. The PLCs in EIU provide teachers in different subjects with a unique platform to develop interdisciplinary competences, while strengthening their self-motivation and inspiring their self-development.

> *After quitting my job as an English teacher, I started to teach EIU for Grade Three as a full-time EIU teacher in this school. In one EIU course, to share the understanding of death, I compared the Day of the Dead in the West with the Qingming Festival in China. When preparing for the course, I encountered trouble in finding features about the Qingming Festival. Fortunately, the teacher in the subject of Chinese in our PLC did me a favor and helped me find relevant materials.* (C3)

> *I am an English teacher and I am used to teaching in English, so it is really hard for me to make EIU students understand the teaching contents in concise Chinese words. The teacher in the subject of Chinese in our PLC observed my classroom teaching several times and helped me improve the teaching language.* (C4)

Third, the teachers should be willing to develop new knowledge, to be reflective and to break their own boundaries. Teachers' teaching quality is closely related to the update of teaching materials, their teaching research and reflections on teaching feedback. As previously mentioned, there are no well-developed teaching materials for EIU. Hence, the teachers in PLCs in Chengdu Horsens Primary School should be more capable of the teaching material preparation than those in traditional subject-based PLCs.

> *I have taught the subject of Chinese for six years and get tired of delivering the same teaching content every day. My enthusiasm for teaching was ignited when I started to participate in PLC in EIU, as I was exposed to different ideas by working with teachers from different subjects. Moreover, my experience in PLC in EIU has positively impacted my teaching in the subject of Chinese. When teaching Chinese, I try to integrate international elements into my class in order to enhance students' international understanding.* (C5)

> *We have attended many conferences on EIU at the Zone, district and national levels. The EIU teaching demonstrated by experts and teachers outside our school provides excellent materials for our curriculum. After joining in the PLC in EIU, I started to collect teaching materials related to EIU, particularly through Weibo, WeChat, the Red Book and shared them with other teachers at the PLC activities. We subsequently integrated them into the teaching materials.* (C2)

4.4. Sense of Community

A sense of community, which is highly dependent on the school's culture and climate, provides a supportive condition for teacher professional development [36]. The interviews reveal that the sense of community in PLCs in EIU in Chengdu Horsens Primary School mainly consists of three components: group membership, collegial influence and emotional bonding. Group membership is the basic unit of a community. Members in the same community share common goals, comply with common requirements and gradually develop a sense of belonging and security while interacting at the PLCs. The participants emphasized that "as the number of PLCs in EIU continues to grow, teachers' sense of community also grows" (D2 and D4). From this quotation, we can find that PLCs and teachers participating in PLCs influence each other. The teachers' improvement in PLC activities can increase the PLCs' cohesion and, in turn, PLCs with greater cohesion and influence can attract more teachers to get involved.

> *I joined the PLC in EIU because my colleagues had participated in it. The PLCs made up of teachers from different subjects have enabled me to find out about other teachers'*

> *perspectives. Additionally, teachers in the PLCs are highly motivated, as evidenced by the fact that they would like to attend PLC activities after finishing classes and handling routine work. I see their real passion for EIU. Now, I am planning to apply for one EIU course next semester to improve my teaching skills.* (D5)

The shared experiences (A1), shared time (C4), shared gains (C5) and good relationships among teachers constitute the unique emotional bonding in the PLCs and shape the collective identity of teachers participating in them. Since nobody has any teaching experiences in the interdisciplinary subject of EIU, there is no distinction between novice and veteran teachers in this subject. Therefore, PLCs in EIU create a more equal atmosphere than those in traditional subjects.

> *In the PLC activities of traditional subjects, we are afraid to speak out our ideas because of the presence of veteran teachers. Yet in PLC activities in EIU, no one has the authority, so the teachers feel free to express their opinions. In this atmosphere, we are able to communicate and brainstorm on an equal basis.* (C4)

5. Discussion

By adopting the Global PLC conceptual framework as the analytical framework, this study identified factors impacting the sustainable development of PLCs in interdisciplinary subjects in Chinese K-12 schools. On the basis of the research results, it can be found that PLCs in interdisciplinary subjects, which are significantly different from PLCs in traditional subjects, offer an excellent platform for teachers in different subjects to collaborate with each other. They can more effectively improve teachers' self-efficacy, foster teachers' emotional bonding and promote teacher professional development. The Global PLC conceptual framework constructed by Huffman et al. [36] is validated in this study, proving that school structures and policies, school leadership, teachers' professionalism and learning capacity and their sense of community are major factors impacting the sustainable development of PLCs in interdisciplinary subjects in Chinese K-12 schools.

First, well-developed school structures and policies provide institutional support for the operation of PLCs in EIU in Chengdu Horsens Primary School. As of now, the curriculum development of EIU has received strong support from the local government and the school. The school, as the major force promoting EIU, has adopted various strategies to facilitate the operation of PLCs in EIU, such as providing funding and space for PLC activities, inviting university experts to provide guidance for PLCs, establishing an online database for resource sharing and fostering the cultural construction on international understanding. This finding confirms Hord's [5] argument that schools' supportive conditions provide the facilities and necessities of when, where and how the staff can come together as a unit to learn, make decisions and carry out new practices.

Second, the principal of Chengdu Horsens Primary School has played a leading role in the PLC activities in EIU. Good leaders can develop visions for their schools according to their personal and professional values. They tend to seize every opportunity to express their goals and visions and thus influence their teachers and other stakeholders. Normally, their schools' educational philosophy, organizational structures and activities are also developed on the basis of their visions [42]. In this study, by prioritizing the interdisciplinary subject of EIU in the school, the principal of Chengdu Horsens Primary School has promoted the operation of PLCs in EIU. Moreover, she has built an EIU Curriculum Studio for teachers in the school and beyond to promote information exchange on EIU.

Third, the subject of EIU requires teachers to have proficient teaching skills and have the ability to integrate different subjects, to learn new knowledge and to reflect on their own teaching. Among these requirements, proficient teaching skills are most critical for becoming a qualified EIU teacher. Moreover, teachers need to have the ability to integrate knowledge from different subjects. In contrast with traditional subjects, the interdisciplinary subject of EIU requires teachers to mobilize knowledge from different subjects and to communicate with and learn from teachers in other subjects. In addition, they need to break down the boundaries between different subjects, foster new knowledge

and reflect on the feedback offered by their colleagues, with the aim of promoting their professional development.

Fourth, with the growing number of teachers participating in PLCs in EIU, their communication and mutual influence may also increase, contributing to the construction of the sense of community. The community culture of PLCs in EIU is characterized by a high degree of openness and equality. Compared to the traditional subject-based PLCs, PLCs in EIUs are nonmandatory. Due to the institutional support and the peer influence among teachers, PLCs in EIU grow very fast, leading to the formation of a school culture promoting the development of EIU. In addition, since every teacher teaching the subject of EIU is a novice, there is no "authority" in the PLCs. Hence, the teachers can trust each other and are able to share their experiences more equally.

In addition, this study identified three differences between PLCs in interdisciplinary subjects and those in traditional subjects. The first difference is that PLCs in interdisciplinary subjects place more emphasis on a collaborative atmosphere inclusive of both harmony and conflict. Lauer and Dean [43] reveal that mutual support and cooperation among teachers is indispensable in the operation of PLCs. Therefore, a harmonious and cooperative atmosphere plays an important role in the sustainable development of PLCs. In practice, a harmonious atmosphere in PLCs is indeed crucial for promoting teacher professional development. However, an excessive pursuit of harmony in the community may lead to teachers' reluctance to challenge authority, reduce their passion for innovation and decrease their ability to make changes, which in turn inhibits the sustainable development of PLCs [27]. In traditional subject-based PLCs, teachers pursue harmonious relationships with their colleagues and are unwilling to challenge more authoritative members. They tend to avoid conflicts and confrontations, which makes critical discussions difficult. Therefore, many problems cannot be easily resolved [18]. In this case, different opinions and teaching methods are also suppressed [44], making teacher professional development hard to achieve. However, in interdisciplinary PLCs, teachers come from different subjects and different grades. There are no authorities in such PLCs. Hence, they do not need to worry about violating the authorities or hurting relationships with other colleagues. Although the teachers participating in PLCs in EIU have conflicting opinions, they are not afraid to share different opinions. They believe that these conflicts enable them to achieve continuous improvement. The exchange of opinions and the conflicts in PLC activities empower them to achieve professional development. After all, conflicts are also crucial in social interactions [45]. On the basis of the research results, it turns out that a cooperative atmosphere in which harmony and conflict coexist is more conducive to the effective operation of PLCs in interdisciplinary subjects.

Second, PLCs in interdisciplinary subjects are dedicated to pursuing the coexistence of individual visions and shared visions rather than only pursuing the shared vision of the community. One characteristic of PLCs is that they have shared values, visions and goals [46]. While engaging in PLCs, teachers are influenced by the values, norms and practices prevailing in the PLCs and thus develop a shared vision [47]. In traditional subject-based PLCs, most teachers focus on the shared vision while neglecting their individual visions. However, it has been recognized that placing individual visions under the shared vision is a potential "danger" for PLCs' sustainable development [47]. When community members hide their true feelings, their motivation to achieve the shared vision will greatly decrease. In addition, they may not proactively pursue progress and growth within the community. In this case, they have to hide their real feelings, which may decrease their motivation to pursue improvement [48]. In Chengdu Horsens Primary School, since the teachers participating in PLCs in EIU have different subject backgrounds, their roles in PLCs are differentiated. The PLCs in EIU thus create a space where individual visions and shared visions can develop together. The PLCs in EIU in Chengdu Horsens Primary School are characterized by openness, as every teacher is allowed to apply to establish PLCs in EIU and the PLCs are open to every teacher in the school. Therefore, the shared visions of the PLCs in EIU are produced based on the continuous exchange and integration of

individual visions. The exchange and integration of individual visions inspire teachers to improve learning autonomy and teaching ability in their own subjects. Consequently, the professionalism of the teachers is enhanced and the sustainable development of PLCs is achieved.

Third, with institutional support from the local government and the school, PLCs in interdisciplinary subjects focus more on an emotional bonding identity. Institutional support provides the infrastructure and requirements of when, where and how the staff can come together as one unit to learn, make decisions and implement new practices [49]. This is necessary for the long-term development of PLCs, because PLCs built on personal relationships are not stable [50]. To avoid instability, many organizations offer institutional support for PLCs to maintain their sustainable development. Meanwhile, organizational leaders are willing to provide institutional support for teachers to collaborate with each other. In practice, institutional support can promote teacher professional development in the beginning of the PLCs' establishment. However, relying solely on institutional support while neglecting teachers' internal development needs will lead to the construction of PLCs becoming formalistic [51], particularly when the administrative interference in PLC activities is excessive. After all, some PLC activities are implemented to fulfill orders from the educational administration, rather than to promote teacher professional development [52]. In this regard, PLCs must strengthen their identity by creating emotional links. It is obvious that teachers participating in PLCs in Chengdu Horsens Primary School are able to fully express their feelings, communicate with each other and promote professional development together, thus forming tightly connected communities linked by emotions. These PLCs continue to expand and continue to pursue a more sustainable symbiotic environment by attracting more teachers to join them. From the above discussion, it can be inferred that the basis for promoting PLCs' sustainable development should be the identity relationship established by the emotional link [48].

In sum, this study argues that the five factors of organizational structure, policies and procedures, leadership, professionalism, learning capacity and sense of community can promote the sustainable development of PLCs in interdisciplinary subjects in Chinese K-12 schools. Compared to traditional subject-based PLCs, PLCs in interdisciplinary subjects particularly highlight the value of sense of community in their development process and present three distinctive features around this: a conflict-inclusive atmosphere, the coexistence of individual and shared visions and an emotional bonding identity. These three features have helped address the problems existing in traditional subject-based PLCs in Chinese K-12 schools to a certain extent. In the interdisciplinary PLCs, teachers' individual visions are respected and their motivations for self-growth and self-development are stimulated. Teachers are more proactive in participating in PLC activities and in communicating with teachers in other subjects, which is more conducive to promoting teacher professional development and to enhancing teaching quality.

6. Conclusions

Based on the empirical investigation of PLCs in EIU in Chengdu Horsens Primary School, this study explored the factors impacting the sustainable development of PLCs in interdisciplinary subjects in Chinese K-12 schools. These research results make significant contributions to the field of PLCs. On the one hand, this study confirms the influence of organizational structure, policies and procedures; leadership; professionalism; learning capacity; and sense of community on the sustainable development of PLCs in interdisciplinary subjects. On the other hand, this study distinguishes factors impacting the development of PLCs in interdisciplinary subjects from those impacting the development of the traditional subject-based PLCs in China. We highlight three differences, which include a conflict-inclusive atmosphere, the coexistence of individual and shared visions and an emotional bonding identity. These three distinctive features also contribute to the sustainable development of PLCs in interdisciplinary subjects in Chinese K-12 schools. It should be noted that PLCs are embedded in cultures [53]. Hence, the findings generated

in this study should not be directly transplanted to other cultural contexts. Nevertheless, the study of PLCs in interdisciplinary subjects in Chinese K-12 schools promotes the understanding of the operation of PLCs in China as most of the existing studies focus on the traditional subject-based PLCs in China. The study also provides implications on the implementation of the PLCs in interdisciplinary subjects for other K-12 schools in China and on the improvement of PLCs in other cultural contexts.

In addition, we are aware that this study has some limitations. The foremost is that it was a single case study and did not carry out ongoing research on the case's PLC activities. Therefore, we advise future scholars to conduct more research on the PLCs in interdisciplinary subjects in other Chinese K-12 schools and conduct a comparative study of the PLCs in interdisciplinary subjects in different regions of China with the aim of identifying their common characteristics. They are also advised to identify the factors that promote and hinder teacher professional development in PLCs in interdisciplinary subjects in Chinese K-12 schools. In addition, we advise future scholars to conduct ongoing research on other PLCs in interdisciplinary subjects in Chinese K-12 schools to explore their operation and relevant issues in order to further promote teacher professional development in China and across the world.

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A Sustainability Lens on the Paradox of Chinese Learners: Four Studies on Chinese Students' Learning Concepts under Li's "Virtue–Mind" Framework

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Abstract: The paradox of Chinese learners refers to a contrast between poor learning approaches and high achievement in China, which reveals a lack of sustainability in Chinese education. In addressing this paradox, Jin Li stood out by studying culture-based learning concepts and providing a comprehensive theoretical framework of the Eastern virtue model versus the Western mind model. However, this framework has not been thoroughly tested in the age of global cultural exchange, and the best learning model for learners has not been determined. This paper used both qualitative (replicating Li's word association test) and quantitative methods to retest and enrich Li's theory in present-day China, using four empirical studies. Studies 1 and 2 revealed the influence of global cultural exchange in narrowing the gap between the two models, with appropriate modifications made to Li's theory. Studies 3 and 4 demonstrated that both of the two models were conducive to students' academic achievement and creativity, greatly enriching Li's theory. The implications of achieving a dynamic balance between the virtue model and the mind model to improve the sustainability of Chinese student development are discussed, which contributes to achieving the United Nations' Sustainable Development Goals.

Keywords: paradox of Chinese learners; learning concept; virtue model; mind model; Confucian culture

1. Introduction

The Chinese education system, the largest education system in the world, has attracted much research attention, with many studies focusing on the paradox of Chinese learners [1]. The Chinese education system is primarily characterized by old-fashioned teaching

and learning, featuring teachers' authoritarian pedagogy, centralized curricula, obedient students, rote learning, and exam-oriented motivation, which have been criticized in numerous articles, books, and media (see [1–3]). Yet Chinese learners constantly outperform their Western counterparts in large-scale international tests such as PISA, TIMSS, etc., and they continue to perform well when they attend Western universities for further education. From a sustainability perspective, the excellent academic performance of Chinese students comes at the expense of some of the valuable sustainable development goals (SDG) proposed by the United Nations. For example, China's exam-oriented education system is often criticized for putting students' mental health at risk [2], which is against SDG 3. In addition, a lack of intrinsic interest in learning results in limited creativity (against SDG 9) and a low willingness to continue learning after graduation (against SDG 4) [3]. These drawbacks raise the question of how to increase the sustainability of Chinese education, which is becoming increasingly important in a new era. Among all of the efforts made to address the paradox of Chinese learners, Jin Li's "virtue–mind" theoretical framework stands out by providing a comprehensive and insightful perspective for understanding the cultural beliefs behind this paradox and for re-examining the advantages and disadvantages of Chinese education, thus shedding light on how to improve its sustainability. However, Li's theory has not been thoroughly tested in this age of global cultural exchange, and the question as to which is more beneficial for learners between the Eastern virtue model and Western mind model has not been determined. Therefore, in this paper, we first critically analyze Li's virtue–mind framework and then present four empirical studies that modify and enrich Li's theory. Finally, we establish a sustainable learning model for Chinese learners based on our findings.

2. Elaboration of the Analytical Framework

2.1. Review of the Literature on the Paradox of Chinese Learners

Chinese learners' high level of achievement has attracted the attention of a number of international scholars since the 1970s, as it threatens the well-developed approaches to learning and teaching in the Western literature. Although numerous, studies aimed at unpacking this paradox have been largely fragmented.

One of the explanations on the paradox frequently cited concerns about Chinese learners' rote learning, which is a mechanical way of learning where thinking is absent. Chinese learners have been criticized for using repetition as a means of memorization. However, studies [4,5] have shown that repetition is also a tool used by Chinese learners to consolidate knowledge and strengthen understanding through the active deployment of the learned material, and that Chinese learners can consciously differentiate between mechanical memorization and memorization with understanding, resulting in modification of the equation between rote learning and repetitive learning.

Similarly, it has been argued that the perceptions of Chinese learners as silent and passive learners and of inadequate interactions with teachers in Chinese classrooms are biased. During lessons, Chinese students usually attentively absorb the knowledge imparted by the teacher, and they consider it rude to interrupt the lecture; instead, they wait until the end of the lesson to ask questions, so student–teacher interactions in China often occur when formal lessons are over, which shows learners' respect for teachers in traditional Chinese culture [6,7].

Consistent with the fresh impression of Chinese students, the image of Chinese teachers after class or outside the classroom is much less authoritarian as well, although they often appear austere during class to ensure discipline and teaching efficiency in large classes. Indeed, Chinese teachers generally encourage students to approach them to clarify what they did not understand in class to better grasp their students' needs and difficulties and to adjust their lesson the next day [8].

In addition to student–teacher relationships, peer relationships have also received a great deal of attention. Unlike Western classrooms, in which high achievers often face peer

harassment, Chinese students are much more united in large classes and often support and respect each other in achieving high scores [9].

Speaking of the large-size Chinese classes, scholars have shown interest in the curriculum design. A recent study revealed that compared with the U.S., the mathematics curriculum in China is more enriched in knowledge points, more specific in standard demands, deeper in terms of difficulty, and better sequenced according to the advancement of grades [10].

In addition to school education, researchers have noted differences in parenting styles. Chinese parents have higher expectations for their children's academic achievement (usually straight A's) than European and American parents, who on average are satisfied with A's and B's [11].

While the above discussion helps reduce the tension embedded in the Paradox of Chinese Learners to some degree, more convincing arguments come that Chinese learners possess an advantageous growth mindset [12], which tends to attribute success to effort rather than ability [13]. In addition, effort is a stable factor over time and across situations, which differs from the definition in the Western literature on motivation [14].

As a central axis, this line of research has induced a shift in research directions toward culture-based learning beliefs, and has identified the Confucian belief in the pursuit of self-perfection, especially in the moral aspect, as the primary goal of learning [15]. Li's work epitomizes this line of research on learning beliefs.

It should be noted that while Western scholars are enthusiastically learning from the Chinese approaches to education and learning [16], their Chinese counterparts are anxiously seeking to emulate the West to address the lack of sustainability in education, in particular students' high academic burdens [17] and low scientific creativity [18]. Chinese students' low scientific creativity is most unsettling, as China has already fallen behind in modern science and technology; therefore, the well-known Needham Question [19] requires some explanation. Some scholars have discussed the influence of traditional Confucian culture on limiting the creativity of people in ancient China (see [19]), but the specific link between culture-based learning beliefs and modern Chinese students' lack of creativity remains unclear. Empirical studies are therefore needed to answer this question.

In summary, although this field has generated a good amount of research and made significant progress, the body of accumulated knowledge remains quite separate and discrete, lacking a comprehensive picture of learners in China and the West.

2.2. Critical Analysis of Li's Virtue–Mind Framework

In view of the aforementioned advancements and limitations in the field, Li explored this topic by synthesizing the wisdom of predecessors into learning beliefs, as beliefs are the core conceptual frames that are shaped by and thus reflect cultural models.

According to Li, educational models in Europe and America are "mind-oriented," stemming from ancient Greek Socratic epistemology and viewing learning as mental development for exploring and understanding the outside world. In contrast, educational models in East Asia are "virtue-oriented," influenced by traditional Confucian teachings, which consider learning as socialized development for cultivating and perfecting a person's morality (see [20–30]). Li established the virtue–mind framework for education and learning by tracing the cultural origins of Eastern and Western models. According to Li's monograph *Cultural Foundations of Learning: East and West* [29] (Chapters 2–4) based on her series of empirical cross-cultural studies and other detailed, reliable, and fascinating materials, the philosophy of education and learning in China and East Asia is mainly influenced by Confucian culture (see [22]). Ancient Eastern learners read the books of sages (*sheng-xian-shu*), pursued self-improvement (*xiushen*), were determined to become men of noble character (*junzi*), emphasized maintaining their relationship with society, assumed social responsibilities, and applied moral principles to support the emperor's implementation of benevolent governance (*ping-tian-xia*), which was seen as the realization of one's life goal and life value. Confucian learners thus valued virtues such as earnestness, diligence,

endurance of hardship, concentration, and perseverance. These excellent learning virtues have been passed down to this day and still feature prominently in contemporary Chinese education. In contrast, the Western philosophy of education and learning is derived from the tradition of ancient Greek epistemology (see [31]). Ancient Greek thinkers such as Socrates and Aristotle were eager to understand the essence of things, the substance of the world, and the laws of the universe; they were curious and enthusiastic about the world and thus developed tools for mathematics and logic to pursue absolute knowledge and eternal truth. To understand the outside world and use knowledge about the world to meet people's needs, Western learners today still tend to value mental qualities, such as curiosity, an inquisitive mind, creativity, critical thinking, and self-expression. In her monograph [29], Li described, explored, and explained the virtue–mind cultural dichotomy from several angles, including learning tradition, emotional reaction, knowledge expression, peer interaction, and parental guidance, but according to Li, the core of the dichotomy lies in people's cultural beliefs about learning. Below, we present Li's two most representative and important studies to understand how she delved into this topic from the perspective of learning beliefs.

In Li's pioneering work [21], published in the *Journal of Educational Psychology* in 2003, she studied learning beliefs from an emic perspective, i.e., learning concepts (see [32]). She asked Chinese and American college students to provide free associations of the word "*xuexi*" or "learning/learn" and found striking differences in the learning vocabulary of the two groups (see Tables 3.1 & 3.2 in [29]). In terms of linguistic features, Chinese associative words mostly included multiple words and modifiers, many of which were presented in the form of proverbs and sayings, such as "it is never too late to learn" (*huo-dao-lao xue-dao-lao*) and "read extensively" (*bo-lan-qun-shu*); however, American associative words were single words, such as "study" and "thinking." With regard to conceptual features, many American associative words involved thoughts and psychological processes (31%), and some referred to external factors, such as resources, institutions, and teachers, which were rarely seen in Chinese associative words. However, the American college students seldom mentioned the concepts of diligence and lifelong learning, which were strongly emphasized by the Chinese students. Regarding emotional and behavioral characteristics, the Chinese terms expressed strong affect, showing desire, enthusiasm, and intensity of learning, as well as a clear call to action, none of which was evident in the English words. Li then used cluster analysis to map the relationships between the different concepts for each culture.

In her study [22] published in the *Journal of Developmental Psychology*, Li investigated the learning concepts of preschoolers in Chinese and American cultures. After hearing stories of a little bird that chose to learn to fly in the face of difficulty and a little bear that chose to give up learning to fish in the face of failure, Chinese and American children aged four to six were asked to continue the stories and evaluate the little bird and the little bear. Li found that almost all of the children in the two cultures expressed affection for the little bird; however, more than half of the children in China did not like the little bear because of its poor learning attitude, whereas only a small number of children in the U.S. did not like the little bear. Although the participants were not yet in primary school, they had already formed a basic cognitive framework for the meaning of learning. This finding thus reveals that the differences in learning concepts between the two cultures appears from an early age.

The two studies above that examine the two ends of the educational pathway demonstrate that the distinction in learning beliefs between the two cultures is pervasive. The two educational models are like two parallel paths that did not intersect until modern globalization, where the two models are manifesting their own merits and demerits, calling for learning from and integration with each other. We argue that what is valuable about Li's virtue–mind framework is that it adopts a neutral view of Eastern and Western models of education and learning without neglecting the contributions of both cultures.

Specifically, as far as we are concerned, Li's framework seems to unintentionally offer an explanation for the well-known Needham Question [19] from the perspective of learning beliefs. Here comes a bold assumption of ours: Could the neglect of the mind in Chinese learning concepts partly explain why China has fallen behind the West in modern science and technology? When the ancient Greeks debated whether the earth was round or flat, the ancient Chinese created the story of Qi, who was haunted by the fear that the sky might fall (*qi-ren-you-tian*), in order to make fun of those with unnecessary anxiety. Just come think about that: the question of whether the sky would fall or not would be so important a topic that the ancient Greek philosophers might like to discuss it. Seen in this light, the Western mind model that advocates truth, emphasizes the cultivation of individual abilities, and pays attention to the use of external resources and strategies is a perfect supplement to the Confucian virtue model, which promotes the sustainability of Chinese students' learning.

Dialectically, Li's virtue–mind theory is not without some deficiencies, which can be summarized as two main errors concerning the impact of culture on students' learning beliefs and the impact of learning beliefs on student performance. Regarding the first flaw, the basic hypothesis underlying all of Li's studies is that culture has a significant impact on people's learning beliefs, which she partly tested by considering the pervasive distinction in learning beliefs between the East (virtue) and the West (mind). However, Li seemed to fail to follow through on the same hypothesis to the end but instead fell into the limitation of self-inconsistency. For example, she believed that "variations remain despite deepening cultural exchange" and that "the basic patterns of cultural learning models are tenacious and unlikely to melt in grand unification" [29] (pp. 331–335), which, as Xiangming Chen pointed out, are contrary to popular beliefs [30] (p. 2 of the preface). It is also worth examining the patterns of virtue and mind learning beliefs that exist under the high level of cultural exchange in the era of globalization. With regard to the second flaw, although Li's original motivation for conducting a series of studies was to explain the Paradox of Chinese Learners, she only stayed on the phenomenological explanation of the distinction between Eastern and Western learning models and did not study the problem directly by determining which cultural learning model is better, despite that some of her recent studies [25–27] have partly addressed this question. Clearly, determining which learning model is more beneficial to student performance is a concern for every educational researcher and educator. Thus, based on the above discussion, the first job for this current paper was to re-examine Li's virtue–mind theory and make some amendments in order to enrich it, before a sustainable learning model could be established.

2.3. Presentation of the Current Studies

Four empirical studies were designed from the perspective of learning concepts (i.e., epistemological beliefs about learning studied from an emic perspective according to Li [20,21], [29] (p. 77), [32,33]).

First, most of Li's studies, which led to the development of her theory, were carried out around the turn of the century. Since then, there has been a rapid increase in globalization and an accelerated integration of world cultures. Thus, it is worth exploring whether the difference in learning concepts between the Eastern virtue model and the Western mind model is still significant today. Is it possible that the spread of Western cultures has caused today's Chinese students to also show a tendency to value mental qualities? Therefore, in Study 1, we explored the changes in Chinese students' learning concepts from a developmental perspective to see whether Li's finding [21] could be replicated.

Second, China is vast, and cultures vary greatly across areas. For example, Shandong province in the north was the cradle of Confucian culture, and Guangdong province in the south has a long history of opening up to the Western world. Does this mean that the virtue and mind learning concepts of students in these two provinces differ? If so, this finding would provide solid evidence to support Li's theory that culture exerts a powerful impact on education and learning. Thus, in Study 2, we compared the differences in students'

learning concepts between northern and southern China to see whether new evidence could be found.

Conducted from a vertical perspective and a horizontal perspective, respectively, Study 1 and Study 2 helped us form a more scientific and dialectical judgment on Li's "virtue–mind" theory.

Third, to study the Paradox of Chinese Learners directly, in Study 3 we examined the relationship between students' virtue and mind learning concepts and their academic achievement to better understand the advantages and disadvantages of Eastern and Western learning models and provide valuable insights for educational practice.

Finally, as the Needham Question, like the Paradox of Chinese Learners, has attracted the attention of scholars and educators, in Study 4 we investigated the correlation between students' virtue and mind learning concepts and their creative tendency and critical thinking to determine whether virtue learning concepts are indeed less conducive to or even stifle students' creativity in comparison to mind learning concepts.

Study 3 and Study 4 helped us establish a more sustainable learning model for Chinese students in light of the combination of Eastern virtue wisdom and Western mind ideology.

On the basis of these four studies, this paper discusses how to promote sustainability in education in today's Chinese context.

3. Study 1: The Development of Chinese Students' Virtue and Mind Learning Concepts

To investigate changes in Chinese students' virtue and mind learning concepts from a developmental perspective and replicate Li's finding [21], in Study 1 we adapted the word association test used by Li [21] to examine the learning concepts of students from Grade 1 in primary school to juniors in university [33].

3.1. Method

3.1.1. Participants

We recruited 2326 Chinese students in regular primary schools, middle schools, and universities in Guangdong province as participants, spanning Grades 1 to 15. The three adjacent grades were combined into one group, such that the participants were divided into five school phase groups: lower primary school (Grades 1–3) (n = 460, 225 boys), upper primary school (Grades 4–6) (n = 520, 277 boys), junior high school (n = 472, 267 male adolescents), senior high school (n = 411, 189 male adolescents), and university (n = 463, 106 men).

3.1.2. Procedure

Step 1: we collected learning-related vocabulary using a word association test. The participants in Grades 4 to 15 were asked to write down at least 20 words, phrases, idioms, or proverbs associated to the word "learn/learning." There was no requirement for the number of associative words for the participants in Grades 1 to 3, but the time limit was set to 10 min. The data for the university group were collected using online questionnaires, and those for the other groups were collected using printed questionnaires.

Step 2: Data cleansing and frequency counting. All of the associative words collected in Step 1 with the same semantic meaning were merged, and several that had little to do with learning were deleted. Next, the frequency of occurrence of the remaining associative words was counted.

Step 3: Classification of associative words. Three coders used NVivo 11.0 to classify the associative words in Step 2 (intercoder reliability = 0.69). All of the cluster levels of the two concept maps in Li's study [21] were taken as the basic categories of learning concepts, and all associative words with the same or similar meaning were classified into the corresponding category to increase the frequency of occurrence. If the independent coder deemed the associative word inappropriate for inclusion in any of the existing basic

categories, he/she could propose to add a new basic category, the naming of which was decided through discussion based on the clusters of learning concepts in Li's study [29].

Step 4: Construction of a hierarchical structure of Chinese students' learning concepts. The basic categories obtained in Step 3 were transformed into a hierarchical structure, and changes in the frequency of learning belief categories were illustrated in a figure to show the trend of development.

3.2. Results

3.2.1. Preliminary Analysis of the Collected Associative Words

The numbers of associative words were 2045 for the lower primary school group, 4068 for the upper primary school group, 9589 for the junior high school group, 8106 for the senior high school group, and 8394 for the university group, totaling 32,202 words. We present the top 10 associative words with the highest frequency in each school phase in Table 1.

Table 1 shows that as the age of the participants increased, the average length of the associative words decreased. In terms of linguistic features, the form of the terms changed from phrases with modifiers or idiomatic sentences containing proverbs to single words. In terms of conceptual characteristics, the degree of heterogeneity in the associative words increased. With regard to affective features, the emotions contained in the associative words were less distinct and weaker as age increased. For behavioral characteristics, the call for behavioral performance gradually weakened. According to Li's findings [29] (pp. 79–81), the above results generally reflected the development trend of Chinese students' learning concepts shifting from the virtue model to the mind model.

3.2.2. Classification of Associative Words and Construction of the Hierarchical Structure of Chinese Students' Learning Concepts

According to the definition of virtue and mind models in Li's studies (see [29]), 33 basic categories were formed and divided into three types: "virtue orientation" (13 categories), "mind orientation" (14 categories), and "negative orientation" (four categories). Then, the basic categories of "virtue orientation" and "mind orientation" were further divided into four sub-categories: "learning motivation," "learning ability and attitude," "learning strategy and support," and "learning content." The full hierarchical structure of Chinese students' learning concepts is shown in Figure 1, with the frequency of occurrence of the basic categories reported in brackets and the basic categories directly adopted from Li's study [21] marked with "*" (24 categories). Below, we analyze the differences in the basic categories between the virtue model and the mind model in the four sub-categories:

1. Learning motivation. The virtue-oriented learning concepts generally pointed inward and focused on the self, the most prominent being "perfection of oneself morally/socially," which is also Confucius's primary objective [29] (p. 35, p. 90). Next, "depth and breadth of knowledge," which represents the degree of mastery of knowledge, is believed to be the most important learning achievement that Chinese learners can hope to achieve [29] (p. 93). People's hope of "promoting their social status" is of great practical importance in realizing the primary goal of Confucianism: "contribution to society" [29] (p. 90). Thus, the meaning of individual learning is extended to the whole community, that is, taking the world as one's duty (*yi-tian-xia-wei-ji-ren*) [29] (p. 46). The mind-oriented learning concepts paid more attention to the outside world. To explore, understand, and control the world, people first need to "develop their abilities/skills" to enable them to become fully functioning members of society [29] (p. 85). In addition, learners in the mind model usually need to receive continuous affirmation to maintain their learning motivation [29] (p. 159). Therefore, feedback and positive reinforcement from or outside of the learning task, such as "praise and rewards," are often used by Western parents and teachers as strategies to strengthen children's learning motivation.

2. Learning ability and attitude. In general, learners in the virtue model focus more on their own attitudes toward learning, whereas those in the mind model pay more attention to their own learning abilities. Specifically, seven categories related to learning attitude in the virtue model were mentioned: "love and passion" [29] (p. 94), "diligence" [29] (p. 126), "cherishing time," "perseverance and endurance of hardship" [29] (pp. 139–144), "concentration" [29] (pp. 144–147), "humility" [29] (pp. 179–180), and "lifelong pursuit" [29] (p. 79, p. 83), all of which are core virtues that Confucian learners must cultivate and practice constantly to "morally/socially perfect themselves" [29] (pp. 49–52). In contrast, there was only one basic category in the mind model that concerned learning attitude: "active engagement" [29] (p. 87, p. 108). Finally, the concept of "cognitive ability" [29] (pp. 33–35, pp. 110–120), which includes inquiry, thinking, and innovation, only appeared in the mind model, whereas the virtue model did not involve any categories related to learning ability.
3. Learning strategy and support. In the virtue model, only one category, "practice and review," was related to learning strategy; the repeated practice of something over a long time is considered by Confucian learners as the only way to attain mastery of knowledge and is inseparable from "diligence," "endurance of hardship," "perseverance," and other virtues [29] (pp. 126–135). In contrast, the mind model included many such categories: "learning and self-management plan" [29] (p. 110), "learning approaches" [29] (p. 82), "exploration and experiment" [29] (pp. 110–116), "thinking and comprehension" [29] (pp. 116–120), and "cooperation and communication" [29] (pp. 120–123), all reflecting learners' agentic process of "active engagement." In addition, neutral categories such as "teaching methods," "learning experiences and environment," "resources, facilities, and tools for learning," and "life processes and stages" only appeared in the mind model, mainly reflecting external support for learning [29] (p. 82).
4. Learning content. "Daily code of conduct" was related to moral education, whereas "school curriculum and basic knowledge" [29] (p. 82) was related to intellectual education.

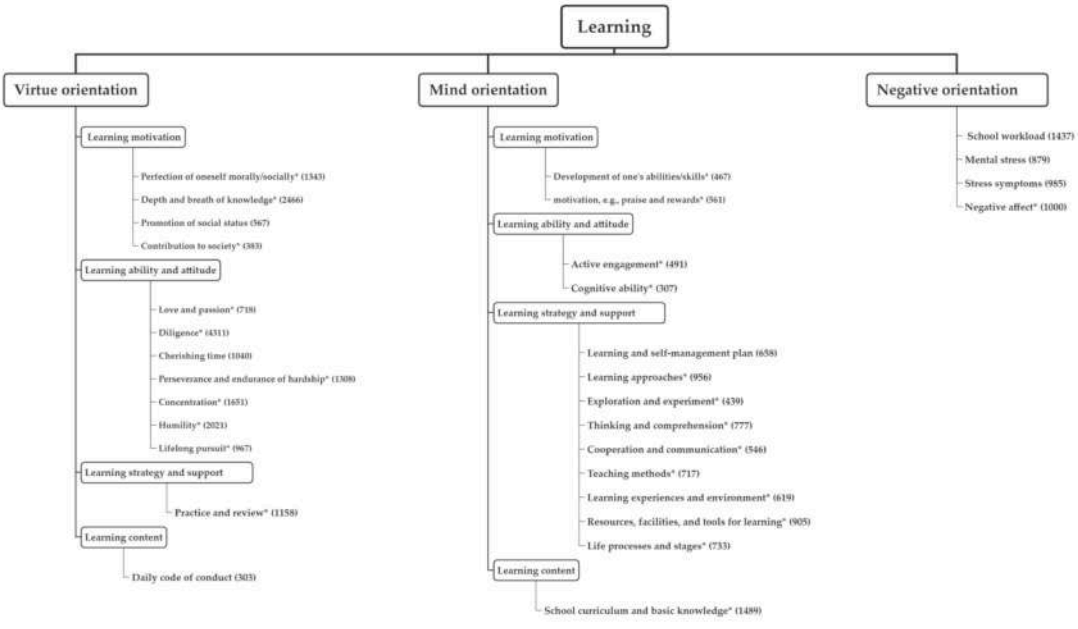

Figure 1. The hierarchical structure of Chinese students' learning concepts. 24 categories marked "*" are directly adopted from Li's study [21].

Table 1. Top 10 associative words with the highest frequency in the five groups of Chinese students and their frequencies in brackets.

Lower Primary School	Upper Primary School	Junior High School	Senior High School	University
1. Study hard and make progress every day (*hao-hao-xue-xi tian-tian-xiang-shang*) (251)	Study hard and make progress every day (*hao-hao-xue-xi tian-tian-xiang-shang*) (208)	There is no boundary to learning (*xue-wu-zhi-jing*) (126)	Learning without thinking is labor lost; thinking without learning is perilous (*xue-er-bu-si-ze-wang si-er-bu-xue-ze-dai*) (139)	Teacher (*laoshi*) (135)
2. Having pored over ten thousand volumes, one can write with godly power (*du-shu-po-wan-juan xia-bi-ru-you-shen*) (152)	Long-term diligence is the road to the mount of knowledge; endurance of hardship is the boat to the boundless sea of learning (*shu-shan-you-lu-qin-wei-jing xue-hai-wu-ya-ku-zuo-zhou*) (130)	Diligence (*qinfen*) (123)	Long-term diligence is the road to the mount of knowledge; endurance of hardship is the boat to the boundless sea of learning (*shu-shan-you-lu-qin-wei-jing xue-hai-wu-ya-ku-zuo-zhou*) (112)	Examination (*kaoshi*) (132)
3. When a book is read a hundred times, its meanings will naturally become clear (*du-shu-bai-bian qi-yi-zi-xian*) (107)	Having pored over ten thousand volumes, one can write with godly power (*du-shu-po-wan-juan xia-bi-ru-you-shen*) (127)	Hard work (*nuli*) (116)	It is never too late to learn (*huo-dao-lao xue-dao-lao*) (106)	Schoolwork (*zuoye*) (106)
4. One who does not study when young will regret it in the future (*du-shu-bu-chen-zao jiang-lai-tu-ao-hui*) (107)	Books are the ladder of human progress (*shu-ji-shi-ren-lei-jin-bu-de-jie-ti*) (123)	Study hard and make progress every day (*hao-hao-xue-xi tian-tian-xiang-shang*) (109)	There is no boundary to learning (*xue-wu-zhi-jing*) (92)	Library (*tu-shu-guan*) (87)
5. Reading a good book is like making a good friend (*du-le-yi-ben-hao-shu xiang-jiao-le-yi-ge-yi-you*) (89)	Laziness in youth spells regret in old age (*shao-zhuang-bu-nu-li lao-da-tu-shang-bei*) (114)	Learning without thinking is labor lost; thinking without learning is perilous (*xue-er-bu-si-ze-wang si-er-bu-xue-ze-dai*) (103)	One can not cease learning (*xue-bu-ke-yi-yi*) (82)	Hard work (*nuli*) (80)
6. Earnestness (*ren-ren-zhen-zhen*) (80)	Discard bedtimes and mealtimes (an idiom to describe one's diligence in learning, *fei-qin-wang-shi*) (111)	Long-term diligence is the road to the mount of knowledge; endurance of hardship is the boat to the boundless sea of learning (*shu-shan-you-lu-qin-wei-jing xue-hai-wu-ya-ku-zuo-zhou*) (88)	Diligence (*qinfen*) (77)	Grade (*chengji*) (75)

Table 1. *Cont.*

Lower Primary School	Upper Primary School	Junior High School	Senior High School	University
7. Stand in the snow to wait upon Master Cheng respectfully (an idiom used to describe someone eager to learn and respectful of his/her teacher; *Cheng-men-li-xue*) (72)	Devotion (*zhuan-xin-zhi-zhi*) (96)	Books are the ladder of human progress (*shu-ji-shi-ren-lei-jin-bu-de-jie-ti*) (84)	Study for the rise of China (*wei-zhong-hua-zhi-jue-qi-er-du-shu*) (75)	Review (*fuxi*) (73)
8. Le Yangzi's wife used the metaphor of cutting the cloth to persuade her husband not to give up learning halfway (*duan-zhi-quan-xue*) (53)	Concentration (*ju-jing-hui-shen*) (89)	One is never ashamed to learn from his/her subordinates (*bu-chi-xia-wen*) (83)	Examination (*kaoshi*) (70)	Mathematics (*shuxue*) (69)
9. Single-minded (*yi-xin-yi-yi*) (45)	Being smart and eager to learn, one is never ashamed to learn from his/her subordinates (*min-er-hao-xue bu-chi-xia-wen*) (86)	Be wealthy in knowledge (*xue-fu-wu-che*) (78)	Hard work (*nuli*) (69)	English (*yingyu*) (61)
10. Being smart and eager to learn, one is never ashamed to learn from his/her subordinates (*min-er-hao-xue bu-chi-xia-wen*) (43)	Diligence (*qinfen*) (85)	Earnestness (*renzhen*) (78)	Perseverance (*jianchi*) (58)	School (*xuexiao*) (61)

3.2.3. Development of Virtue and Mind Learning Concepts from Primary School to University

We summed the total frequency of all formally retained associative words in each basic category and divided it by the total number of associative words in each school phase group to obtain the frequency of occurrence of each category in each group, as shown in Table 2 and Figure 2. Figure 2 shows that the development of Chinese students' learning concepts exhibited an evolutionary trend from a dominance of the virtue model to a balance between the virtue model and the mind model, validating our hypothesis to some extent. Although the tradition of virtue-oriented learning is still rooted in China, the influence of global cultural exchange has narrowed the gap between the virtue model and the mind model, with a tendency toward full inclusion.

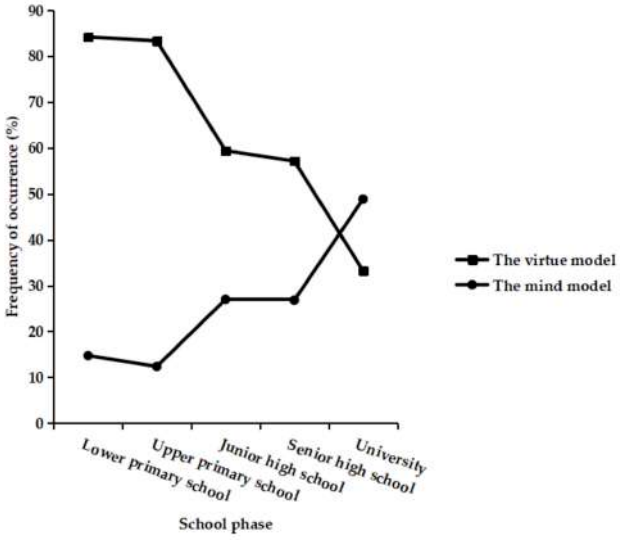

Figure 2. The development of Chinese students' virtue and mind learning concepts.

3.3. Discussion

As discussed in Section 2, the underlying assumption of Li's research is that culture has a significant impact on learners' learning beliefs and thus influences their performance. However, Li failed to fully validate this assumption in terms of the effect of global cultural exchange. Study 1 assessed this hypothesis from a developmental perspective, and the results indicate important changes that can be made to Li's virtue–mind theory. To replicate Li's study [21] conducted around 20 years ago, we conducted a large-scale survey of Chinese students' learning concepts from Grade 1 in primary school to juniors in university. The results showed that although the tradition of the Confucian virtue model was maintained to a large extent, as the age of the participants increased, they acted out more components of the mind model to the point of exceeding those of the virtue model, which means that learners' learning concepts are not immutable but will develop with educational experiences. Today's education in China has been fundamentally altered as a result of Western influence, from its system to curriculum content, which was acknowledged by Li [29] (pp. 63–64). Chinese students are constantly absorbing Western culture through education, so their learning concepts are also Westernized. The gap between the virtue model and the mind model is likely to be further narrowed and even eliminated in the future [33].

Table 2. The frequency (%) of occurrence of each basic category in each group.

Basic Categories	Lower Primary School	Upper Primary School	Junior High School	Senior High School	University
		Virtue Model			
Learning motivation					
Perfection of oneself morally/socially	7.29	2.58	4.85	4.05	3.53
Depth and breadth of knowledge	8.95	11.16	9.27	7.57	3.88
Promotion of social status	0.29	0.27	1.84	2.91	1.64
Contribution to society	1.76	2.56	1.14	1.31	0.33
Learning ability and attitude					
Love and passion	1.76	0.44	2.33	3.29	2.07
Diligence	18.09	28.29	13.58	11.89	6.24
Cherishing time	7.68	6.93	3.22	1.80	1.74
Perseverance and endurance of hardship	1.37	3.24	5.35	5.03	2.70
Concentration	16.14	12.51	3.89	3.03	2.30
Humility	14.13	11.28	5.92	5.90	2.70
Lifelong pursuit	1.61	1.28	3.06	5.17	2.03
Learning strategy and support					
Practice and review	1.96	2.51	3.79	4.13	3.79
Learning content					
Daily code of conduct	3.18	0.32	1.19	1.06	0.30
Total	84.21	83.37	59.43	57.14	33.25
		Mind Model			
Learning motivation					
Development of one's abilities/skills	0.05	0.12	1.36	1.71	2.29
External motivation, e.g., praise and rewards	0.44	0.25	2.12	1.54	2.55
Learning ability and attitude					
Active engagement	0.20	0.25	1.33	1.25	2.95
Cognitive ability	0.10	0.17	0.55	1.54	1.43
Learning strategy and support					
Learning and self-management plan	0.34	0.32	1.38	2.32	3.79
Learning approaches	9.68	3.54	2.00	1.79	3.30
Exploration and experiment	0.29	0.34	1.27	1.73	1.87
Thinking and comprehension	0.39	1.92	2.44	3.34	2.22
Cooperation and communication	0.15	0.76	1.84	1.51	2.55
Teaching methods	0.73	0.57	2.32	2.00	3.51
Learning experiences and environment	0.05	0.47	1.78	1.06	4.07
Resources, facilities, and tools for learning	0.88	2.29	1.26	1.63	6.45
Life processes and stages	0.39	0.22	1.80	2.26	4.29
Learning content					
School curriculum and basic knowledge	1.03	1.13	5.54	3.13	7.59
Total	14.72	12.35	26.99	26.81	48.86

However, due to a lack of resources, the difficulty of surveying primary school students, and the enormous workload of processing associative words, Study 1 only included participants from Guangdong province, which may have biased the results because of large regional cultural differences in China. And probing into the regional difference of learning concepts of Chinese students would be of great interest in accordance with Li's theory. Therefore, in Study 2, we used a different measurement method to investigate the virtue and mind learning concepts of students from Shandong, a culturally different province from Guangdong province, especially in terms of Confucian tradition.

4. Study 2: Regional Differences in Chinese College Students' Virtue and Mind Learning Concepts

To compare North–South regional differences in Chinese students' learning concepts, in Study 2, we selected key virtue and mind learning concepts from Study 1 and asked university students from Shandong province and Guangdong province to rate the correlations between these concepts and "learning" on a 7-point Likert scale.

4.1. Method

4.1.1. Participants

On the basis of Study 1, Chinese university students with both virtue and mind learning concepts were suitable for regional cultural comparison. Thus, 453 higher education students born and raised in Shandong province (northern China, cradle of Confucian culture) and Guangdong province (southern China, pioneer in openness to the outside world) were randomly recruited from the Internet. We obtained 368 valid questionnaires (222 in Guangdong and 146 in Shandong). Detailed information about the participants is presented in Table 3.

4.1.2. Procedure

Step 1: we selected key virtue and mind learning concepts. Eight experts familiar with Li's studies were asked to select 20 key concepts (10 for each model) from Study 1 through discussion. In this process, the frequency of occurrence of a concept in Study 1 was an important criterion for inclusion. The 10 key concepts of the virtue model selected were diligence (*qinfen*), earnestness (*renzhen*), endurance of hardship (*keku*), perseverance (*jianchi*), concentration (*zhuanzhu*), carefulness (*xizhi*), cherishing time (*xishi*), proficiency (*shulian*), recitation (*beisong*), and ambition (*zhixiang*); the 10 key concepts of the mind model were intelligence (*zhili*), talent (*tianfu*), smartness (*congming*), thinking (*siwei*), comprehension (*lijie*), exploration (*tansuo*), discovery (*faxian*), discussion (*taolun*), innovation (*chuangxin*), and interest (*xingqu*).

Step 2: Create a scale for rating the correlations between the chosen concepts and "learning." The 20 learning concepts were randomly presented on a 7-point Likert scale, ranging from 1 = "weak correlation with learning" to 7 = "strong correlated with learning." The principle of this assessment to measure the participants' learning concepts was similar to the word association test in Study 1. Both were used to examine Chinese students' learning concepts by reflecting the semantic distances between the virtue and mind concepts and learning; however, the rating scale was easier to implement and interpret.

Step 3: Data collection, processing, and analysis. The survey containing the 7-point Likert scale and questions about the participants' demographics was distributed through Wenjuanxing, a platform offering functions similar to Amazon Mechanical Turk. After cleaning the data to ensure that all of the participants were born and raised in Shandong province and Guangdong province, the mean correlations for the virtue model and the mind model were calculated separately. Then, an independent-samples *t*-test was used to analyze the differences in learning concepts between the North and the South.

Table 3. Detailed information about the participants in Study 2.

		Guangdong Province		Shandong Province	
		n	**%**	***n***	**%**
Gender	Male	67	30.2	21	14.4
	Female	155	69.8	125	85.6
Type of university	985/211 key universities	74	33.3	10	6.9
	General Type I universities	57	25.7	124	84.9
	Type II or III universities	67	30.2	11	7.5
	Technical or vocational colleges	24	10.8	1	0.7
Type of major	Sciences	132	59.5	46	31.5
	Liberal arts	90	40.5	100	68.5
Grade	Freshman	55	24.8	62	42.5
	Sophomore	62	27.9	38	26.0
	Junior	91	41.0	43	29.5
	Senior	14	6.3	3	2.0
Academic ranking	Top 25%	102	45.9	56	38.4
	Middle 25%–75%	107	48.2	79	54.1
	Bottom 25%	13	5.9	11	7.5
Course failure	Yes	39	17.6	23	15.8
	No	183	82.4	123	84.2
Ethnicity	Han	222	100	145	99.3
	Minority	0	0	1	0.7
Type of family	Urban	123	55.4	53	36.3
	Rural	99	44.6	93	63.7
Single child	Yes	61	27.5	52	35.6
	No	161	72.5	94	64.4
Total		222	100	146	100

4.2. Results

The results of Study 2 are shown in Figure 3. In the mind model, there was no significant difference (t = 0.798, df = 366, p = 0.425) in the students' learning concepts between the North (M = 56.35, SD = 9.349) and the South (M = 55.54, SD = 9.696). In the virtue model, the scores of students in Shandong province (M = 59.27, SD = 8.328) were significantly higher (t = 2.022, df = 366, p = 0.044) than those in Guangdong province (M = 57.25, SD = 9.968). The scores for the virtue model were also higher than those for the mind model in both provinces.

4.3. Discussion

In Study 2, we further tested Li's bold hypothesis of the influence of culture on Chinese students' learning concepts proposed in her virtue–mind theory, and we provided direct and strong evidence supporting this hypothesis from the perspective of regional cultural differences. China has a vast territory with notable cultural differences between northern and southern China, which provides a favorable setting to explore the influence of regional cultural differences on students' learning concepts and thus verify Li's hypothesis. Study 2 used two representative provinces in northern and southern China, Shandong and Guangdong, respectively, that have extreme cultural differences. Located in northern China and close to the Central Plains, Shandong province was the hometown of Confucius and the cradle of Confucian culture. With the prolonged and profound influence of Confucian culture, the students in Shandong province tend to value the virtues of learning. In contrast, located in southern China and far from the center of ancient Chinese civilization, Guangdong province was one of the first places to open up and communicate with the outside world and therefore had more opportunities for contact with foreign cultures. Therefore,

it is reasonable to believe that students in Guangdong province are less influenced by China's traditional Confucian culture and more by Western cultures; thus, their learning concepts should display more elements of the mind model. The results of Study 2 partially supported our conjecture. In the virtue model, students in Shandong province did indeed score significantly higher than those in Guangdong province due to the longer and deeper influence of Confucian culture in history. However, in the mind model, there was no significant difference between the two provinces. The reason for this result may be that with China involved in the globalization process of globalization for more than 20 years, the tide of global cultural exchange has rolled Shandong and Guangdong into the baptism of Western cultures to nearly the same degree. However, in both Shandong and Guangdong provinces, the scores for the virtue model were higher than those for the mind model, indicating that the origin of China's Confucian tradition has not changed. The melting of the two cultural learning models amid deepening globalization with a deeper tradition of Confucian virtue model in China revealed in Study 2 further confirmed the conclusion of Study 1. Taken together, the results of Study 1 and Study 2 critically support Li's theory but enriched it with some modifications.

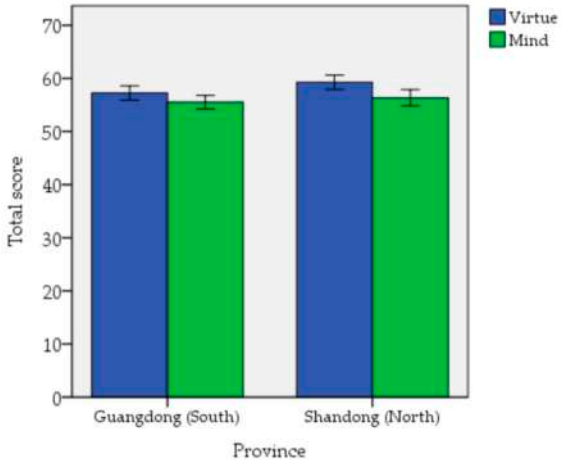

Figure 3. Regional differences in Chinese students' virtue and mind learning concepts.

5. Study 3: The Relationship between Virtue and Mind Learning Concepts and Students' Academic Achievement

To examine the influence of students' virtue and mind learning concepts on their academic performance, in Study 3, we divided the Study 2 participants into two groups according to their academic achievement and compared the differences in learning concepts between the two groups.

5.1. Method

The 368 participants in Study 2 were divided into three academic achievement groups based on three criteria: university quality, student GPA ranking, and course failure. Those who were in the top 25% of their majors, who studied at 985/211 universities (key universities in China), and had no course failure records were classified as high achievers (107 participants, around 30% of the sample); those who studied at Type II or III universities or technical or vocational colleges were classified as low achievers (103 participants, around 30% of the sample); the remaining 158 participants (around 40% of the sample) who ranked in the bottom had course failure records at 985/211 universities or who studied in other Type I universities were classified as mid-level achievers and excluded from the comparison. We grouped the participants in this way because in China, the top students

go to 985/211 key universities, while those with poor academic performance go to Type II or III universities or technical or vocational colleges. Therefore, there is a significant gap in academic achievement between high achievers in 985/211 universities with no course failures and students in Type II or III universities or technical or vocational colleges. Next, we used independent-sample *t*-tests to examine the differences between the two groups.

5.2. Results

As shown in Table 4, overall, high achievers scored significantly higher than low achievers on both the virtue model ($t = 3.736$, $df = 208$, $p < 0.001$) and the mind model ($t = 2.964$, $df = 208$, $p = 0.003$), suggesting that both models play an important role in learners' academic performance and should not be ignored.

Taking a closer look at each conception, we obtained the following interesting results. Among the 20 concepts, only five showed no statistically significant correlations with academic achievement: recitation, talent, intelligence, smartness, and interest; the first concept belonged to the virtue model and the others belonged to the mind model. In some sense, these results indicate that, first, the virtue learning concepts may be slightly more beneficial to students' academic performance than the mind concepts because only one virtue concept was not significant, compared with four in the mind model. Second, high achievers in China do not rely on rote learning, and it is more beneficial for students to better understand and flexibly use their knowledge, which confirms the conclusion of previous studies [4,5]. Third, Chinese students' academic performance is not affected by their interest (or lack thereof), which means that they are able to acquire knowledge from their courses even if they are not interested in their content, which differs from Western learners, as we discuss later. Fourth, Chinese students place great importance on acquired knowledge and do not believe that fixed innate factors such as talent, intelligence, and smartness have a direct effect on their academic achievement, reflecting a growth mindset [12], which we also discuss later.

5.3. Discussion

Determining the influence of learners' learning concepts on their academic achievement is an important topic that Li's series of studies did not address, which constitutes the main contribution of this paper and enriches Li's virtue–mind theory. Notwithstanding certain methodological limitations, the conclusion of Study 3 answers the question of which model is best for learners: the virtue model and the mind model are almost equally important for learners' academic development, so both models should be equally integrated.

The main advantage of virtue-oriented learning concepts lies in their ability to stimulate and fully mobilize learners' subjective initiatives. They provide learners with rich psychological resources in the face of setbacks in the learning process and help them actively cope with difficulties to excel academically [34]. This result is consistent with the findings of previous studies, among which the most notable contributions relate to the attribution of achievement (see [13]). Western children, parents, and teachers explain learners' achievement based on the notion of ability, which tends to be inborn, fixed, and unchanging, whereas their East Asian counterparts attribute learners' achievement to their effort, whose initiative can be completely grasped at hand. Therefore, learners with effort attribution adopt a growth mindset, an incremental motivational framework that promotes resilience (see [12]). Other studies (e.g., [14]) have also shown that unlike Westerners who perceive "effort" as an internal but unstable factor (i.e., whether a person makes an effort depends on the task at hand), Chinese students believe that they should make a constant effort in learning, regardless of setbacks, obstacles, boredom, or lack of natural ability. These findings are confirmed by Study 3, which showed that Chinese learners placed more emphasis on diligence and endurance of hardship and less on talent, intelligence, smartness, and interest.

Table 4. Differences in correlation scores between high and low achievers.

Concept	Group	*n*	*M*	*SD*	*t*	95% CI
			Virtue Model			
Diligence	High	107	6.16	1.038	2.644 **	[0.122, 0.837]
	Low	103	5.68	1.548		
Earnestness	High	107	6.45	0.73	4.018 ***	[0.313, 0.915]
	Low	103	5.83	1.394		
Endurance of hardship	High	107	6.05	1.067	2.124 *	[0.027, 0.727]
	Low	103	5.67	1.478		
Perseverance	High	107	6.5	0.925	3.748 ***	[0.29, 0.933]
	Low	103	5.89	1.4		
Concentration	High	107	6.17	0.947	2.884 **	[0.152, 0.806]
	Low	103	5.69	1.421		
Carefulness	High	107	5.98	0.971	2.836 **	[0.142, 0.791]
	Low	103	5.51	1.385		
Cherishing time	High	107	6.01	1.014	3.793 ***	[0.312, 0.988]
	Low	103	5.36	1.441		
Proficiency	High	107	6.08	1.011	3.656 ***	[0.289, 0.966]
	Low	103	5.46	1.447		
Recitation	High	107	5.04	1.324	1.783	[−0.037, 0.733]
	Low	103	4.69	1.502		
Ambition	High	107	5.79	1.108	2.068 *	[0.016, 0.68]
	Low	103	5.44	1.326		
Total	High	107	60.22	6.436	3.736 ***	[2.362, 7.64]
	Low	103	55.22	12.196		
			Mind Model			
Intelligence	High	107	5.2	1.377	0.389	[−0.285, 0.425]
	Low	103	5.13	1.226		
Talent	High	107	5.07	1.442	0.801	[−0.238, 0.563]
	Low	103	4.9	1.498		
Smartness	High	107	5.17	1.217	1.369	[−0.108, 0.6]
	Low	103	4.92	1.384		
Thinking	High	107	6.52	0.731	4.76 ***	[0.437, 1.056]
	Low	103	5.78	1.441		
Comprehension	High	107	6.53	0.705	4.198 ***	[0.334, 0.926]
	Low	103	5.9	1.376		
Exploration	High	107	6.08	1.02	3.292 ***	[0.232, 0.926]
	Low	103	5.5	1.494		
Discovery	High	107	5.85	1.026	2.584 **	[0.105, 0.78]
	Low	103	5.41	1.431		
Discussion	High	107	5.54	1.127	2.412 *	[0.081, 0.809]
	Low	103	5.1	1.524		
Innovation	High	107	5.78	1.176	2.252 *	[0.056, 0.836]
	Low	103	5.33	1.659		
Interest	High	107	5.99	1.068	1.564	[−0.068, 0.593]
	Low	103	5.73	1.352		
Total	High	107	57.73	7.484	2.964 **	[1.35, 6.71]
	Low	103	53.7	11.815		

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; CI = confidence interval.

Nevertheless, the virtue model alone is not enough for contemporary knowledge learning. Indeed, the old-fashioned virtue approaches have their own flaws; as the results of Study 3 showed, traditional rote learning is not helpful for high academic achievement. In addition, with the changing times, people's need to explore and conquer the outside world is greater than ever. Thus, the concept of "mind" as the supreme human capacity to understand the world and obtain verified, objective, and reliable knowledge is prized in an unprecedented way; the intrinsic fascination, wonder, and passion for the truth, as well as the inquisitive and critical mind that characterizes a scientist, are always essential in the process of learning and education. As discussed above, with the enhancement of

cultural exchange, the virtue model and the mind model should be integrated. A balanced integration of the two models should be the ideal vision of education for Eastern and Western societies to learn from each other in the context of globalization.

However, our criteria for grouping high and low achievers in Study 3 might not be objective enough. We used several partitioning methods, such as grouping all participants from 985/211 universities as high achievers and those in the bottom 75% in other schools as low achievers, and we obtained almost the same results, which confirmed that our results in Study 3 were generally valid and robust. In Study 4, we used two new indicators of sustainable learning (creative tendency and critical thinking) and further examined the impact of Chinese students' virtue and mind learning concepts on their creativity to provide a preliminary answer to the Needham Question and enrich our research results.

6. Study 4: Correlations between the Virtue and Mind Learning Concepts and Students' Creativity

To explore the Needham Question from the perspective of learning concepts, in Study 4, we analyzed the correlations between Chinese students' virtue and mind learning concepts and their creativity, the latter of which was assessed from the two aspects of creative tendency and critical thinking which correspond to an ideal creative person's typical personality trait and mindset, respectively.

6.1. Method

6.1.1. Participants

Fifty college students (36 female students) across China were randomly recruited as participants through Wenjuanxing, and their characteristics (e.g., grades, majors, academic achievement) were balanced.

6.1.2. Tools

The participants' virtue and mind learning concepts were measured using the same 7-point Likert scale as in Studies 2 and 3. Their creative tendency and critical thinking were measured using two well-designed and widely applied survey instruments: the Chinese versions of Williams Prefer Measurement Forms [35] and the Critical Thinking Disposition Inventory [36], both using a 5-point Likert scale, with 5 indicating the best. The first instrument included 50 items and had a Cronbach's α of 0.871. The second instrument included 70 items and had a Cronbach's α of 0.829.

6.2. Results

As shown in Table 5, the virtue and mind learning concepts were strongly correlated with creative tendency and critical thinking, with the correlation coefficients for the mind learning concepts being significantly higher than those for the virtue concepts.

Table 5. Descriptive statistics and Pearson's correlation coefficients between the virtue and mind learning concepts, creative tendency, and critical thinking.

	M	*SD*	Virtue	Mind	Creative Tendency	Critical Thinking
Virtue	5.754	0.486	1			
Mind	5.624	0.495	0.443 **	1		
Creative tendency	3.541	0.38	0.352 *	0.468 **	1	
Critical thinking	3.544	0.273	0.346 *	0.441**	0.639 **	1

* $p < 0.05$, ** $p < 0.01$.

6.3. Discussion

The results of Study 4 showed that both cultural learning models play an important role in fostering students' creativity, consolidating the conclusion of Study 3 that the Western mind model is a crucial and indispensable complement to the development of

Chinese students. Despite a not so rigorous research method, the finding that the mind model contributes slightly more to students' creativity than the virtue model partly answers the Needham Question, as the lack of emphasis on the mind model in Chinese education may somehow hold China back in terms of modern science and technology from a global perspective. Combining the results of Studies 3 and 4, we suggest that the virtue model creates more favorable characteristics for knowledge acquisition, which relies more on effort, whereas the mind model is more advantageous for knowledge application, which requires more mental ability. As knowledge import and export are both important for learning and development, the virtue model and the mind model should be combined to ensure sustainability in Chinese education.

7. General Discussion: Establishing a Sustainable Learning Model for Chinese Students by Dynamically Balancing Virtue and Mind

The call for sustainability covers all areas of life and has become crucial in education and learning. Though without an accurate definition, it is generally accepted that a sustainable learning model should focus on (1) individual holistic growth, fostering both intellectual and non-intellectual abilities; (2) lifelong development, stimulating not only short-term motivation, such as passing a high-stakes exam, but also long-term initiatives, such as cultivating a keen interest in a particular area; and (3) balancing the weight of knowledge acquisition and creative problem-solving. However, the sustainability of Chinese education has long raised controversial issues, as indicated by the well-known paradox of Chinese learners. Typical problems include high mental health risk, limited creativity, and an unwillingness to continue learning after graduation, which respectively go against SDGs 3, 9, and 4.

In light of Jin Li's insightful virtue–mind framework, which attempts to address this paradox, this paper presents four empirical studies conducted in China under the backdrop of sharp global cultural blending and collision. The results make important modifications and enrich Li's theory, helping us to develop an ideal model of education and learning that combines virtue and mind. Notwithstanding certain methodological limitations, the following two conclusions can be drawn. First, according to the results of Studies 1 and 2, global cultural integration today requires a combination of virtue and mind learning concepts to bridge the gap between the two models. Second, according to the results of Studies 3 and 4, the virtue model and the mind model are essential to student growth, and neither should be ignored. Consequently, for a future in which the distinction between virtue and mind is eliminated, a visionary model of education and learning integrating Eastern and Western wisdom should be developed [33].

Therefore, the key to building a sustainable learning model that promotes students' all-round and long-term development lies in the balance between the Eastern virtue model and the Western mind model. Traditionally, the Chinese virtue model focuses too much on learners' learning attitudes, pushing students to work too hard, which leads to high academic performance in exams but forces students to be docile, numb, unthinking, uncritical, uncreative, and highly stressed [34,37], resulting in the Paradox of Chinese Learners [34]. In contrast, the Western mind model advocates cultivating students' abilities and interest in exploring the world. However, because of a lack of expectations from teachers and parents regarding perseverance through adversity, Western students are more likely to slack off and make little progress, which does not build a solid foundation of basic knowledge and skills. Today, Western educational researchers have acknowledged the merits of the Eastern virtue model [16] and proposed a "grit" movement in education [38]. Meanwhile, Chinese education is expected to absorb the advantages of the Western mind model to boost student creativity and improve the sustainability of China's education system. Below, we offer some suggestions for achieving a dynamic balance between virtue and mind [33] in Chinese education. The schematic diagram is shown in Figure 4.

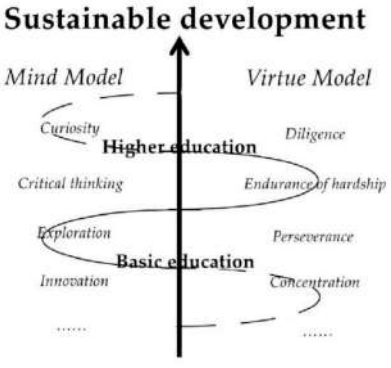

Figure 4. Schematic diagram of a sustainable learning model dynamically balancing virtue and mind for Chinese education. The solid lines in the helix indicate that the mind model in basic education and the virtue model in higher education should be promoted.

In K-12 education, more attention should be paid to the development of children's minds. Every child is a natural learner and spontaneous explorer, full of curiosity about the world and a desire for knowledge, which are among their most precious traits. Therefore, all we need to do is provide children with enough space and freedom to experience, question, try, and learn with a little guidance. Limiting children to the classroom and strict instruction will only stifle their enthusiasm for the unknown, making them passive and self-limiting. Especially in primary education, with more emphasis on protecting and encouraging children's curiosity, interest, and thirst for learning, we can eliminate some of the bad names attached to our education system by Westerners, such as "utilitarian" [39]. In secondary education, we should facilitate students' use of learning methods and strategies. We argue that focusing on various learning methods and strategies is a compromise between the virtue model and the mind model because the use of learning methods and strategies is a way not only to mobilize students' subjective initiatives but also to increase their problem-solving skills, such as critical and scientific thinking, team cooperation, and oral expression, to integrate learning virtues and intellectual abilities [34]. In addition, teaching various learning methods and strategies is conducive to empowering students with lifelong independent learning competence, which is undoubtedly necessary in the era of rapid knowledge renewal from a sustainability perspective. Moreover, among many intellectual abilities, the development of students' thinking abilities should be central in secondary education [40], which is the critical period for the development of students' thinking, as emphasized by developmental psychology [41].

In higher education, although students' intellectual abilities need to be further improved, the tradition of the virtue model should not be forgotten, especially in view of the sharp decline in the learning concepts of the virtue model in Study 1. At a time when the Ministry of Education of China plans to increase (reasonably) the academic burden of university students to reverse the phenomenon of "a desperate high school, a happy university" [17,42], which is specific to China, value education re-equipping university students with traditional Chinese virtues such as assiduity, conscientiousness, and aspiration should be reinforced to retain and adhere to Confucian learning culture. However, special attention should be paid to the mental health of university students. There are notable differences in almost every aspect of basic education and higher education in China. After passing their college entrance examination, which is closest to China's traditional Confucian learning culture, high school graduates usually experience sudden changes in life and learning, which may trigger self-doubt and the denial of their past belief system, weakening their virtue learning concepts [43]. First-year university students are particularly at risk. Whether they manage to get through this period of maladjustment in the first year will be decisive for their academic success in higher education. To deal with this problem,

proper freshmen education should be offered during the summer break after high school graduation to better prepare students for university by providing them with a fulfilling rather than empty post-entrance exam life.

8. Conclusions

This paper presents four empirical studies investigating Chinese students' learning concepts in accordance with Jin Li's virtue–mind framework. The results of our four studies make important modifications and enrich Li's theory. The main findings and theoretical contributions of this paper are summarized as follows.

First, from a vertical perspective, Study 1 revealed a developmental trend in Chinese students' learning concepts (i.e., an increase in mind learning concepts and a decline in virtue learning concepts) in the era of global cultural exchange, amending Li's viewpoint of "despite today's accelerated cultural exchange, these learning models do not diminish but endure" [29] (abstract).

Second, from a horizontal perspective, Study 2 demonstrated North–South regional differences in students' virtue and mind learning concepts in China (i.e., a higher proportion of virtue learning concepts in Shandong province, northern China, than in Guangdong province, southern China), providing direct evidence for Li's basic hypothesis that culture has a significant effect on people's fundamental learning beliefs.

Third, after Li's theory was retested in Studies 1 and 2, Studies 3 and 4 examined the key question regarding which cultural learning concepts are more beneficial for students' sustainable development (academic achievement and creativity), a key contribution of our paper, as Li did not directly address this question. Our results indicated that both virtue and mind learning concepts are important and require a reasonable balance, thereby enriching Li's theory and verifying the findings of previous studies related to Chinese learners' memorization with understanding [4,5] and growth mindset [12–14].

Fourth, based on Studies 3 and 4, we developed a sustainable learning model that dynamically balances virtue and mind for Chinese education, thus deepening the academic value of Li's theory to achieve the SDGs set by the United Nations, such as promoting mental health and well-being (SDG 3), fostering innovation (SDG 9), and ensuring lifelong learning (SDG 4).

In summary, under Li's virtue–mind framework, this paper provides a comprehensive picture of the advantages and disadvantages of Chinese education from a sustainability lens on the Paradox of Chinese Learners.

9. Limitations and Future Research Directions

Our four studies and Li's series of studies inevitably have limitations which should be addressed in future research. The most important limitation concerns the methods used to measure students' virtue and mind learning concepts. The word association test used in Study 1 and other methods used by Li, such as story continuation and picture description tasks and discourse analysis, are qualitative, which makes it difficult to provide a clear definition of the virtue model or the mind model or to apply them to large-scale studies because of the heavy data processing workload. This is a problem for most studies of cultural beliefs. In Studies 2, 3, and 4, we took a first step in using quantitative methods to estimate the proportion of Chinese students' virtue and mind learning concepts, but these methods are too crude to draw robust conclusions. Accordingly, future research should explore new quantitative methods, such as developing a scale of virtue and mind learning concepts or adopting an implicit associative test to replicate our findings [44]. It would also be meaningful to replicate our studies in Western countries to obtain cross-cultural results by comparing the extent to which global cultural exchange affects Eastern and Western learning beliefs.

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The Reception of Education for Sustainable Development (ESD) in China: A Historical Review

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Abstract: This article reveals the changes that have taken place in the under-researched Education for Sustainable Development (ESD) discourse in China over the past three decades and presents new findings. The authors conducted discourse analysis to examine the changes of ESD discourse in official policy documents and compared them with the concept of ESD as it appears in the UNESCO framework. Findings suggest that ESD in China has been redefined by domestic discourse and interests. The concept of 'Ecological Civilisation' replaces the identity and function of ESD as it appears in China's education policies, while ESD primarily targets the environmental sector. This redefining of ESD weakens the interconnection between ESD and sustainable development (SD) that exists within the UNESCO framework and presents an unstable approach to ESD in China. This research contributes to ESD development in China and updates its potential education challenges considering China's 2030 Agenda.

Keywords: education for sustainable development; China; education policy; sustainable development

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1. Introduction

Since the 1980s, the results of excessive environmental degradation have raised global concern. The term 'sustainability', which originates from the forestry industry in Germany, has spread internationally and has encouraged reconsideration of modern development patterns [1]. In 1987, the birth of the Brundtland Report, 'Our Common Future', reinforced the influences of Sustainable Development (SD) on the global agenda and identified it as the most important and urgent issue of the 21st century [2]. In 1992, the Rio Earth Summit further established SD and identified Education for Sustainable Development (ESD) as a key promoter for fostering SD. In the years following its creation, including the 2002 establishment of the Decade of Education for Sustainable Development (DESD), ESD has become central to the international agenda for SD. In 2015, ESD was identified as a method to accomplish the 17 Sustainable Development Goals (SDGs) established by the United Nations General Assembly.

The concept of SD entered China in the early 1990s following the publication of China's *Agenda 21*, a document that addresses 'the consensus view of sustainable development as economic and social development without prejudice to the resource base and environmental quality for future generations' and has had a lasting and wide-ranging impact on Chinese governmental actions [3] (p. 100). ESD-related projects followed soon after. For instance, the UNESCO sponsored the ESD project, 'Educating for a Sustainable Future: Environment, Population and Sustainable Development (EPD)' which has rapidly developed since 1998. By the end of 2008, 'Educating for a Sustainable Future' registered over 1000 schools from 14 provinces as ESD pilot schools in China [4].

Though the development of ESD in China has been rapid, there is limited literature on the empirical development and theoretical considerations of ESD in China's contextual settings. This is significant because studies agree that the lack of an official policy for ESD in China often misleads interpretations of ESD and creates implementation barriers [5]. As

the authors will establish, ESD discourse has varied over time as it has been contextualized and shaped by domestic interests across China's education policies and SD reports. In domestic discourse, 'ecological civilization' was invented in association with ESD and has become a stand-in for ESD in Chinese education policies in recent years. Domestic ESD discourse has nonetheless created disputes over the functions and scopes of ESD, which has made it difficult to address ESD in educational system in China. Therefore, this research aims to explore the ESD discourse that has taken place in China's SD report and education policies since the 1990s. In doing so, this research encourages constructive criticism of ESD in China regarding its 2030 agenda.

The following section will introduce the international origins and theoretical considerations of ESD. By using discourse analysis, this research explores China's education policies and SD reports, and records three decades' worth of changes in ESD discourse, from international recognition to domestic policy agenda. The discussion section highlights the implications of environmental conservation focused ESD and its consequences on shaping the future of ESD in China.

2. A Brief History of Education for Sustainable Development

Sustainability has ecological and economic qualities woven into its definition. The term was originally used in forestry by economists in reference to the size a harvest needed to maintain long-term production [6]. The term quickly became a globally recognised concept due to rising concerns about environmental degradation and natural resource scarcity. Beyond forestry, sustainability 'literally means "a capacity to maintain some entity, outcome, or process over time" and carrying out activities that do not exhaust the resources on which that capacity depends' [1] (p. 69). Since then, the term 'sustainability' has been used widely due to its inclusivity and compatibility.

In 1987, the Brundtland Report introduced the concept of SD and paid attention to social, ecological, and economic issues that exist in the contemporary world [2]. SD as a concept was then created and defined as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' [7] (p. 43). This idea was eventually divided into three dimensions according to Elkington's (1994) Triple Bottom Line Theory: social sustainability, economic sustainability, and ecological sustainability. Social sustainability, often called social solidarity or social inclusion, includes the development of social equality for people regardless of their race, gender, or nationality and focuses on human development [8]. Economic sustainability refers to the development of economic activities that eliminate hunger and poverty, improve human health conditions, and foster efficient economic activities without compromising the other two pillars [8]. Environmental sustainability refers to the reduction of carbon emissions and pollution, protection of the ecosystem, and the reduction of environmental degradation [8].

Before the global adoption of ESD, environmental education (EE) emerged in the 1970s in reaction to increasing awareness of environmental degradation and development issues. Gaining insight from *The Limits to Growth* (1972) and other books, conferences, and social activities, the United Nations quickly proposed an EE framework in the Belgrade Charter (1975). The goal of the proposed EE was to raise public awareness of the current state of the environment and its associated problems, and to develop 'knowledge, skills, attitudes, motivations, and commitment to work individually and collectively towards solutions to current problems, and the prevention of new ones' [9] (p. 3). The framework was further developed in the Tbilisi Declaration (1977), which proposed extending EE to include 'biological, ethical, social, cultural, and economic aspects of environmental issues' and building the foundation for EE and later ESD in the global paradigm [10] (p. 734).

The Rio Earth Summit (1992) further catalysed the connection between EE and ESD. 'Chapter 36' of Agenda 21, which was established at the conference, reoriented education goals towards SD. These objectives built upon the EE framework proposed by the Tbilisi Declaration (1977) and emphasised the importance of this approach [11] 'Chapter 36' of Agenda 21 proposed four education goals: 'promote and improve the quality of education,

reorient the curricula [towards sustainability], raise public awareness of the concept of sustainable development, [and] train the workforce' [12] (p. 7). However, these educational objectives included facets of social justice, economic development, culture, equality, and sustainability that surpassed the scope of EE [12]. These newly-added educational objectives were equally important, however, and needed to be addressed. ESD was thus created to address growing concerns about the environment and humanity and fulfil needs in the education and development sectors [10]. The paradigm shifted; ESD joined SD, as a chief objective of the global agenda.

After 1992, UNESCO developed the concept and framework of ESD. Since the Convention of SDGs in 2015, the definition and scope of ESD have been broadened to meet the increasing challenges that society faces. According to UNESCO, ESD is meant '[to] empower learners with knowledge, skills, values and attitudes to take informed decisions and make responsible actions for environmental integrity, economic viability and a just society . . . while respecting cultural diversity' [13]. UNESCO proposes a balanced approach to applying ESD to environmental, economic, social, and cultural issues and focuses on learning outcomes, learning content, pedagogy, and learning environment. ESD is also a component of the fourth goal of SDGs, which aims to promote education access, equity, and quality [14]. Most importantly, the UNESCO ESD framework explains the intimate relationship between SD and ESD. ESD brings SD knowledge to the public and promotes social transformation towards sustainability [15].

The adoption of ESD can be divided into two main facets: (1) the actualisation of SD stakeholders' beliefs in using education as a tool to promote global sustainability (i.e., the SD perspective) and (2) the establishment of education stakeholders who integrate SD ideas into education systems over the past decade (i.e., the education perspective) [15]. The SD perspective attempts to use education as a tool for facilitating and promoting SD values, knowledge, and beliefs, whereas the education perspective employs SD values in educational practices such as skills and competency training in schools. The relationship between the two perspectives is best described by Scott and Gough (2003) in 'Theory of Change', in which they connect education and change and identify three types of interconnections of SD (Table 1). The first approach, or the Type One Theory, considers environmental problems as the fundamental issue of SD [16]. Scott and Gough (2003) propose a linear relationship between education and change in SD: 'educating people about environmental issues would automatically result in more pro-environmental behaviors' [16] (p. 112). Despite previous research decrying a linear relationship between education and change, Scott and Gough (2003) argue that such a relationship is feasible within the context of SD. Environmental problems can be understood through scientific perspectives and solved via social actions and education technologies that emphasise environmental knowledge [16].

Table 1. Theory of Change by Scott and Gough (2003) (Organised by the Authors) [16].

	Type 1	**Type 2**	**Type 3**
Problems of Sustainable Development	Environmental	Social and/or political actions with environmental consequences	A sophisticated situation beyond existing knowledge
Solutions of Sustainable Development	Environmental and social actions, advancements, and technologies	Social, political, and scientific developments in knowledge and technologies	A heuristic and open-ended learning process to overcome the uncertain challenges of the future

The Type Two Theory, or second approach, that Scott and Gough (2003) propose suggests that social, rather than environmental, problems are the central issue of SD. Scott and Gough (2003) employ critical theory that they attempt to not only understand the issue but also resolve the matter through educational perspectives [16]. Type Two Theory suggests that the social problems of SD can be solved through advanced educational technology that motivates learners to understand the social impediments to SD and to take "appropriate [collective] social, political and environmental action[s]" [16] (p. 113).

The Type Three Theory, or third approach, rejects the previously proposed interrelations between Education and SD. Scott and Gough (2003) argue that the Type One and Type Two Theories are incompatible and restrict our vision for a sustainable future. The Type Three Theory suggests that SD is an issue associated with complexity, uncertainty, risk, and necessity [16]. These attributes contribute to inadequately defined problem of Sustainable Development in Type One and Type Two, as these previous theories disproportionately attribute problems to the environment or society respectively [16]. Scott and Gough (2003) suggest that education should be open-minded, heuristic, and flexible because the problem of SD is multilateral and cross-dimensional. Scott and Gough (2003)'s theory provides a unique lens through which to view the problem of SD in China and the changing definition of ESD in recent decades. Following the current development of ESD on the global stage, ESD emerged in China in 1992. In fact, China's Agenda 21 listed environmental education as a pivotal tool to foster SD in the education system; however, disparities linked to the scope, definition, and functions of ESD persist. Aside from a lack of ESD policy at the national level, ESD as a concept has been redefined by domestic interests. This research thus aims to reveal these definitional variations in SD reports and education policies and to investigate functions and patterns of ESD in China.

3. Method

There is no official ESD policy in China, so this research has aimed to define ESD via the Chinese government's education policies. As there are limited education policy documents containing the term 'ESD', we have investigated three National SD Reports (1997, 2002, and 2011) to understand the relationship between SD and ESD, and the role, function, and scope of ESD in China. In total, we have identified seven policy and report documents that include the term 'ESD' and explain its meaning and function (Table 2).

Table 2. National Reports on Sustainable Development and Education Policies (Organised by the Authors).

Release Date	Policy Document/Report
1994	China's Agenda 21
1997	China's National Sustainable Development and Progress Report
2002	China's National Report on Sustainable Development
2008	The Guidelines of Education for Sustainable Development for Primary and Secondary Schools in Beijing
2010	The Outline of China's National Plan for Medium and Long-Term Education Reform and Development 2010–2020
2011	China's National Report on Sustainable Development
2017	Outline of the 13th Five-Year Plan for the National Cause of Education

To better serve the purpose of this study, we have used discourse analysis as our analytical method. This research has borrowed, in part, from Reisigl and Wodak (2001)'s discourse-historical approach, an analysis that highlights historical and contextual factors in shaping discursive discourse development, and Dunn and Neumann (2016)'s methodological strategies to capture the appearances and changes of ESD discourse in China. The interdisciplinarity of Reisigl and Wodak (2001)'s discourse-historical approach has allowed this research to investigate ESD discourse from an educational and political perspective, rather than from a purely linguistic approach [17]. The identifying and mapping discourse strategies from Dunn and Neumann (2016) have offered a heuristic, analytical, and strategic mechanism to identify, connect, and interpret ESD discourse found in multiple policies and reports [18].

The analysis follows a chronological order and is divided into three sections: 1990s, 2000s, and post-2010.

3.1. ESD Discourse in the 1990s

Education is widely considered a crucial means of distributing and promoting SD on a global scale [15], as is evidenced by China's *Agenda 21*. Motivated by China's interests on economic expansion and poverty eradication in the 1990s, *Agenda 21* introduces the concept of a knowledge economy and proposes education development and quality improvement to foster development expertise [19]. Hypothetically, trained SD expertise promotes economic prosperity, which eventually leads to the elimination of poverty in China. Agenda 21 also includes educational objectives such as the improvement of financial support for public schools and the continuation of improvement of compulsory education quality across the country. This establishment of EE components in the education system signals the connection between SD and education in China. For example, the report includes the following objectives:

> *" . . . Strengthen the inculcation of sustainable development ideas for the learners. Include contents of resources, ecology, environment and sustainable development in the courses of 'Nature' in elementary schools and 'Geography' in secondary schools; offer module of "Development and Environment" in colleges and universities, and establish courses closely related to sustainable development, such as Environmental Studies, etc., run the idea of sustainable development throughout the entire education process from elementary level to higher education (Translated by Author)."* [19] (p. 41)

Here 'sustainable development ideas' are closely associated with resources, ecology, environment, and SD contents. This relationship is framed by the international recognition of SD and is intended to balance development and environmental conservation. China is influenced by the international discourse surrounding SD, namely its environmental focus [20]. China thus promotes environmental protections in its education system to amplify SD values. This focus also appears in the first National Sustainable Development and Progress Report in 1997. The discourse surrounding ESD emerges in the education and population participation section of the report, in which the phrase 'Education for Sustainable Development' is linked with education for environmental protection in the Chinese education system:

> *"The Chinese government attaches great importance to education for sustainable development. Since 1992, a number of higher education institutions have newly set up environmental protection disciplines, departments, and colleges; . . . environmental education courses have been added to the textbooks of primary and secondary schools to cultivate young generation's environmental awareness (Translated by Author)."* [19] (p. 30)

During this time, the discourse on ESD shifts its meaning to centre on EE. SD values thus transform into 'environmental awareness' in schools. In the education system, EE is formed in the school curriculum. Under such influences, projects such as those linked to EPD further develop EE across public primary and secondary schools in China. Aside from building EE into the education system, the 1997 Report makes 'resource awareness' a key task for the public. 'Resource awareness' refers to the proper use of resources and promotion of SD in society. To promote awareness, the Chinese government creates social initiatives to introduce SD values to the public. For example, the government hosts annual activities and festivals, such as 'Energy-Saving Week', 'World Water Day', and 'China Water Day', in schools and wider society [21].

3.2. ESD Discourse in 2000s

With the rapid development of EE in China, discourse on ESD remains stable in the second China National Report on Sustainable Development. The report is released prior to the Earth Summit in 2002, which broadens conceptions of SD. Earth Summit 2002 establishes the DESD (2005–2014), which provides more opportunities and initiatives for adopting ESD in China. As ESD discourse changes internationally, China's domestic EE programmes, such as EPD, also transform their purposes and visions to prioritise ESD. Due to both international and domestic influences, Beijing has established a city-level ESD

policy in 2008 (i.e., the Guidelines of Education for Sustainable Development for Primary and Secondary Schools in Beijing), which broadens the discourse on ESD in China. This initiative is one of the few major domestic education policies in China to mention ESD in its title before the third National SD report. The policy establishment also reflects the process of reconstructing ESD discourse in China.

Throughout the 2008 policy, the definition of ESD remains similar to that which the UNESCO established, but with elements of Chinese culture incorporated. ESD is defined as acquiring scientific knowledge of an SD lifestyle and development of values and behaviours that promote social, cultural, economic, and environmental transformation [22]. The policy emphasises nine topics related to the four pillars of ESD, which relate to the environment, economy, society, and culture. Implementation plans, such as developing social corporations and school communications, are also included in the policy. Most importantly, there are four goals for constructing ESD in primary and secondary education outlined in the policy, which explicitly reflect the underlying ESD discourse and function within China's education system.

The first goal is to 'cultivate primary and secondary school students' sustainable development values, sense of SD responsibility and behaviors, which are to respect life, respect others, respect society, and respect nature' [22]. SD values, behaviours, and responsibilities are attached to a sense of respect in the policy. Respecting life, others, society, and nature indicates the construction of a harmonious relationship, not only between humanity and nature but also between humanity, life, and society. This reflects a shift in ESD discourse from EE-focused discourse to a broader educational commitment. Such an expansion is also illustrated in the efforts that UNESCO has taken since the early 2000s to quickly develop SD and ESD on the international stage. Education has continued to function as a tool to shape and cultivate learners' SD values, senses, and responsibilities. In this respect, China has followed UNESCO in its definition and adoption of ESD. The second goal of the policy is to continue carrying out EE and '. . . help students to develop a scientific lifestyle and behavioural habits that protect the environment, save resources, and conserve biodiversity' [22]. Here, ESD serves as a type of EE and is presented as a means of cultivating students' environmental integrity in knowledge, skills, and awareness, which is consistent with previous educational efforts.

The third and fourth goals of ESD policy reflect domestic interests, meaning that contextual and cultural considerations shape the reconstruction of ESD discourse in China. The third goal of ESD is to 'cultivate [in] primary and secondary school students a sense of responsibility to promote traditional Chinese culture, guide them to respect cultural diversity, [and] understand and respect the culture of different countries and regions' [22]. In focusing on cultural diversity, ESD gains a stronger role in the promotion of traditional Chinese culture. Cultural diversity includes ethics and values and reflects harmonious relationships between countries and ethnic groups. Since respecting cultural differences is a key component of the international recognition of ESD, these particular considerations have led to the expansion of ESD discourse in China [15].

The fourth goal of the ESD policy is tied to the SD discourse presented as the concept 'Scientific Outlook on Development'. According to this document, ESD aims to 'gradually develop [in] primary and secondary school students a people-oriented, comprehensive, coordinated, and sustainable scientific outlook on development . . . and form a sense of responsibility and ability to pay attention and solve practical problems in social, cultural, environmental and economic sustainable development' [22]. Here, ESD serves two functions. The first is to establish value in education based on domestic SD principles. 'Scientific Outlook on Development' is a political theory and slogan developed by the Chinese Communist Party (CPC). It endorses economic and social development, harmonious development of humans and nature, and domestic development that fosters broad growth and advancement in China. 'Scientific Outlook on Development' is created to fulfil both international demands and domestic needs while promoting SD in China [23]. Here, the value placed on education in furthering ESD leads to the 'Scientific Outlook on

Development' in future generations and therefore shifts the development patterns of China towards sustainability with Chinese characteristics.

The second function of ESD is to develop awareness and competence related to the four pillars outlined in ESD concepts. Interestingly, social and cultural SD problems are listed as the first two aspects of the policy. Knowledge and awareness related to social justice, poverty, public safety, and cultural diversity are prioritised in enacting ESD in the education system. The emphasis here indicates that fostering the individual–society relationship as well as the human–human relationship is a priority under ESD principles. They are also the key components for a harmonious society, which is a goal of the 'Scientific Outlook on Sustainable Development'. This does not mean that environment-related education is unimportant, as it is mentioned independently in the policy as the second goal of promoting ESD; however, unlike in the multiple prior National SD Reports, the economic aspect of SD is positioned after the other three pillars. It is uncertain whether the economic perspective is considered less important in China's ESD at the primary and secondary education level, or if there are difficulties with integrating economic knowledge and competency training in ESD.

With the establishment of the Guidelines of Education for Sustainable Development for Primary and Secondary Schools in Beijing (2008), the discourse on ESD has transformed and expanded from an EE focus to a more comprehensive approach. This is due to the shift in SD and ESD sparked by UNESCO at the international level. The integration of the domestic discourse 'Scientific Outlook on Sustainable Development' into ESD signals a change in the relationship between education and SD in China.

3.3. ESD Discourse Post-2010

In 2010, the Outline of China's National Plan for Medium and Long-Term Education Reform and Development 2010–2020 was issued by the Ministry of Education. It outlines a ten-year plan for the education system and identifies educational priorities and interests for the coming decade. In the report, ESD appears as an educational priority along with Safety Education, Life Education, and National Defence Education. These areas are situated under the guise of promoting all-round development education. The policy further outlines the importance of ESD in China's education system; however, it lacks detailed ESD discourse and specific implementation plans, which creates doubt as to whether the emphasis on ESD is merely rhetoric [7]. Once again, definitions of ESD are absent in the policy.

In the following year, the third National Report on Sustainable Development (2011) further outlined the role of education in SD. Although the exact term 'ESD' does not appear in the report, the educational focus related to SD shifts towards education equity, compulsory education, vocational education, and health education [24]. Previous focuses in either the SD report or domestic policies regarding ESD content, such as EE, were not mentioned. Instead, the report illustrates ideas such as 'green consumption style' to increase citizens' ecological protection and energy conservation awareness [24]. Although the phrases ESD, EE, and even ecological education are missing in this report, the idea of environmental sustainability continues its important role in China's ESD agenda.

With UNESCO's rapid development of ESD, the end of DESD in 2014 offered an opportunity to reshape SD and ESD discourse on the international stage. During the 2015 UNSD Summit, member states of the UN proposed 17 SDGs in the 2030 Sustainable Development Agenda. The role of ESD is readdressed in target 4.7, which adds human rights, gender equality, cultural diversity, and other related topics to the construction of a sustainable future [13]. ESD is given a more important role, not only as a tool for spreading values and knowledge of SD but also as a practical approach to developing students' skills to contribute to SD.

While the definition of ESD remains volatile at the international level, discourse on ESD has been reshaped in China. In the outline of the 13th Five-Year Plan for the National Cause of Education (2017), the term ESD is listed and redefined under the term 'Enhancing Ecological Civilisation Competence':

> *"Extensively carry out education for sustainable development, deepen water, electricity, and food saving education, guide students to practice strict economy and combat waste, establish an ecological civilisation consciousness of respecting, conforming to and protecting nature, and therefore form sustainable development concepts, knowledge and competences, practice a thrifty, green and low-carbon, civilised and healthy lifestyle, and lead the green trend in society (Translated by Author)."* [25]

A few implications emerge from the description of ESD appearing in this policy. Here, the scope of ESD has been narrowed to education for diligence and thrift, environmental awareness building, and forming SD values. A strict economy and an opposition to excessive waste are associated with the kind of low-carbon lifestyle that China has promoted since 2009. Education on waste and energy reduction is also associated with multiple goals in the SDGs, such as Goals 1, 2, and 12, which are related to poverty, hunger, and responsible consumption. The domestic interests in these areas meet the UNESCO ESD agenda and continue to construct ESD discourse and practice in China (Table 3).

Table 3. Comparison between the Key Features and ESD Discourse from the Outline of the 13th Five-Year Plan for the National Cause of Education (2017) and the UNESCO ESD Framework (Organised by the Author) [14,25].

Date	ESD in China	The UNESCO ESD Framework
Post-2015	1. The term 'ESD' is subject to 'the Scientific Outlook of Development' and the 'Ecological Civilisation' 2. ESD relates to education for diligence and thriftiness, environmental awareness building, and forming sustainable development values. 3. Other ESD aspects of ESD principles from the UNESCO framework, such as education equality and poverty are distributed to other education goals in the policy	1. ESD empowers learners with knowledge, skills, values and attitudes to take informed decisions and make responsible actions for environmental integrity, economic viability and a just society. 2. ESD is a key enabler for the 17 SDGs and is part of Goal 4 Quality Education. 3. ESD is a lifelong learning process and is holistic and transformational, and encompasses learning content and outcomes, pedagogy and the learning environment itself.

The second implication of the 2017 policy is connected to the goal of constructing harmonious relationships between humanity and nature. A new discourse (i.e., 'the ecological civilisation') appears as an important indicator proposing environmental significance in relation to the promotion of social transformations [26]. Extrapolated from the prevailing SD discourse, or the 'Scientific Outlook of Development', 'ecological civilisation' is 'a promise . . . [that enhanced] environmental consciousness of all citizens, a turn towards green need not reduce economic growth' [27] (p. 323). This discourse first appears in 2007 and is extensively used beginning in 2012 [28]. Internationally, the concept of 'Ecological Civilisation' appeared in multiple international fora and negotiations led by China to show its efforts to combat climate change and foster SD [27]. Domestically, the reinforcement of an 'Ecological Civilization' signals an ideological transformation that stresses the importance of building intimate relationships between economic growth and environmental protection [29]. With the establishment of an 'Ecological Civilization', the re-emphasis of ecological protection has created an important role for education. As a goal of ESD, enhancing civil awareness of respecting and protecting the environment has been an important educational task since ESD entered China. 'As domestic discourse redefines the international standards of ESD, 'ecological civilisation' simply combines ideas of environmental sustainability from previous adaptations of EE and ESD.

The third implication of the 2017 policy relates to the concept 'SD Awareness, Knowledge, and Concept', which is built on the premise of diligence and thrift within EE. The contemporary discourse of ESD in China is distinct from previous policies and reports. For example, education equality and cultural diversity education are not currently connected with ESD; however, the absence of these focuses from this discourse does not necessarily mean that they are excluded from China's education system altogether. In the outline of the

13th Five-Year Plan for the National Cause of Education (2017), education equality, gender equality education, cultural education, and other focuses—whether they are mentioned in previous ESD policies and documents or proposed by UNESCO on the international stage—are listed independently and mentioned as prioritised education emphases [25]. These concepts in China are distinct from those employed in international ESD discourse. As a result, these independent educational objectives, such as lifelong learning, are not considered to be within the scope of ESD in China. The key changes in ESD discourse that emerge in national policies and reports are displayed below (Table 4).

Table 4. Key Features and ESD Discourses from the National Report on Sustainable Development and Education Policies (Organised by the Author).

Released Date	Document/Report	Level of Establishment	Key Features and Discourses
1994	China's Agenda 21 [19]	National	Ties and builds education and SD in the education system
			Focuses on education on ecology, resources, environment, and sustainable development
1997	China's National Sustainable Development and Progress Report [21]	National	Connects the term 'ESD' with EE and 'resource awareness'
2002	China's National Report on Sustainable Development	National	ESD discourse remains the same, connected with environmental education
2008	The Guidelines of Education for Sustainable Development for Primary and Secondary Schools in Beijing [22]	Municipal	Utilises UNESCO's ESD framework while adding Chinese culture
			ESD is defined as acquisition of scientific knowledge of a sustainable development lifestyle and development of values and behaviours to promote social, cultural, economic, and environmental transformation
			Embeds 'the Scientific Outlook on Development' in the ESD as its primary guideline
2010	The Outline of China's National Plan for Medium and Long-Term Education Reform and Development 2010-2020 [30]	National	ESD is an education priority
			The term 'ESD' relates to Safety Education, Life Education, and National Defence Education to promote all-around development education
2011	China's National Report on Sustainable Development [24]	National	The term 'ESD' is not used in the report
			Education prioritises shift to education equity, compulsory education, vocational education, and health education
2017	Outline of the 13th Five-Year Plan for the National Cause of Education [25]	National	The term 'ESD' is incorporated in the discourses, 'the Scientific Outlook of Development' and 'Ecological Civilisation'
			ESD relates to education for diligence and thrift, environmental awareness, and the formation of SD values.
			Other aspects of ESD principles from the UNESCO framework are attributed to separate education goals

4. Discussion

China's most recent policy appears to limit the definition of ESD to EE. More importantly, political discourses from the domestic agenda play increasingly prominent roles in establishing ESD's form and purpose in national policies. As argued above, the domestic concepts 'The Scientific Outlook of Development' and 'Ecological Civilisation' have become

embedded into Chinese ESD discourse. This assimilation has two implications. The first implication is the growing significance of ESD in China's national agenda, as is evidenced by the involvement of political discourse within policies [31]. The second implication is the internalising of ESD in Chinese culture, as is evidenced by different definitions of ESD in China's policies compared with those of UNESCO.

The reinterpretation of ESD within China's policy discourses 'The Scientific Outlook of Development' and 'Ecological Civilisation' reveals two pivotal relationships that remain to be investigated. The first is the relationship between UNESCO's concept of ESD and China's implied concept of ESD seen in 'The Scientific Outlook of Development' and 'Ecological Civilisation'. Returning to Scott and Gough (2003)'s theory of change, Type One Theory suggests that the problem of SD is purely environmental, while Type Two Theory suggests that the problem of SD is social. Type Three Theory recognises the multilateral and cross-dimensional problems of SD, which cannot be solved through solely environmental or social actions. UNESCO's definition of ESD adheres to Type Three Theory, as it integrates social, cultural, economic, and environmental objectives into the SDGs. For example, SDG 8: 'Decent Work and Economic Growth', utilises an economic perspective but asks educators to prepare students to solve both economic and social problems of SD. Education thus serves as a tool to solve the multilateral and cross-dimensional problems of current and future SD. In contrast, China's definition of ESD more closely resembles Scott and Gough (2003)'s Type One and Type Two Theories. The SD problems that ESD addresses in China's most recent 2017 Policy are environmental and social; the policy focuses on EE and education on responsible consumption. The discourse of 'Ecological Civilisation' further typifies China's goals of ESD—environmental conservation and responsible consumption—which depart from the UNESCO ESD framework. A clear comparison is presented in Figure 1.

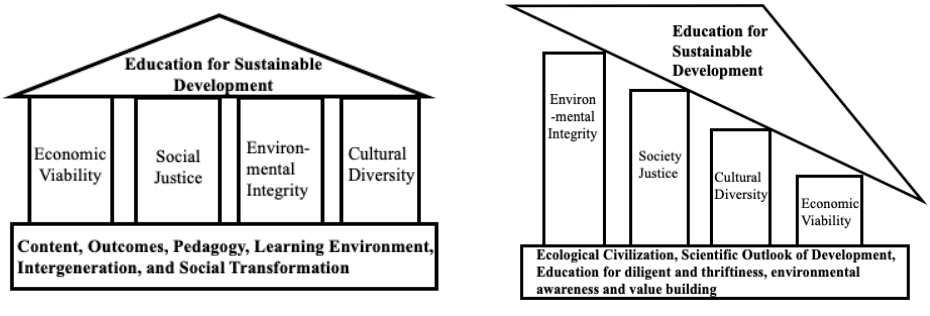
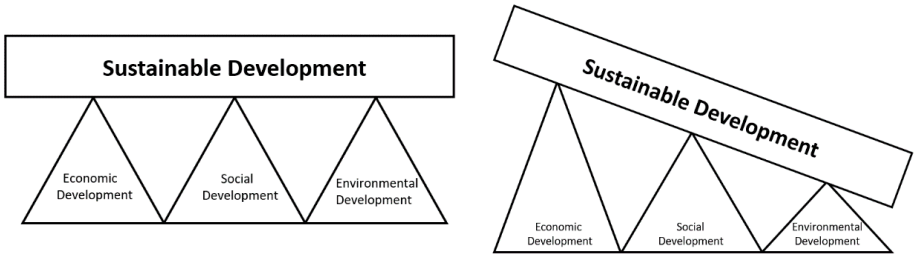


Figure 1. UNESCO concept of ESD vs. China's ESD. (**a**) Ideal education for sustainable development. (**b**) Education for sustainable development in China.

UNESCO's four dimensions of ESD are equally important to prepare students for the future of SD [13]. In contrast, China's current policies on ESD seem to overemphasise strictly environmental goals. Analysing the most recent 2017 policy, it appears that the scope of ESD is explicitly limited to responsible consumption and natural conservation. Much of the original meaning of UNESCO's vision for ESD has been substituted by domestic discourse via the 'Ecological Civilisation' concept. The environmental integrity mentioned in UNESCO's definition of ESD is conceptually different form that of 'Ecological Civilisation'. According to the UNESCO framework, environmental integrity is interconnected with economic, social and cultural sustainability. For example, SDG 13 'Climate Action' requires environmental considerations in reducing emissions and aims to integrate socio-economic factors, such as energy transition, when implementing educational policies. In contrast, 'Ecological Civilisation' solely focuses on the environmental conservation and lacks the ability to interconnect the potential social, cultural, and economic impacts of the

actions. According to 'Ecological Civilisation', UNESCO's four pillars and interdisciplinary approach to ESD are disconnected and weak. The purpose of ESD in China has moved away from nurturing learners and providing the knowledge, awareness, and competency needed for a sustainable society; rather, ESD, or the 'Ecological Civilisation', has become a tool primarily used for promoting environmental awareness, knowledge, and competence.

The differing schedules of SD challenges that are recognised by China and UNESCO also affect the relationship between SD and the 'Ecological Civilisation' in China. The relationship between SD and ESD has been nurtured since the birth of both concepts [15]. Education has been viewed as an important tool to share SD content and knowledge with learners and enhance their SD attitude and awareness; however, the introduction of the 'Ecological Civilisation' in China seems to weaken this relationship. According to Xie et al.'s (2008) study on the role of sustainability in China's development between 1978 and 2008, SD in China quantifiably overemphasises economics (Figure 2) [32].



(**a**) (**b**)

Figure 2. A comparison between (**a**) Ideal UNESCO sustainable development status vs. (**b**) China's sustainable development status [32] (p. 535).

Based on a statistical analysis of the data from 1978 to 2008, China's inferior SD status indicates that environmental development is in a state of disrepair. Unlike the balanced approach promoted by UNESCO, China's economic development index, social development index, and environmental development index are 0.92, 0.81, and 0.47 (−1 and 1 scale) respectively [32]. This means that economic development and social development in China is highly sustainable, whereas the environmental development index is nearly half that of the economic index [32]. Most importantly, the natural resource sustainability index is 0.38, which is far below the economic and social development index [32]. This disparity raises concerns about the environmental capacity for accommodating rapid economic and social development and the delay of environmental development in the overall picture of SD [30]. Although China has recently expressed interest in addressing climate change and the development of a low-carbon economy, the status of SD remains precarious [26].

Given the skewed SD in China, the introduction of 'Ecological Civilisation' brings educational opportunities for China to restore the environmental goals of SD. 'Ecological Civilisation' introduces knowledge and incentivises learners to behave in ways that are environmentally sustainable. Results from Xie et al. (2008)'s study suggest the urgent need to improve environmental sustainability in China. The introduction of 'Ecological Civilisation' therefore may potentially address the weakness of the environmental aspect of SD in China given the recent endorsement by Xi Jinping, the president of China. However, the relationship between 'Ecological Civilisation' and SD remains unbalanced. As mentioned earlier, 'Ecological Civilisation' only covers the environmental aspects of ESD and overlooks its other three components (shown in Figure 1). The acknowledgment of economic impacts while promoting 'Ecological Civilisation' is absent throughout the examined education policies. However, China's SD focus remains on economic development despite the Chinese government's extensive promotion of environmental sustainability [33].

These conflicting goals create a disconnection between SD and ESD and raise uncertainty about the true function of ESD in China. Internationally, ESD resides as a tool within the larger scope of accomplishing SD [4]. In China, where the priorities of ESD are different, the extent to which 'Ecological Civilisation' can actualise the complete objective of SD remains questionable. Again, the scope of 'Ecological Civilisation' mentioned in the 2017 policy only targets knowledge, attitudes, and competence related to education for ecological conservation and responsible consumption. Key issues related to the economic and competency goals of SD in China such as 'green economy', energy transition, and key competence such as strategic competency and systems thinking competency are inadequate under the current scope of 'Ecological Civilisation [15,21,34]. Given China's divergent definitions of SD and ESD, 'Ecological Civilisation' therefore can only provide limited educational support to the environmental goals of ESD, as it loses its educational function to fully support the existing SD in China.

5. Conclusions

This research examines the reception of ESD in Chinese education policies over recent decades. Findings show that the concept of 'Ecological Civilisation' replaces traditional definitions of ESD in China's most recent policies. Furthermore, China's domestic discourse dilutes UNESCO's definition of ESD to environmental protection education and weakens the relationship between ESD and SD. Analysis shows that 'Ecological Civilisation' is unable to foster the educational function that promotes SD; rather, the term is a domestic substitute that aims to develop students' environmental awareness, knowledge, and competence. A possible reason 'Ecological Civilisation' is replacing ESD despite these problems is the absence of a national definition of ESD. Since ESD remains undefined and its scope remains unclear, it is essential to establish comprehensive ESD policies in China that clarify the function, scope, and role of ESD in the education system and its relationship with SD.

This research has several limitations. First, this research only reveals the changes in ESD discourse in China's education policies. ESD may also appear as supplementary elements in other policy documents, such as regional development policies and development agendas. These ESD discourses can further demonstrate the meaning, importance, and role of ESD in China. Second, 'Ecological Civilisation' and 'Scientific Outlook on Development' are political discourses heavily endorsed by the Chinese government. In short, 'Ecological Civilisation' provides a new approach to ESD that is filled with domestic interests. Although there are discrepancies in the function and scope of ESD within the concept of the 'Ecological Civilisation', this new interpretation of ESD can build a foundation for future ESD implementations in China. Therefore, further empirical research is suggested to investigate the implementation and effectiveness of the 'Ecological Civilisation' in educational institutions in China.

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How Urban Residents Perceive Nature Education: A Survey from Eight Metropolises in China

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Abstract: "Nature education" has become a striking trend in the field of environmental and sustainable development education in mainland China in recent years, which is considered to be a powerful force to realize the 11th goal of the 2030 Agenda for Sustainable Development, namely, "Sustainable Cities and Communities". Chinese urban residents' perceptions of "nature education" are fundamental to the success of "nature education" but we still know very little about it. This study aims to gather insights on the awareness, attitudes, and behaviors towards nature and nature education. In this paper, online questionnaires and random sampling methods were used. An online questionnaire survey was conducted among urban residents in eight representative cities in China, namely, Beijing (n = 313), Shanghai (n = 314), Guangzhou (n = 307), Shenzhen (n = 308), Chengdu (n = 206), Xiamen (n = 207), Hangzhou (n = 203), and Wuhan (n = 206). This study implied that Chinese urban residents are willing to accept nature education. There is a strong sense among the Chinese public in cities that living in harmony with nature, improving wellbeing through healthy and sustainable actions, and enjoying and protecting nature are desirable actions. However, respondents were slightly less likely to consider the emotional benefits and the development of social and functional (technical) skills as important elements of participating in nature education. The results also confirm that Chinese urban residents' perceptions of nature education can be positively predicted by the individual's relationship with nature and the individual's experience related to nature education. These are important key messages for nature education organizations to communicate. The results of the study put forward some questions worthy of in-depth consideration for the development of China's nature education, which can provide a foundation and direction for the further development of nature education in China.

Keywords: nature education; urban residents; perception; survey

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1. Introduction

With the rapid development of China, about 64% of the Chinese people currently live in cities [1]. As a result, the understanding, views, attitudes, and associated environmental behaviors of urban residents increasingly pose challenges to China's environment and sustainable development. Therefore, educating urban residents on the environment and sustainable development will undoubtedly help improve the resilience and sustainability of cities and contribute to the realization of Goal 11 of the Sustainable Development Goals, "Sustainable Cities and Communities".

In recent years, "nature education" has become a striking trend in the field of environmental and sustainable development education in mainland China. According to incomplete statistics, since 2010, China's industry institution carrying out "nature education"-related activities have shown a trend of explosive development and have formed a market

that has begun to take shape, and there are more latecomers eagerly preparing to enter this field. Although there is no general consensus on "nature education", its advocates and practitioners believe that receiving "nature education" can help modern urban residents who lack direct contact with nature to improve their cognitive level [2], develop environmentally friendly attitudes [3], increase environmentally friendly behaviors [4], enhance physical fitness [5], and reinforce prosocial tendencies [6], so as to provide strong support for the grand visions of "ecological civilization", "green development", and "beautiful China".

Although the aforementioned studies and reports have pointed out that nature education can help establish nature connections and may play an important role in the construction of a sustainable society in China, the acceptability of the public must be seriously considered if the social significance of nature education is to be truly realized [7]. Are urban residents willing to receive nature education? What factors affect their acceptance of nature education? There is no clear research result for this concern at present. Urban residents are the main clients of nature education in China. Knowing their needs, expectations, preferences, intentions, etc., for "nature education" can help policy makers, nature education institutions, and practitioners provide them with targeted services. On the other hand, it can also help to make preliminary assessments on the potential role and development direction of nature education on nature protection and people's lives. Therefore, we carried out a quantitative study to understand urban residents' perceptions towards nature education. This study was motivated by two research questions: (a) what are Chinese urban residents' views on nature education and (b) what affects their views on nature education?

2. Literature Review

2.1. Urban Residents and Nature Connection

Previous studies have discussed urban residents' perceptions of nature from different perspectives. For example, Madureira et al. [8] explored residents' beliefs concerning the benefits of urban green spaces. Although the residents of the sample cities had mixed perceptions of the benefits of green spaces, the importance of urban green spaces for personal wellbeing and for human contact with nature was noted by the residents of all the four urban areas researched. Bonthoux et al. [9] investigated urban residents' perceptions of green streets in cities and found that people favored vegetated pavements over asphalt pavements, perceiving the former more beautiful and stimulating even though they are less frequently maintained. In addition, many scholars examine urban natural facilities, such as parks or public gardens. According to Xu [10] and Zhao et al. [11], returning to nature is one of the main motivations for urban residents choosing urban park recreation. Wang [12] suggests that natural scenery and psychological safety are the main factors influencing urban residents' satisfaction with recreation.

The impact of nature-related activities on urban residents has also been explored. In the research of Soga et al. [13], urban residents' (students from the University of Tokyo) perceptions of natural environments and biodiversity were assessed by a questionnaire survey. The results showed that a large number of natural experiences enhanced their emotional attachment to nature and also improved their positive perceptions of urban nature. Taylor et al. [14] studied the effects of nature on children's self-discipline in urban areas and found that girls living close to green spaces demonstrated better concentration and emotional regulation skills than boys and that children in greener environments had more outdoor playtime and showed greater creativity.

Many studies have focused on the relationship between urban nature and residents' physical and mental health. Bennett [15] explored the relationship between urban residents visiting public gardens and stress reduction and found that urban residents reported less stress after visiting the gardens. It is believed that relaxing, stress relief, and inspiration drawing are the three main reasons for visiting gardens. In the study of Gubbels [16], more natural elements in the community helped lessen urban residents' symptoms of depression. In the study by Rostami et al. [17], the respondents indicated that their visit

to an urban garden was primarily driven by the natural environment and vegetation, and that recreation and nature observation were the most likely activities. In addition, residents realized that exposure to the natural environment contributed to health, reduced stress, relieved mental fatigue, enhanced concentration, increased neighborhood interactions, and promoted social connections. Cleary et al. [18] claim that mental health is associated with the perception of local urban green space. However, a study by Allard-Poesi et al. [19] found that compared with city parks or public gardens, residents sensed that undomesticated nature was more closely linked to wellbeing, suggesting that the degree of the domestication of the nature around residents is negatively related to their wellbeing. Rasidi et al. [20] surveyed urban residents' views on "how the design of urban green space affects their own social interactions" and the results indicated that the diversity of subspaces, such as vegetation density, animal populations, undulating topography, and water bodies, was a key factor for residents' social interaction behavior.

Additionally, scholars have also conducted retrospective research on urban residents and nature, discussing the long-term effects of natural activities on residents. For example, Hosaka et al. [21] examined the relationship between childhood nature play and adult nature recreation after the control of variables such as gender, age, and income, finding that the frequency of childhood play in green spaces was correlated positively with that of all nature-based recreational activities in adulthood. Through interviews with respondents, Cleary et al. [22] found that past childhood and the duration of current urban nature experiences at home and in the city are likely to have a significant influence on how connected these adults feel to nature. However, people lacking experience with nature during childhood can still develop a high sense of nature connection through experiencing nature in adulthood.

Moreover, extant studies have also explored the relationship between the cognition, emotions, willingness, and behaviors of urban residents. For example, Chen et al. [23] investigated how the perception of green space promoting health influences young urban residents' park-using volition and actual use. The results revealed that the perception of green space components (e.g., green space access, types, sizes, plants, water, sensory features, microclimate environments, and amenity facilities) for health promotion greatly impacted their willingness to use parks, while it remained less influential with respect to their actual park-use behavior (the frequency and duration). The findings of Bashan et al. [24] highlight that decreased opportunities to interact with nature undermine cognitive and affective relations to nature. Such reductions could affect the overall attachment to man–nature relationships, thereby weakening people's relationship values such as caring for nature and a sense of belonging, place, and identity, and could ultimately negatively impact both humans' wellbeing and environmental stewardship.

2.2. Urban Residents and Nature Education

Although the term "natural education" has been familiar to educators in mainland China since 2014, there is no clear and systematic data or literature to prove its historical origin and academic definition. Some scholars believe that "nature education" is a derivative form of environmental education [25]. Some scholars think that it is not consistent with the focus of environmental education. For example, it puts more emphasis on the concepts of the "natural", "ecological", and "harmonious development between man and nature" [11,26,27], emphasizes the accumulation and inheritance of "knowledge about nature" [28], and has unique Chinese cultural connotations [29]. The definition proposed by the "National Nature Education Network" [30], a non-governmental institution of Chinese nature education practitioners, emphasizes the two elements of nature education as the "connection between man and nature" and "activity in nature", representing the basic understanding of China's nature education field so far. The former one points out that the purpose of nature education is to rebuild and strengthen "the connection between man and nature", while the latter one indicates that the basic way to achieve this purpose is "activity in nature". This has also become the basis for Chinese nature education practitioners to

carry out nature education and the general public to understand nature education. Therefore, as long as there are related activities with these two elements, it can be considered "natural education".

From this perspective, the related research on "nature education" is vague and extensive, which shares many commonalities with "nature-based learning", "learning in nature", "nature study", "nature appreciation", "outdoor education", etc. Most previous studies have focused on the effect of urban residents receiving nature education (NE). According to Yılmaz [31], short-term NE has improved urban children's connectedness to nature and to animals, as well as biophilic tendencies. Ferreira [32] studied the implementation effects of NE. Taking the three-day nature learning experience project in Table Mountain National Park as an example, the researchers found that 13-year-old urban children have begun to notice environmental problems after the project, but there were still deficiencies in their basic attitudes and behaviors towards recycling, such as their reluctance in picking up litter at home and in school, unwillingness to join environmental clubs, and reluctance in raising funds to support the environmental cause. Gautheron [33] explored the effects of learning in a natural environment for junior high school students from the perspective of teachers. The interviewed teachers mentioned the benefits of nature-based learning, including promoting active engagement, more willingness to take risks, better enjoyment of school life, and more capable management of the natural environment. Meanwhile, the teachers also noticed an improvement in their attitudes and behaviors towards students in the natural environment, and a more harmonious teacher–student relationship.

The effects have also been reported in higher education. Magulod [34] explored the effect of nature experiential learning activities on improving college students' environmental attitudes. Respondents indicated that various experience-based learning activities were very intriguing, among which the tree planting campaign and the environmental film poster design were the most beneficial in arousing their learning interest. In Kras' study [35], through nature-based learning, the participation in an animal care-related project enabled the urban community college students to gain ideas and knowledge about future careers and to obtain happiness through interacting and learning with animals. Cheang et al. [36] studied the nature-based experiential learning program at the University of Hong Kong and found that participants perceived an enhancement in their knowledge and skills in certain fields and in environmental and nature awareness, which would facilitate their personal growth and future professional development.

Some scholars have studied the impact of a nature-based curriculum on urban residents. For example, a study by Supramaniam [37] found that a nature-based curriculum helped develop children's creativity, comprehension, and cognitive abilities. Experiencing and learning in the natural environment can further improve children's social and emotion-regulation skills. It is noted that children develop affection for nature only when they are engaged with nature.

Literature reviews help us recognize research gaps in prior research and help us build research hypotheses. Given all of the previous studies, participating in nature experience activities can help urban residents strengthen their nature connections and have a positive impact on urban residents in terms of physical, psychological, and social interactions. At the same time, previous studies have confirmed the beneficial effects of nature education on people of different ages and have also preliminarily discussed the influencing factors of urban residents' participation in nature education. However, there are very few related studies on Chinese urban residents' views on nature education and the factors that influence Chinese residents' views on nature education. Therefore, this study attempts to explore the current status of Chinese urban residents' views on nature education and the factors that influence Chinese residents' views on nature education. Based on prior research, this study proposes the following hypotheses:

H1. *Chinese urban residents possess a positive perception of nature education.*

H2. *Chinese urban residents' perceptions of nature education can be positively predicted by the individual's relationship with nature.*

H3. *Chinese urban residents' perceptions of nature education can be positively predicted by the individual's experience related to nature education.*

3. Materials and Methods

3.1. Research Design and Data Source

This study is quantitative research. Given the enormous size of China's population and the widespread urban distribution, there are obvious financial and administrative difficulties in conducting a large-scale survey. Therefore, this study adopted the method of purposeful sampling and selected 8 representative cities in China. A total of 4 tier-1 cities, or national central cities (Beijing, Shanghai, Guangzhou, and Shenzhen), and 4 tier-2 cities, or regional central cities (Chengdu, Xiamen, Hangzhou, and Wuhan), as the most representative cities with the densest population and the earlier start of nature education in China, were selected to be the sample cities (see Table 1).

Table 1. Sample cities.

Name		Population (Unit: 10,000)	Characteristics
Tier-1 cities (national central cities)	Beijing	2189.31	Capital of China; megacity in northern China
	Shanghai	2487.09	Biggest city in China; megacity in eastern China
	Guangzhou	1887.06	Capital of Guangdong province; megacity in southern China
	Shenzhen	1767.38	First special economic zone in China; megacity in southern China
Tier-2 cities (regional central cities)	Chengdu	2093.78	Capital of Sichuan province; megacity in southwest China
	Xiamen	516.40	Central city of the southeast coastal area in China
	Hangzhou	1220.40	Capital of Zhejiang province; megacity in eastern China
	Wuhan	1232.65	Capital of Hubei province; megacity in central China

In this study, a questionnaire survey and random sampling methods were used to collect data. We used a quantitative instrument developed by the China Nature Education Network (CNEN) in 2020 to measure the attitudes, values, and behaviors towards nature education of the general population in China. An online questionnaire survey was conducted among urban residents in eight cities with a large number of respondents: Beijing (n = 313), Shanghai (n = 314), Guangzhou (n = 307), Shenzhen (n = 308), Chengdu (n = 206), Xiamen (n = 207), Hangzhou (n = 203), and Wuhan (n = 206). A sample of n = 2064 Chinese adults were surveyed using a consumer panel provider. Respondents were targeted and screened for gender, age, education, and cities. The data constructed the research data of the current research. The majority of the respondents were married and half of them were with one child. Table 2 shows the demographic information of the participants.

The respondents came from eight cities in China, with each city accounting for 9.8–15.2%, showing a fairly even distribution. Of the 2064 respondents, 41.6% were male and 58.0% female. Regarding their marriage status, 63.4% were in a marriage and 36.6% were not (including unmarried, divorced, and widowed). In terms of age, nearly half of the respondents were aged from 18 to 30, a third of them from 31 to 40, and only 13.2% of them were aged above 40. Of the 2064 respondents, 75.4% had a bachelor's degree or above. Most families earned an average monthly income between 10,000 and 50,000 yuan (middle income in China), accounting for 68.1% of the total.

Table 2. Basic information of participants (n = 2064).

Characteristics		Value (%)
Gender	Male	41.8
	Female	58.2
Marriage	Married	63.4
	Not married	36.6
Age	18–30	49.2
	31–40	37.5
	41–50	10.0
	>50	3.2
Education	High school or below	7.5
	Junior college	17.1
	Bachelor	65.8
	Master or above	9.6
Average monthly household income (yuan) (1 yuan ≅ 0.14 euro)	<5000	7.8
	5000–10,000	19.4
	10,000–20,000	43.0
	20,000–50,000	25.1
	50,000–100,000	2.7
	>100,000	1.9

3.2. Variables

The dependent variables: "knowledge of nature education" (Z1) and "understanding of the role of nature education" (Z2) were the two dependent variables used to describe and explore the perceptions and attitudes of Chinese urban residents towards nature education.

The independent variables: There were two categories for the independent variables. One was the "individual's relationship with nature" (X) and the other was the "individual's experience related to nature education" (Y). The former could be divided into 4 independent variables, namely, "knowledge of nature" (X1), "emphasis on nature" (X2), "understanding of role of nature" (X3), and the "frequency of exposure to nature" (X4). The latter could be divided into 2 independent variables, namely, "involved types of nature education activities" (Y1) and "satisfaction with involved nature education activities" (Y2).

The control variables: the control variables included the city of residence, age, gender, educational background, marital status, number of underage children, and average monthly household income.

The hypothetical relationship between the dependent variables and the independent variables is shown in Figure 1.

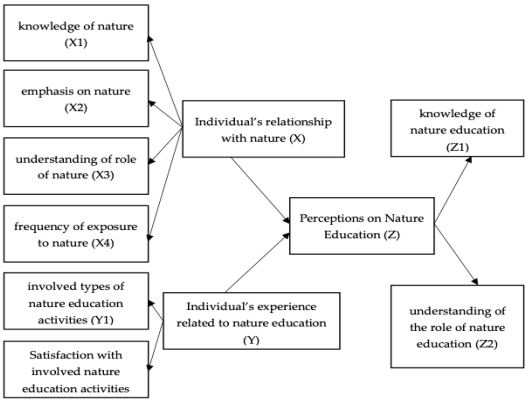

Figure 1. Hypothetical relationship between dependent and independent variables.

3.3. Questionnaire

This study adopted the paradigm of quantitative research. An online questionnaire was developed to explore Chinese urban residents' views on nature and nature education. The questionnaire consisted of five parts: basic information, perceptions of nature education, participation in nature education activities, motivations for participation, and the tendency to participate in the future. The questionnaire for the survey, with a total of 28 items, was approximately 10 min in length. Data were collected between 31 March and 13 April 2021. 8 items composed the part of the basic information while 7 items were in the part of the perceptions of nature education, 5 items were in the part of the participation in nature education activities, 2 items were in the part of motivations for participation, and 6 items were in the part of the tendency to participate in the future.

The basic information included the respondents' city of residence (Beijing, Shanghai, Guangzhou, Chengdu, Xiamen, Shenzhen, Hangzhou, or Wuhan), age, gender (0 = male, 1 = female), educational background (1 = high school degree or below, 2 = junior college degree, 3 = Bachelor's degree, 4 = Master's degree or above), marital status (1 = in a marriage, 0 = not in a marriage), number of underage children, and average monthly household income.

The self-assessment scale was used to examine the respondents' perception and attitude towards nature. The degree to which nature is valued is reflected in the response to the question "How important is it to you to spend time in nature?" The degree of the knowledge of nature is reflected in "How would you rate your knowledge of nature?" Both questions were self-rated on a scale from 0 to 10, with a higher score indicating a deeper understanding of nature.

The scale of nature cognition included 14 items in total, such as "I recognize and prectice the idea of human living in harmony with nature" and "I enjoy being in nature." Respondents could choose from five dimensions: 1 = strongly disagree, 2 = somewhat disagree, 3 = indifferent, 4 = somewhat agree, and 5 = strongly agree. A higher score indicates a stronger identification with nature.

The measurement of the perceptions and attitudes towards NE included a single-choice question with a scale from 1 to 5 ("How would you rate your knowledge of nature education?") and a multiple-choice question consisting of 11 choices and one open answer ("Please select from the list below all the areas where you feel that participating in nature education activities will help you or your child develop or improve.").

The motives for participation in NE were explored through a ranking question ("Which are the reasons do you think most motivating for you or your child to participate in nature education activities?"), inviting the respondents to select the five most important items from all the lists and rank them, with 1 being the first and 5 being the fifth.

The tendency to partake in NE activities in the future was investigated via another ranking question ("Which type of nature education activities interests you or your child most?"), requiring the respondents to choose three out of seven items and rank them.

The likelihood of future participation was measured through the question "How likely will you participate in nature education activities within the next 12 months?" (1 = very unlikely, 2 = relatively unlikely, 3 = uncertain, 4 = relatively likely, and 5 = very likely).

3.4. Analysis

To attain the goal of exploring the views and attitudes of Chinese urban habitants towards nature and NE, descriptive statistics were used to describe the status quo of the respondents' understanding of nature and NE and their potential to engage in relevant activities in the future. The figures in the charts and tables in this report are expressed in percentages unless otherwise noted. The total percentages may not add to 100 because of rounding. SPSS 26 software was used to analyze the data statistically. A *t*-test was adopted to further measure the variances in the views of the respondents with different genders and marital statuses. Additionally, an analysis of variance (ANOVA) was utilized to examine the differences in attitudes among the participants with different ages, education levels, and

family incomes. In addition, the residents' motivation and preferences for nature education were analyzed to display a fuller picture of Chinese urban dwellers' perspectives on nature education (see Table 3). Finally, an Ordinary Least Square regression (OLS) was used to explore relevant factors that affect urban residents' understanding of nature education. The effects of the factors related to nature and nature education on their perceptions on nature education were analyzed separately.

Table 3. *t*-test and ANOVA of Chinese urban dwellers' perspectives on NE.

	M *	SD *	Min *	Max *	T/F *	Sign *
How important is it to you to spend time in nature?	7.63	1.50	1	10		
Male	7.61	1.55			0.51	0.61
Female	7.65	1.45				
Married	7.35	1.40			−6.36	0.000
Not married	7.79	1.59				
Age					5.85	0.000
Education					4.31	0.005
Income					7.29	0.000
How would you rate your knowledge of nature?	6.59	1.72	1	10		
Male	6.77	1.70			−3.94	0.000
Female	6.46	1.72				
In a marriage	7.79	1.41			−8.01	0.000
Not in a marriage	7.35	1.59				
Age					6.83	0.000
Education					3.94	0.005
Income					7.18	0.000
How much do you know about nature education?	6.52	1.82	1	10		
Gender						
Male	6.71	1.82			−4.01	0.000
Female	6.39	1.81				
Married						
Not married	6.10	1.94				
Not in a marriage	6.75	1.72			−7.75	
Age					6.31	0.000
Education					2.58	0.052
Income					5.12	0.000
How likely will you participate in nature education activities within the next 12 months?	3.99	0.98	1	5		
Male	4.06	1.00			−2.75	0.006
Female	3.94	0.96				
Married	4.18	0.88			−12.02	0.000
Not married	3.65	1.06				
Age					13.91	0.000
Education					20.42	0.000
Income					19.89	0.000

* SD = standard deviation; * Min = minimum; * Max = maximum; * T/F = significance test; * Sign = significance test.

4. Results

We will now present the results from the different analyses of the data. The results include the results of the descriptive statistics and a linear regression analysis.

4.1. Resuts of Descriptive Statistics

4.1.1. Most City Dwellers Possess a Positive Attitude towards "Nature" and "Contact with Nature"

Shown in Table 3, the average score for knowledge of nature was 6.59 (SD = 1.72). Male respondents showed a deeper understanding of nature than female ones. Residents in a marriage indicated a richer knowledge of nature than those not in a marriage. The degree of knowledge also differed among groups of different ages, education backgrounds, and family income. The vast majority of the respondents believed in the significance of exposure to nature, with an average score of 7.63 (SD = 1.49). There was no gender difference in the value of the connection with nature, but there was a difference across marital status, age, education level, and household income.

Table 4 also indicates that the vast majority of individuals tended to engage in nature. A total of 92.1% of people recognized and practiced the concept of harmony between man and nature, 89.9% of people enjoyed being in nature, and 85.4% of people felt joy while being in nature. A total of 90.4% of residents tried to minimize their negative impact on nature and about 82% of respondents supported actions that benefit the environment, trying their best to protect nature and the environment. Except for "Spend your spare time with family and friends", the other options were pro-nature behaviors, on which all the respondents scored high with an average score of 3.4 (SD = 0.5, on a scale of 1–5).

Table 4. Attitudes towards nature and self.

Items	Disagree	Neutral	Agree	Total
Recognize/practice the concept of harmony between man and nature	2.2	5.7	92.1	100.0
Enjoy being in nature	2.5	7.6	89.9	100.0
Support actions aimed at addressing environmental issues	3.3	14.8	81.9	100.0
Reduce your negative impacts on the environment/nature	2.3	7.3	90.4	100.0
Try your best to protect the environment/nature	3.6	14.4	82.0	100.0
Improve the health and environment of yourself and your family	2.7	12.0	85.3	100.0
Spare more free time in nature	28.0	37.1	34.9	100.0
Do exercise to maintain physical and mental health	13.8	20.6	65.6	100.0
Enjoy being in nature	4.0	10.6	85.4	100.0
Challenge yourself/try new things in nature	9.3	26.6	64.2	100.0
Prioritize outdoor activities for yourself and your family in spare time	16.4	24.6	59.0	100.0

4.1.2. Most City Dwellers Believe They Had a Basic Understanding of "NE"

Tables 3 and 4 also show that the average score of the respondents' understanding of NE was 6.5 points (SD = 1.8). Only 6.5% of the respondents thought that they had no knowledge of NE, while 53.7% of the respondents felt satisfactory about their understanding of NE. Male respondents (M = 6.71, SD = 1.82) reported better knowledge of NE than female ones (M = 6.39, SD = 1.81), and residents not in a marriage reported better knowledge than those in a marriage. In addition, significant differences were noticed in the understanding of NE among city dwellers across age, educational level, and family income. However, among people with different education backgrounds, there existed no significant differences. In terms of age, compared with people aged 18–25, those aged 26–40 showed a more

solid understanding of NE, but there was no significant difference between people aged 40–60 and people aged 18–25. Families with a lower monthly income (3000–5000 yuan) demonstrated significantly less understanding of NE compared with higher-income families (20,000–100,000 yuan).

4.1.3. Most City Dwellers Participated in NE Activities out of Concern for "Self-Development"

Table 5 shows that the respondents' motivation for participating in NE activities could be divided into two categories: self-development motivation and social interaction motivation. Many respondents considered meeting self-growth needs the main reason for their engagement in NE activities. Comparatively, only a few respondents suggested their main purpose of participation in NE activities was to satisfy the needs of social interaction, such as increasing opportunities to interact with other peers, strengthening community connections, promoting community development, supporting diverse groups, and experiencing a safe and supportive environment.

Table 5. Motivations for city dwellers' participation in NE.

Self-development	Enhance human–nature connect and respect nature (48.8%) Learn scientific knowledge related to nature (48.6%) Know oneself in nature (39.6%) Relax in nature and entertain (31.3%) Develop habits conducive to long-term individual growth (30.9%) Learn derived skills (29.2%) Generate pro-nature behaviors (19.6%) Foster curiosity and interest in nature (18.9%) Supplement schooling/expand channels for self-growth (7.5%) Partake in stimulating, adventurous activities (2.1%)
Social interaction	Obtain an opportunity to interact with peers (9.3%) Strengthen community connections and promote community development (6.6%) Experience a safe and supportive environment (4.9%) Support diverse communities (3.1%)

Overall, respondents' engagement in NE activities was mainly driven by their self-growth demands, anticipating the acquisition of relevant knowledge and skills, the generation of habits and behaviors conducive to the environment, and personal development.

4.1.4. Most City Dwellers Displayed Strongest Interest in Nature Experience NE Activities

According to Table 6, the most popular NE activities included nature experience, natural history, environmental protection and popular science, farming, outdoor exploration, travel for studies, project-based learning, and handicraft, among which activities related to natural experience accounted for the highest proportion (78.8%). Obviously, most people yearned for contact with nature. This was followed by the study of natural history, environmental protection, and popular science, accounting for 48.3%. The third one was ecological farming activities. There existed no significant gender difference in terms of the favored NE activities, but males preferred natural history science, project-based research, and outdoor adventure, whereas women demonstrated more interest in farming and crafting.

A total of 77.5% of the respondents mentioned the possibility to partake in NE activities in the future, of which 42.6% were very likely to participate. Only 9.4% showed unwillingness and the remaining 13.1% reported uncertainty. The overall score was 3.99 (full score = 5), indicating a high possibility, with male respondents displaying a significantly higher possibility than female ones on average. The average score of the male respondents was 4.06 (SD = 1), while that of the female respondents was 3.94 (SD = 0.96). People not in a marriage (M = 4.18) were less likely to participate than those in a marriage (M = 3.65).

Table 6. NE activities most attractive to Chinese city residents.

Activities	Total (%)	Male (%)	Female (%)
Nature experience	78.8	54.2	54.1
Farming	48.3	15.6	16.9
Natural history, environmental protection, and popular science	62.9	18.6	16.5
Project-based learning	21.0	2.6	2.4
Outdoor exploration	28.4	4.9	3.3
Travel for studies	39.1	3.5	4.2
Handicraft	21.5	0.6	2.5

4.2. Results of Linear Regression Analysis

4.2.1. Most Independent Variables Can Positively Predict the Residents' Knowledge of Nature Education

Table 7 shows the linear regression of the factors of "individual's relationship with nature" (X) and "individual's experience related to nature education" (Y) on the residents' self-assessed "knowledge of nature education" (Z1). Model 2, Model 3, Model 4, and Model 5, respectively, represent the influence of X factors on Z1, the influence of Y factors on Z1, the influence of X and Y factors on Z1, and the influence of various factors on Z1 after controlling the control variables. The "knowledge of nature" (X1), "emphasis on nature" (X2), and "frequency of exposure to nature" (X4) were positively correlated with Z1. However, understanding of role of nature (X3) was negatively correlated with Z1. This is an interesting phenomenon. One possible reason is that those who think they have a full understanding of the role of nature are no longer willing to participate in nature education activities. Of course, this needs further exploration.

Table 7. OLS of residents' self-assessment of their understanding of nature education.

	Model 1	Model 2	Model 3	Model 4	Model 5
Knowledge of nature		0.658 **		0.584 **	0.585 **
Emphasis on nature		0.250 **		0.237 **	0.241 **
Understanding of the role of nature		−0.204 **		−0.228 **	−0.218 **
Frequency of exposure to nature		0.074 **		0.0424 *	0.0379 *
Involved types of nature education activities			0.468 **	0.195 **	0.185 **
Satisfaction with involved nature education activities			0.437**	0.115 **	0.1212 **
City (Beijing)					
Shanghai	−0.09				−0.0002
Guangzhou	−0.163				0.097
Chengdu	0.037				0.043
Xiamen	−0.195				0.137
Shenzhen	−0.321 *				−0.119
Hangzhou	−0.120				0.108
Wuhan	−0.456				−0.118
Age	−0.1176 **				−0.059 *

Table 7. *Cont.*

	Model 1	Model 2	Model 3	Model 4	Model 5
Education (high school or below)					
Junior college	0.211				−0.110
Bachelor	0.318 +				−0.211 +
Master or above	0.200				−0.240 +
Marriage (married)	0.485 **				0.086
Gender (female)	−0.346 **				−0.123 *
Income	0.012				−0.005
Number of kids	0.357 **				0.021
Constant	6.077 **	0.667 *	4.208 **	0.829 **	1.141 **
Observations	1789	1789	1789	1789	1789
F	8.69	663.17	149.66	356.19	110.74
R-squared	0.066	0.572	0.152	0.559	0.566

Robust standard errors in parentheses. ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$.

For residents who have participated in nature education activities, the more types of nature education activities they participated in, the more their knowledge of nature education; the higher their satisfaction with nature education activities, the more their knowledge of nature education. The table also shows that the younger the age, the higher the understanding of nature education. Compared with women, men had a higher understanding of nature education.

4.2.2. Most Independent Variables Can Also Positively Predict Residents' Understanding of the Role of Nature Education

Table 8 shows the linear regression of urban residents' "understanding of the role of nature education" (Z2). As noted, Model 2, Model 3, Model 4, and Model 5, respectively, represent the influence of X factors on Z2, the influence of Y factors on Z2, the influence of X and Y factors on Z2, and the influence of various factors on Z2 after controlling the control variables. The results show that after controlling for all the variables, X1 had little effect on Z2, but X2 and X3 were positively correlated with Z2. Additionally, the more Y1, the more Z2, although the growth was little. The unmarried residents were more aware of the role of nature education than the married residents, and women were more aware than men.

Table 8. OLS of residents' understanding of the role of nature education.

	Model 1	Model 2	Model 3	Model 4	Model 5
Knowledge of nature		−0.067		−0.089 +	−0.090 +
Emphasis on nature		0.173 **		0.140 *	0.135 *
Understanding of the role of nature		1.258 **		1.192 **	1.144 **
Frequency of exposure to nature		0.088 *		0.023	0.061
Involved types of nature education activities			0.858 **	0.852 **	0.864 **
Satisfaction with involved nature education activities			0.124	0.0181	0.009

Table 8. *Cont.*

	Model 1	Model 2	Model 3	Model 4	Model 5
City (Beijing)					
Shanghai	−0.284				−0.094
Guangzhou	−0.734 **				−0.574 **
Chengdu	−0.107				−0.186
Xiamen	−0.152				0.031
Shenzhen	−0.244				0.015
Hangzhou	−0.341				−0.337
Wuhan	−0.340				−0.209
Age	0.014				0.070
Education (High school or below)					
Junior college					0.360
Bachelor					0.222
Master or above					0.050
Marriage (married)	−0.591 **				−0.710 **
Gender (female)	0.407 **				0.331 **
Income	−0.096				−0.156
Number of kids	0.186				0.116
Constant	5.400	−1.339 *	3.548 **	−1.038	−1.212 *
Observations	1789	1789	1789	1789	1789
F	3.03	23.47	108.57	45.34	18.36
R-squared	0.015	0.085	0.126	0.188	0.212

Robust standard errors in parentheses. ** $p < 0.01$, * $p < 0.05$, + $p < 0.1$.

5. Discussion

The sample size of this study was limited and data were only collected online, so there is a certain sampling bias. However, the results of this study still raise some questions worthy of further consideration for the development of nature education in China. The results confirm the previous hypothesis that Chinese urban residents are willing to accept nature education and that Chinese urban residents' perceptions of nature education can be positively predicted by the individual's relationship with nature and the individual's experience related to nature education. This study shows that Chinese urban residents have positive attitudes towards "nature" and "contact with nature" and are willing to engage in pro-nature behaviors. Additionally, urban residents in China attach great importance to the opportunity for themselves and their children to get in touch with nature, and the vast majority believe that exposure to nature is very important for both individuals and children. However, previous surveys have shown that children in Chinese cities very much lack opportunities to get in contact with nature and that the times and the frequency of contact with nature are not ideal. It seems to reflect the contrast between strong will and less action. Why is the strong desire to "contact nature" rarely translated into the actual action of "experience nature"? What role can nature education play in this? These questions need to be answered by good follow-up research. This study also reveals that Chinese urban residents are more aware of nature education. Most of the respondents indicated that they had a good understanding of nature education and there was little difference between

cities. The concept of "nature education" has only been popular in China for a few years, and it has gained a relatively broad and uniform understanding. It can be seen that Chinese society has formed a good atmosphere that pays attention to "environmentally friendly", "ecological", "green", and other concepts, which will be an important ideological basis for China to promote the realization of the UN's Sustainable Development Goals. However, how can one turn the foundation of thought into practical action? Could nature education play a role in this process? Researchers of Chinese nature education may need more detailed research to make nature education truly become an effective bridge to connect "will" with "action". Notably, the findings also report differences in the perceptions of nature and nature education among urban residents of different socioeconomic statuses. People with different income levels have different degrees of an understanding of nature and different understandings of contact with nature. Additionally, families with lower monthly incomes are significantly less aware of nature education than families with higher incomes. This seems to validate the view held by several scholars that socioeconomic status is positively correlated with educational achievement [38]. It is also difficult to separate education from socioeconomic contexts in the conceptualization of urban education [12].

Research has also shown that self-developmental motivations dominate when it comes to motivation to participate in nature education activities. Acquiring the knowledge and skills to facilitate individuals to change their environmental behavior has become the main purpose of an individual's natural education. It can support the utility of nature education in individual development. These findings provide encouraging evidence for advocates of nature education. However, we must also see that nature education also has many social development effects. Why have these effects not become the driving force for most urban residents to participate in nature education activities? It is probably worthy of reflection by the organizers of nature education.

Most Chinese urban residents are most interested in nature education activities such as nature experience, and they also indicate that they may participate in nature education activities in the future. This also shows that, judging from a wide range of practical cases in China, "the connection between man and nature" and "activity in nature" are indeed the fundamental characteristics of nature education. However, how does "activity in nature" in pursuit of the "connection between man and nature" become a part of education? How do they serve educational goals? These are also the problems that China's nature education must solve in the future.

6. Conclusions

This study found that Chinese urban residents have good attitudes towards "nature" and "contact with nature", and most of the respondents already have a basic understanding of nature education. Whether motivated by self-development or social interaction, most Chinese urban residents have expectations for long-term participation in nature education and are highly interested in nature experience activities. This is a good start and foundation. The residents of big cities place a high degree of importance on spending time in nature for themselves and their children. The respondents felt positively connected to several attitudinal and behavioral statements relating to their relationship with nature, wellbeing, and environmental attitudes. A majority of those surveyed said they and their children have participated in a nature education program in the past. Nearly all the respondents said they were at least somewhat likely to participate in nature education in the next 12 months, with nearly half saying they were "very likely" to participate. Overall, the main benefits and motivations of participating in nature education for oneself or one's children were the sense of feeling harmonious with nature and developing a sense of responsibility to nature and the planet.

The general public in China may not fully understand the definition of nature education and/or what nature education is comprised. The sector could benefit by developing a clear definition of what nature education is and what it is not. This can help to better define and position the types of activities organized by nature education organizations. For

example, finding opportunities to better formalize the sector could help the public better understand what nature education is and the benefits associated with it.

There is a strong sense among the Chinese public in cities that living in harmony with nature, improving wellbeing through healthy and sustainable actions, and enjoying and protecting nature are desirable actions. These are important key messages for nature education organizations to communicate. However, respondents were slightly less likely to consider the emotional benefits and the development of social and functional (technical) skills as important elements of participating in nature education. These may be important messages that are being missed by the public.

How to combine education for sustainable development with the current school education is an important topic of the Education 2030 Framework for Action. Some cases have shown that nature education can integrate some elements of sustainable development education into the education system through thematic activities, curriculum resource development, comprehensive practical activities, etc. The United Nations' 2030 Agenda for Sustainable Development (2015), UNESCO's Education 2030 Framework for Action (2015), and the Chinese Government's National Plan for the Implementation of the 2030 Agenda for Sustainable Development provide a solid governance and normative foundation for promoting nature education under the framework of sustainable development education. This has pointed out the development direction for promoting the development of China's nature education, and even promotes the transformation of education and society towards ecological civilization.

This study provided a foundation for understanding nature education in China. It can be expected that in the near future, China's nature education will develop rapidly and with high quality. The data in this study only reflect the perceptions of residents in eight major cities in China, and the national data cannot be randomly sampled. However, China has a vast territory and uneven regional development. There may be huge regional differences in Chinese residents' understandings and perceptions of nature education. Future research can conduct an in-depth exploration through more comprehensive data. Additionally, a comparative study of urban and rural conditions is possible, and interesting findings are sure to be found.

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Sustaining Higher Education Quality by Building an Educational Innovation Ecosystem in China—Policies, Implementations and Effects

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Abstract: This article analyzes how China has worked to develop and build a higher education innovation ecosystem in the past decade. Binding its analysis to three types of data, namely clusters of national policies issued by important Chinese government bodies, dozens of articles in an internal journal of the Ministry of Education, and various Chinese media accounts, the article unravels how resources are mobilized and the direction chartered for unprecedented engagement between different stakeholders for education purposes. The findings reveal that the establishment of a higher education innovation ecosystem derives from the need to improve the overall higher education quality in full swing and has been realized as a strategic consensus among the government, enterprises, higher education, and social forces. The ecosystem is underpinned by the assigning of different roles to different stakeholders based on collaboration and division of labor. At the same time, there is also substantive capital, resource mobility, and the infusion of industrial technological expertise underpinning such an innovation ecosystem that involves six categories of collaboration at macro and micro levels. The impact of the higher education innovation ecosystem thus far includes deepened and extensive participation in higher education quality improvement by multiple types of stakeholders and the same type of stakeholders across different tiers. Instructors' teaching and students' learning have experienced changes due to the ecosystem's impact at a micro level, and many institutions have increased shared governance practices to better cater to the synergy among different sides. At the same time, there is an unevenness in the innovation ecosystem in terms of participating higher education institutions and enterprises.

Keywords: educational innovation ecosystem; higher education; education sustainability; university-industry collaboration; Chinese higher education

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1. Introduction

As the 21st century continues to undertake a new round of technological and industrial revolution with the deepening of Industry 4.0, the world demand for competent application-oriented manpower and high-quality talents has increased at an unparalleled pace and scale [1–3]. Against such a backdrop, higher education institutions are highly expected to update their education quality as professional organizations responsible for the provision of such quality manpower and talents. The reality, however, is that there has been considerable public concern over higher education quality on the part of both higher education institutions themselves and other stakeholders, such as the government, the industry sector, and other non-governmental social forces. Many national governments around the world are concerned about whether their societies will be refilled ceaselessly with sufficient competent university graduates and manpower to sustain economic growth and meet social challenges. Industrial insiders, at the same time, are perplexed about the gap between the university provision and industrial needs, namely not being able to recruit

those university graduates who fully have the technical and professional skills needed in the workplace [4]. Other social stakeholders (e.g., parents) are beset by other issues that affect university students' growth and development, such as the escalation of education costs, credentialization of higher education, unemployment issues, and so forth [5]. The interest in university education quality and higher education sustainability has not faded, but on the contrary, even resurged as scientific and technological revolutions of the world continue to scale greater heights.

Despite the fact that higher education quality is affected by various factors, such as the massification of the sector itself, an unsatisfied faculty-student ratio, insufficient education facilities, or the pro-research evaluation mechanism for faculty members [6,7], the limited exposure of faculty members to authentic industrial experiences, the insufficient existence of state-of-the-art expertise from the industry, and the lack of an educational innovation ecosystem where different stakeholders collectively infuse higher education sector with their respective strengths have been increasingly recognized as factors hindering the improvement of higher education quality over the years [4,8–10]. As such, university-industry collaboration under the coordination and auspices of the government has been commonly perceived as an effective way to resolve the gap between university education provision and the real graduate attributes needed by society in the past decade [11–13].

It is worth noting that a large proportion of the current university-industry collaboration worldwide lies in research collaboration and technology transfer [14] under the currently prevalent interaction framework between the government, universities, and the industry sector, with teaching or education-focused collaboration practiced to a much lesser extent [15]. When it comes to the innovation ecosystem that involves the synergy between various stakeholders, the goal is mostly focused on non-education aspects. While these research collaborations do provide benefits for both sides, such as the commercialization of university-based technologies for financial gains, enhancing technological capacity and economic competitiveness for companies, and access to research networks or precursors to other collaborations [14,16], the extent to which state-of-the-art technology taking place in the industrial sector is exposed by university students is limited. In other words, the long-standing systematic and structural university-industry gaps are not well addressed by these research-focused collaborations. As such, in many parts of the world, government, academia, and the industry sectors are still beset with how to enable universities to cultivate talents that can effectively and efficiently meet industrial demands to maximize economic competitiveness in the knowledge economy. The root cause of such a problem lies in the lack of a stable, sustainable, and effective education-focused innovation ecosystem as opposed to one that focuses on other aspects such as research.

Research has identified various preconditions for inter-organizational collaborations, such as necessity, reciprocity, efficiency, stability, legitimacy, asymmetry, etc. [16]. As different types of organizations, government bodies, higher education institutions, and companies from the industry sector, despite their recognition of the prominence of collaboration for education purposes, often find it difficult to match their goals, interest pursuits, and operation habitus in collaboration for a given project. Their incentives for substantive collaborative education are therefore limited. For instance, companies have the nature to pursue short-term economic returns and the tendency to train personnel with a highly concentrated focus., but such training would be difficult if that personnel, especially new recruits, do not have a solid theoretical foundation on campus, as those trained would not be able to understand the rationale of the state-of-the-art technology [17]. On the other hand, without exposure to authentic project cases, students not only have difficulty understanding the theories learned due to their high degree of abstraction and the de-contextualized learning approach, but also cannot make of the skills needed in authentic workplace settings [4,18]. The government, however, has to strike and keep a balance between endeavors that have long-term social yields and short and medium-term innovations which are more focused on economic returns. As such, how to build an effective educational innovation ecosystem to ensure that different types of stakeholders deeply understand each other's

demands and concerns, afforded by effective resource input, policy guidance, and incentive mechanism to offset the innate divergences across sectors, is crucial in yielding stable and effective education-focused collaboration that maintains higher education quality.

In recent years, China has gone to great lengths to distribute policy mechanisms to coordinate between the higher education sector and the industry sector for collaborative education, with building a sustainable higher education sector constituting a major agenda for the Chinese government. Such sustainability is perceived to be underpinned by the high degree of synergy between the higher education sector and other important stakeholders in scaling greater heights in the overall teaching and education quality and enabling higher education to be more responsive to industrial and societal demands. To achieve such sustainability, relevant policies have been issued not only by China's Ministry of Education (MOE), which is especially responsible for education affairs throughout the country but also by other important state-level bodies such as the State Council, the Ministry of Finance, the Chinese Academy of Engineering to forge synergy for the university-industry collaborative education. Platforms are specially provided biannually for enterprises and universities to understand each other's demands and strengths and identify appropriate partners. The initial yields in mobilizing resources and fostering synergy in enhancing university education quality have been salient. Enterprises have been largely motivated to engage in universities' education reform, including reform to teaching patterns, course structure, and other stages of student learning. Over the several years, the number of enterprises participating in education-focused university-industry collaboration soared from 15 only in 2015 to 501 in 2020. Involved collaborative projects burgeoned from 243 in 2015 to 16,717 in 2020, and business investment in such collaborations increased from 17 million RMB in 2015 to 559 million RMB in 2020 [19]. Furthermore, the government bodies, enterprises, and higher education institutions involved are comprehensive across tiers and levels. Not only premier universities, world-renowned enterprises, and national governmental departments are taking an active part in fueling the collaborative education projects, but so are ordinary higher education institutions, less known enterprises, and local governments as well.

Despite the fact that sustainability has recently emerged to constitute an important theme in the global literature on higher education [20–22], most of the existing studies on this topic derive from the Western context, especially the European context. Few studies have probed into the development of the sustainable higher education sector in the Chinese context where the education system has a different landscape and the practices for developing sustainable higher education have their unique features. Given such a research gap, this study therefore binds its analysis to the policies, implementation, and effects of China's attempts to build a multiple stakeholders-underpinned and synergy-oriented sustainable higher education sector in the most recent years. Specifically, the study will answer three research questions: (1) Why does China want to develop a sustainable higher education sector? (2) How can a sustainable higher education sector be achieved? (3) What is the preliminary impact of China's effort thus far?

2. Sustainable Entrepreneurial University (SEU) as a Conceptual Framework

Contemporary higher education reforms in the global higher education community have been premised upon the assumption that higher education institutions are no longer supposed to be the ivory towers where time elapses at a leisured pace for academics' unhurried contemplations. Rather, higher education institutions are expected to be more socially responsible, fuel social innovation, cater more to industrial demands, and support sustainable development at large [23,24]. The SEU has been recently conceptualized as an ideal type of university to embody the new societal engagement roles expected of higher education institutions [20]. SEUs are socially responsive entities that co-create sustainability in collaboration with other stakeholders by incorporating social, ethical, and environmental principles and values within their main functions and becoming key agents in optimizing the regional institutional environment [25,26]. SEUs' roles, to be noted, are beyond the

narrowed scope of promoting economic growth but involve much broader engagement for social transformation.

Cai and Ahmad point out that compared with ivory-tower universities or traditionally defined entrepreneurial universities, SEUs take on new features in terms of teaching, research, societal engagement, organization and administration, knowledge flow, interactions with innovation actors, and university and society relations [20]. Specifically, SEUs shift the role from technology transfer to knowledge co-creation and carry out societal engagement in global terms. With an aim to serve society's current demands and shapes its future, SEUs not only institutionalize interdisciplinary collaboration and university networks as new sources of administration but also go to great lengths to reconcile both entrepreneurial and sustainability mindsets on course to driving societal changes. Rather than being knowledge producers on their own, SEUs more often than not work as anchor organizations for knowledge exchange where creativity, invention, and innovation across disciplines and sectors are triggered by the intensified interaction of people, culture, and technology. For this goal, building trust among collaborators in innovation ecosystems is also a core feature of SEUs in that the actors involved in the innovation system are more diverse, hence the necessity of trust in realizing the value of weak ties and diffusing innovation. Moreover, SEUs seek to shape a better future society through transforming society at large rather than just meeting the needs for economic development.

In this article, we draw upon the concept of the SEU to express a situated uptake of the innovation ecosystem in the context of Chinese higher education and to discuss the preliminary impact of China's reform efforts thus far. Although Cai and Ahmand argue that there might be no universities that can meet all the features of an SEU in reality [20], this concept can signal the direction of a Chinese approach to creating synergistic relationships and set the standards against which the goals and objectives in China's educational development at postsecondary level can be benchmarked. This concept also sheds light upon the way in which resources, capital, and expertise are mobilized to form mutual support among the government, enterprises, higher education institutions, and social forces for a win-win educational outcome.

3. Methodology: Content Analysis

The study employs content analysis of the policies and implementation of China's attempts to build a higher education innovation ecosystem. The data are derived from three types of sources. The first type of data is the clusters of policies per se, with the aim to unravel how the Chinese government has mobilized resources and charted the direction for deeper engagement between companies and higher education institutions. More than a dozen policies issued by the State Council, important ministries, and departments over the past five years are included for analysis. From such policy clusters, a comprehensive view of policy intents regarding the establishment of higher education innovation ecosystem will be obtained. Policy themes include national efforts to deepen the industry-education integration, developing a broad range of application-oriented disciplines such as New Engineering Education, Emerging Agricultural Education, New Medical Education, and New Humanities Education.

The second type of data is an internal journal specifically covering university-industry collaborative education issued by China's MOE. Unlike other academic journals, this internal journal is highly practice-oriented, encapsulating a large number of authentic practices and implementations between the industry and the higher education sector in co-developing talent skills that cater to industrial demands, and serving the purpose of informing policymakers of the areas in which improvements should be made of the initiative. The contents analyzed from this source include the remarks of MOE leaders and the overall landscape of university-industry educational collaboration over the past few years and typical university and industry cases of praxis in several important areas, such as manpower cultivation pattern reform, course structure, and system reform, university

teaching reform, enterprises' innovation in engaging with universities, and promotion of regional economic development.

The third type of data is derived from media accounts on the practices, effectiveness, and problems regarding collaborative education and the education innovation ecosystem at large. Here different perspectives and reflections on the implementation of relevant policies can be gained. For example, MOE has built a special platform for university-industry collaboration where all participating enterprises' information can be found, and many practitioners share their specific cases of collaborating with universities. The special online platform of university-industry collaboration comprises various sub-columns such as the communication and partnership conferences by universities and companies, business requirements and guidelines on collaborating with universities, excellent and exemplary collaboration, and ecosystem development cases. Thousands of participating enterprises' guidelines on the collaboration are listed on this platform. Furthermore, one of the leading and most influential domestic media Global Times has opened up a special section on China's university-industry collaboration and the development of the innovation ecosystem. Other media accounts include online newspaper articles, academic essays, and online opinion pieces that present professional comments and reflections on the implementation of the innovation ecosystem development. These media accounts are good sources to obtain Chinese responses to and reflections on this study's research topic.

Tables 1 and 2 outline the specific policy documents, contents of the MOE's internal journal, and media accounts selected for data analysis. The research method for the three types of data included interpretation for the purpose of meaning extraction, understanding seeking, and knowledge presentation [27,28].

Table 1. Policies included in building the higher education innovation ecosystem.

No.	Year	Issuing Unit	Policy	Source
1	2015	State Council	On Deepening Innovation and Entrepreneurship Education Reform	http://www.gov.cn/zhengce/content/2015-05/13/content_9740.htm (accessed on 12 February 2022)
2	2017	State Council	On Deepening Industry-education Integration	http://www.gov.cn/zhengce/content/2017-12/19/content_5248564.htm (accessed on 12 February 2022)
3	2017	MOE	New Engineering Education State 1—'Fudan Consensus'	http://www.moe.gov.cn/s78/A08/moe_745/201702/t20170223_297122.html (accessed on 12 February 2022)
4	2017	MOE	New Engineering Education State 2—'Tianda Action'	http://www.moe.gov.cn/s78/A08/moe_745/201704/t20170412_302427.html (accessed on 12 February 2022)
5	2017	MOE	New Engineering Education State 3—'Beijing Compass'	http://news.sciencenet.cn/htmlnews/2017/6/379053.shtm (accessed on 12 February 2022)
6	2017	MOE	Notifications on Carrying out New Engineering Education Research and Practice	http://www.moe.gov.cn/s78/A08/tongzhi/201702/t20170223_297158.html (accessed on 12 February 2022)
7	2017	MOE	Notifications on Recommending New Engineering Education Research and Practice Projects	http://www.moe.gov.cn/srcsite/A08/s7056/201707/t20170703_308464.html (accessed on 12 February 2022)
8	2018	MOE, MII, CAE	On Accelerating the Development of New Engineering Education for the Cultivation of Extraordinary Engineers (Plan 2.0)	http://www.moe.gov.cn/srcsite/A08/moe_742/s3860/201810/t20181017_351890.html (accessed on 12 February 2022)
9	2018	MOE	On Accelerating the Development of High-quality Undergraduate Education and Enhancing the Quality of Talent Cultivation in Full Swing	http://www.moe.gov.cn/srcsite/A08/s7056/201810/t20181017_351887.html (accessed on 12 February 2022)
10	2019	MOE	Emerging Agricultural Education State 1—'Anji Consensus'	http://news.cau.edu.cn/art/2019/6/29/art_8779_626286.html (accessed on 12 February 2022)
11	2019	MOE	Emerging Agricultural Education State 2—'Beidacang Action'	http://www.moe.gov.cn/jyb_xwfb/s5147/201909/t20190923_400289.html (accessed on 12 February 2022)
12	2019	MOE	Emerging Agricultural Education State 3—'Beijing Guide'	http://www.centv.cn/p/343210.html (accessed on 12 February 2022)
13	2020	State Council	On Accelerating the Innovation of Medical Education	http://www.gov.cn/zhengce/content/2020-09/23/content_5546373.htm (accessed on 12 February 2022)

Table 1. *Cont.*

No.	Year	Issuing Unit	Policy	Source
14	2020	MOE	Announcement on Initiating New Humanities Education	http://www.moe.gov.cn/jyb_xwfb/gzdt_gzdt/s5987/202011/t20201103_498067.html (accessed on 12 February 2022)
15	2020	MOE	University-Industry Collaborative Education Program Notification by Ministry of Education	http://www.moe.gov.cn/srcsite/A08/s7056/202001/t20200120_416153.html (accessed on 12 February 2022)
16	2020	MOE	Notification on Soliciting University-industry Collaborative Education Projects in 2020 by the Ministry of Education	http://www.moe.gov.cn/s78/A08/tongzhi/202005/t20200529_460209.html (accessed on 12 February 2022)

Table 2. Contents Analyzed from the MOE Internal Journal.

No.	Title	Author	Author Positions	Page
1	Remarks on New Engineering Education Peking University International Conference	Wu Yan	Head of Department of Higher Education, MOE	1–2
2	Progress and Reflections of China's Higher Education–Industry Collaborative Education	Xu Xiaofei et al.	Expert Panel Members of MOE's University-industry Collaborative Education, University Representatives	3–10
3	Data on MOE's University-industry Collaborative Education (2015–2020)	Shi Yang et al.	Expert Panel Members of MOE's University-industry Collaborative Education, University Representatives, Company Representatives	11–17
4	"Two Cross-disciplines and Four Integration": Jingying Extraordinary Engineering Education Talent Cultivation Pattern	Zheng Qinghua	Participating University Representative from Xi'an Jiaotong University	18–23
5	Engineering University-oriented University-industry Collaborative Education Pattern	Zhou Zhipeng et al.	Participating University Representative from Nanjing University of Aeronautics and Astronautics	24–29
6	Hot Spots of China's University-industry Collaborative Education	Yang Lihai et al.	Participating University and Company Representatives from Henan Polytechnic University and Shenzhen Aoya Design Co. Ltd.	30–37
7	Bottlenecks and Solutions to University Work against the Backdrop of "Revitalizing Northeast China + University-industry Collaboration": Dalian City as an Example	Wu Di & Shi Hui	Participating University Representative from Dalian University of Technology and Liaoning Normal University	38–41
8	Reforms to the Synergy and Innovation Mechanism for Application and Industry-oriented Higher Education Institutions	Zhou Li et al.	Participating University Representative from Beijing Wuzi University and Capital University of Economics and Businesses	42–47
9	Reform to the Teaching of Customer Experience Design against the Backdrop of New Engineering Education: Based on Four Integrations	Zhao Tianjiao et al.	Participating University and Company Representatives from Tianjin University and Nanjing Qianxue Education Technology Co. Ltd.	48–54
10	Exploration and Practices of University and Industry Collaborative Education-oriented Course Development	Dai Xiao'ai et al.	Participating University and Company Representatives from Chengdu University of Technology and Beijing Hangtian Hongtu Information Technology Co. Ltd.	55–60
11	University-industry Collaboration-based Development of Computer Science at Universities of Western China	Zhu Lei et al.	Participating University and Company Representatives from Xi'an University of Technology and Shenzhen Tecent Computer System Co. Ltd.	61–67
12	PBL-based Engineering Ethics Education for Traffic Engineering Programs	Li Yingshuai & Wang Weijie	Participating University Representative from Nanjing University of Technology	68–72
13	Exploration and Practices of Talent Cultivation based upon University-industry Collaboration	Zeng Xianqun et al.	Participating University and Company Representatives from Donguan University of Technology and Beijing Wenhua Online Education Co. Ltd.	73–77
14	Practical Exploration of University-industry Collaborative Education against the Backdrop of Technology Iteration	Wang Zanshe et al.	Participating University and Company Representatives from Xi'an Jiaotong University, Xi'an University of Architecture and Technology, and Xianyang Jingwei Fucha Co. Ltd.	78–81
15	Patterns of Cultivation of Innovative Talents in the Field of Automation based on University-industry Collaboration	Zhang Lanyong et al.	Participating University Representative from Harbin Engineering University	82–86
16	Practice and Exploration of University-industry Collaborative Education for the Field of Digital Media and Arts	Jing Fei	Participating University Representative from Nanjing University of Technology	87–89

Table 2. *Cont.*

No.	Title	Author	Author Positions	Page
17	Project-based Multiple-dimension University-industry Integrative and Collaborative Education: AI Programs as Examples	Zhou Xue	Participating University Representative from University of Electronic Science and Technology of China	90–93
18	Innovation of University-led Collaborative Education with the Industry: Example of Developing Rhizoma Bletillae Glucomannan Mucosal Repair Factor	Guan Li et al.	Participating University Representative from Xi'an Medical College	94–96
19	University-industry Collaboration in Developing New Engineering, Agriculture, Medicine and Humanities Education	Cheng Huan	Participating Company Representative from Beijing Chinasoft International	97–103
20	Cloud-based Cultivation of New Engineers	Liu Xiangwen et al.	Participating Company Representative from Ali Cloud Computation Company	104–110
21	Establishing Effective Patterns for Key Fundamental Software Talents	He Shu et al.	Participating Company Representative from Qilin Software Co. Ltd.	111–115
22	Developing Digital Manpower for the New Times based on Industry-education Integration	Huike Group	Participating Company Representative from Huike Group	116–121
23	Exemplary Cases for Promoting University-industry Collaborative Education via a Win-win Pattern: Example from Cross-boarder E-commerce Cases	Gao Gongbu et al.	Participating University and Company Representatives from Yangzhou University and Kaiyuan E-commerce (Shenzhen) Co. Ltd.	122–127

4. Results

A content analysis of the data reveals that the attempts to establish and maintain a higher education innovation ecosystem in the past few years result from China's intention to promote its overall higher education quality to a higher level, and such an endeavor has been realized as a strategic consensus among the government, enterprises, higher education sector, and other social forces. There is substantive capital and resource mobility underpinning such an innovation ecosystem, as opposed to mere calls or slogans. Multiple types of stakeholders, as well as the same type of stakeholder across different tiers, have been involved in the collective creation of the innovation ecosystem in a synergistic and concurrent manner, and the innovation in higher education takes place at both the macro policy level and micro course level on the part of university education. At the same time, there are also reflections of the advancement of the education innovation ecosystem among Chinese academia and media outlets.

4.1. Question 1: Why Establishing a Sustainable Higher Education Sector?

4.1.1. Quality Improvement as the Rationale

Our data analysis reveals that improving the overall higher education quality and building up a quality culture constitute the original impetus for developing a higher education innovation ecosystem in China in the first place. Across the 16 governmental documents we analyzed as shown in Table 1, quality (质量 , zhi liang) in relation to teaching and learning, talent cultivation, and other aspects of higher education is a high-frequency word appearing many times to emphasize the telos of the operation of the Chinese higher education. In the Chinese language, a core conception such as quality is often expressed together with either an adjective or a noun to signal the desired state of the conception or the expected aspect where the conception should play a role, and therefore there are a variety of lexical ways for a conception to be manifest. In our case, quality is jointly used with phrases to denote the heights that higher education is expected to scale or the facets where higher education should better meet people's demands. Examples include human resource quality (人力资源质量 , ren li zi yuan zhi liang), education, teaching and learning quality (教育教学质量 , jiao yu jiao xue zhi liang), higher quality (更高质量 , geng gao zhi liang), new quality (新质量 , xin zhi liang), and so forth. Table 3 summarizes the manifestations of the word quality across the 16 official documents analyzed, from which it can be seen that quality appears a total of 109 times in various forms. Among all, talent cultivation quality and teaching and learning quality top the list of frequency of appearance. At the same time, a wide range of aspects is expected to be filled with strong quality elements, such as students' employability, faculty training, textbook development,

capstone project completion, program development, overall graduate attributes, and so on. The means through which goals are to be realized also include a variety of respects, such as developing and maintaining quality culture, quality assurance mechanisms, quality standards, etc.

Table 3. Quality-related Phrases across the 16 Sampler Official Policy Documents.

No.	Chinese Phrase	English Translation	Frequency
1	高质量	high quality	7
2	高等教育质量	higher education quality	5
3	人才培养质量	talent cultivation quality	16
4	教学质量	teaching and learning quality	15
5	教育质量	education quality	6
6	就业质量	employment quality	4
7	质量	quality	6
8	人力资源质量	human resource quality	1
9	新质量	new quality	5
10	质量文化	quality culture	7
11	专业质量	program quality	3
12	毕业生质量	graduate quality	1
13	质量提升	quality improvement	1
14	质量评价	quality evaluation	5
15	质量标准	quality standard	4
16	工作质量	work quality	3
17	毕业设计质量	capstone project quality	1
18	教材编写质量	textbook development quality	1
19	质量保障	quality assurance	9
20	质量监测	quality monitoring	3
21	质量革命	quality revolution	3
22	质量中国	quality China	1
23	生源质量	new student quality	1
24	住培基地质量	training base quality	1
	Total		109

As can be seen, quality improvement, on top of previous standards, has taken up the dominant theme of China's higher education discourses over the past few years. It also works as a strong impetus for China to build a higher education innovation ecosystem, out of the need to address quality concerns and resolve quality problems.

4.1.2. The Need for Building a Higher Education Innovation Ecosystem

Apart from the frequent appearance of quality-related lexical resources across the 16 governmental documents, quality also shows up considerably in our second type of data, namely dozens of articulations by various non-government actors, as shown in Table 2. As such, the development of a higher education innovation ecosystem is not just proposed and propelled by the Chinese government but is a strategic consensus realized among many different types of important stakeholders of higher education. In the past eight years, the State Council, being China's top administrative body, as well as important governmental departments such as the Ministry of Education and the Ministry of

Industry and Information, participating enterprises from the industrial sector, and scholars from academia, all now have a consensus on the importance of building an innovation ecosystem of higher education featuring a high degree of cross-sector and cross-disciplinary collaboration, synergy, integration, and cooperation, if China's higher education quality is to scale greater heights. Two aspects are worth noting regarding such a consensus on the higher education innovation ecosystem. Firstly, such a consensus goes beyond the rationale of China's national effort to build world-class universities or disciplines, as revealed in much current scholarship [29], because it involves a variety of stakeholders across different sectors and tiers in full swing. Secondly, this ecosystem is highly education-focused, rather than focusing on other aspects of cross-sector collaboration (e.g., research), which has been going on for a long time.

"Integration", "ecosystem", and "innovation" are also high-frequency phrases across many policies issued between 2015 and 2020. For instance, as early as seven years ago, out of the need to grow the small and medium-sized private economy and further resolve employment issues by encouraging more graduates to start their own businesses, entrepreneurship education was accentuated against the larger economic backdrop. However, the government started to signal a message that university graduates' competence, including entrepreneurship competence, should be catered to by the industrial sector with authentic industrial expertise. As such, the policy document On Deepening Innovation and Entrepreneurship Education Reform issued by the State Council that year called for universities to make use of all possible resources in and outside the higher education sector and called for society to provide collective care and support for universities' entrepreneurship education advancement (Policy No. 1, Table 1).

Not long afterward, in 2017, the State Council issued another important guiding document on deepening industry-education integration. The stipulation of this document is derived from the gap between the provision of graduates on the university side and the demand for high-caliber application-oriented talents on the market side. Facilitating university-industry collaborative education and promoting the structural reform of the supply mechanisms for manpower constituted the central concern of the government agenda. In this particular document, it writes that all stakeholders involved should "develop and complete an innovation ecosystem where higher education institutions highly collaborate with major enterprises, small and medium-sized enterprises to augment the competence to cultivate higher-caliber talents, upgrade industrial capacity, ... based on a network of industry-education integration featured by smooth order, functional complementarity, resource sharing, and close collaboration" (Policy No. 2, Table 1).

The innovation ecosystem is not limited to only a few individual disciplines but is afforded by the development in a broad range of important areas. The "Four New" Project, which literally refers to "New Engineering Education", "Emerging Agricultural Education", "New Medical Education", and "New Humanities Education", are special national projects in recent years to underpin the development of the higher education innovation ecosystem. As can be seen from the title and contents of the policy documents shown in Table 1, the development of the "Four New" Project is featured by unprecedented enterprises' participation in course reform, teaching reform, and other aspects of reforms to higher education quality on the university side (Policy No. 3–8, No. 10–14, Table 1). The rationale for these national strategies is that against the global backdrop of Industry 4.0 and Biomedicine 3.0, China, as a developing country and an emerging economy, especially needs a broad range of skilled workers and innovators with expertise in these key areas for the transition to a knowledge-based and innovation-driven economy. For all of the four areas to achieve better results in cultivating talents, China understands that the measures it needs to take should be a complete overhaul of its existing education patterns instead of tinkering with superficial changes. Given the long-standing university-industry gap and sparse awareness of authentic workplace settings by university faculty and students, which applies to different disciplines and areas, forces outside the higher education domain

are conceptualized as prominent facilitators for the overall manpower provision to scale greater heights.

4.2. Question 2: How Can the Sustainable Higher Education Sector Be Achieved?

4.2.1. Roles of Different Stakeholders Based on Collaboration and Division of Labor

According to the three types of data collected, the higher education innovation ecosystem is based upon both collaboration and division of labor in terms of different stakeholders' distinctive roles. On the one hand, coordination and close ties are expected of government bodies, enterprises, universities and colleges, and non-governmental industrial associations as social forces. As outlined above, there is a strong consensus among different stakeholders pertaining to the necessity of developing a higher education innovation ecosystem. On the other hand, different stakeholders are expected to support each other with the ultimate purpose of upgrading higher education quality.

Specifically, contrary to a lot of literature that portrays the Chinese government as the grand boss that controls everything, the government's role in this new round of discourse is stipulated as more of a supporter and coordinator that fuels enterprises to be actively engaged with university education affairs and builds up open platforms for universities and the industry sector to find appropriate partners. Not only education-related ministries (e.g., MOE) are supposed to provide favorable policies for industrial associations and enterprises to participate in various educational activities on campus, but other non-education-related governmental departments (e.g., Ministry of Finance) are also required to provide financial incentives to ensure that all parties are motivated to work towards the goal of educational collaboration (Policy No. 2, Table 1).

Enterprises, at the same time, are accorded the main role in assisting higher education institutions to improve education contents and methods as they are believed to stand at the technological forefront (Policy No. 2, Table 1). It fully recognizes the educational subjectivity of enterprises apart from that of universities and colleges in ensuring higher education quality, while still acknowledging enterprises' innate nature to pursue profits and short-term economic returns. Outputting their technological expertise to higher education institutions, among others, is an important expectation of enterprises to play their role in fueling Chinese university education quality.

Universities and colleges themselves, unsurprisingly, are expected to undertake the main-actor role as well. They are required to carefully research several extremely prominent aspects perceived to impinge upon the education quality at the end of the day, including demands of industry, technological forefronts, students' new ways of learning and interest in learning, a scientific accountability mechanism, international disciplinary frontiers (Policy No. 4, Table 1). To be more specific, engineering-savvy universities and colleges ought to develop new programs catering to emerging technologies, upgrade the contents of existing programs to keep up with the times, and develop more cross-disciplinary and problem and project-based engineering course modules that are more liable to cultivate innovative students. National comprehensive universities are expected to achieve breakthroughs in basic research and foster new areas of revolutionary innovation based upon comprehensive disciplinary and cross-disciplinary strengths. Local institutions of higher learning are expected to further strengthen a few major areas to cultivate application-oriented talents to serve local economic development. Cultivating students' praxis competence is highly prioritized in their overall agenda (Policy No. 3, Table 1).

Other social forces, such as industrial associations, foundations, and reputative celebrities, are expected to help bridge the gap between the provision of university education and the demands on the side of the industry and provide funds for the operation of the innovation ecosystem (Policy No. 2, Table 1; Articles from Table 2).

4.2.2. Capital Flow and Resource Mobility Propping up the Higher Education Sustainability

It warrants a mention that the progress of the higher education innovation ecosystem over the past few years in China has been made by no means through policy intents alone

but has been underpinned by substantive capital flow and resource mobility according to our content analysis. For instance, the State Council documents mentioned above explicitly advocates favorable conditions for enterprises that provide support to universities and colleges regarding their education improvement. These favorable conditions for the industrial sector include but are not limited to tax reduction, economic compensation, financial support, and so forth. Examples include policy statements such as "various levels of fiscal and tax departments ought to take structural tax-reduction measures for companies which take an active part in deepening the university–industry collaboration in education" (Policy No. 2, Table 1). Moreover, enterprises that are providing substantive support to collaborative education are entitled to reduced tax burden and even favorable prices for purchasing resources (e.g., land) for their business development. The government bodies required to form the synergy for such ecosystem advancement, according to the State Council policies, go beyond merely educational departments, but also include a broad range of ministries in other sectors, such as the Ministry of Finance, the Ministry of Land and Resources, State Development and Reform Commission, and so forth.

However, the direction of the resource mobility is not from the government to enterprises only. On the special platform for the university-industry collaboration established by MOE, which belongs to the third type of data analyzed, thousands of enterprises have listed their schemes and plans regarding how they would collaborate with higher education institutions across disciplines. As can be seen, for every collaborative project having been established or to be established, participating enterprises offer at least 50,000 or 100,000 RMB (roughly 7000 or 14,000 Euro) depending upon the category of the project. An enterprise usually joins universities and colleges to develop dozens of collaborative educational projects (e.g., course development, practical education, faculty training) per phase, which means contributions to higher education institutions worth more than a million RMB for each individual enterprise. For those well-resourced big names such as Alibaba, they support more than 100 such projects during every phase of collaboration, which amounts to more than 10 million RMB capital flow from the enterprise to the university-industry collaboration projects.

Through the content analysis of the second type of data, namely the numerous cases shown in the internal journal, there are at least three types of benefits enterprises can gain through engaging in the university-industry collaborative education: enhancement of brand name, acquisition of economic returns, and open up new business areas. Firstly, as can be revealed from the third type of data, especially the special MOE platform on university-industry collaboration, every participating enterprise is openly listed and known to the general public as a higher education reform facilitator. As of 2021, a total of 1059 enterprises have disseminated their strengths, features, values, and competitiveness through this platform and other media reports because of their collaboration with relevant universities or colleges in promoting talent cultivation. The advertising effects and halo effects have been pronounced despite their cost in supporting the collaborative projects. Secondly, these halo effects do pay off for these participating enterprises, which are able to attract many more higher education institutions to purchase their tailored technology and products generated from the existing educational collaboration. The rationale is that through participating with partner universities on the improvement of certain course quality, enterprises can have a better understanding of where university courses or teaching can be improved and the exact selling points of themselves. Although they have to provide financial support to these partner institutions, they can sell their products to a broader range of low-tier institutions which run the same programs and have the same demands for education quality improvement. Thirdly, against such a bigger context as mentioned above, some enterprises have especially targeted university education shortfalls as the business scope, hence creating more industry chains and rapid financial growth.

As such, there is an activated flow in terms of capital, resource, and benefits running between the three important stakeholders of the innovation ecosystem: the government, the enterprises, and the higher education institutions. Such a flow plays an underpinning role

in sustaining the full-swing university-industry collaboration and the innovation ecosystem at large.

4.2.3. Sustaining Higher Education Quality with Industrial Technological Expertise

Another important aspect of the higher education innovation ecosystem is manifest in the fact that there has been massive industrial technological expertise brought into the higher education system for its quality enhancement and sustainability. As can be seen from the MOE special platform where all enterprises list their technological strengths, which is the third type of data analyzed, every participating enterprise, while applying to be recognized by MOE as an appropriate and qualified collaboration partner, has to explicate what specific technological expertise or state-of-the-art technology it will bring to relevant university partners.

For instance, China's Internet giant Baidu writes to offer its Apollo Technology and smart network vehicle test areas to help partner universities and colleges with their praxis education. Baidu also establishes its own special online platform, Baidu Pinecone School, for collaborating with higher education institutions throughout China in terms of course collaboration, engineering education alliances, college student academic contests, student internships, practical education, and so forth. Co-building laboratories for emerging technology such as AI, cloud computing, and big data within higher education institutions is also on Baidu's agenda, with the contextualization of education contents being a prioritized area. Another example is Intel which contributes to the collaborative education in various manifestations with its own technological might, such as AI-oriented OPENVINO software platform, deep learning and machine learning course contents, big data AI platform, oneAPI and cloud computation resources, Intel FPGA programming, etc. Intel's collaboration with universities and colleges covers multiple categories including teaching content and course structure reform, faculty training, practical competence building, entrepreneurship, and start-up education, the "Four New" project collaboration.

For all intents and purposes, ushering in technological strengths from the industrial sector to update and renew existing university course contents, if not reconfiguring them, is an important telos of the full-scaled university-industry collaboration and the higher education innovation ecosystem over the years. Industrial participation and integration with the industrial sector have been found to be significant factors in sustaining university faculty and students' commitment to effective teaching practices and ensuring that the higher education system keeps up with the technological momentum and does not lose out.

4.2.4. Six Categories of Collaboration at Macro and Micro Levels

The innovation elements of the created higher education ecosystem are mainly manifest in six categories of university-industry collaborative education at both macro and micro levels according to various policy documents and the MOE internal journal. The six categories are (1) "four new projects" (New Engineering Education, Emerging Agricultural Education, New Medical Education, New Humanities Education) co-promoted by both the industry and higher education sector (macro level); (2) teaching contents and curricular system reform (micro level); (3) faculty training projects (micro level); (4) praxis education condition improvement and base development (micro level); (5) entrepreneurship education and reform (micro level); and (6) entrepreneurship education funding project (macro level).

For the first category, the "four new projects", a high degree of cross-disciplinary and collaborative elements are especially emphasized. The traditional disciplinary barriers to changing teaching practices that make student learning fragmented are sonorously called to be tackled. With the industry sector ushered in to tide universities and colleges over, collaboration between academia and industry in charting the overall direction of these important areas has been underscored.

The second category concerns the reform of the teaching contents and the course structure on campus. Universities and enterprises are required to have intensive and extensive discussions and communications on what type of talents are especially needed in the new

times, and jointly set up standards, schemes, and education plans for cultivating high-caliber application-oriented students that cater to industrial demands. Higher education institutions, making use of enterprises' funding, expertise, technology, and platforms, are expected to provide students with many more state-of-the-art resources, such as authentic engineering cases, forefront technology, or highly applicable package instruments.

The third category regards the training of faculty members with more exposure to frontline industrial experiences. The training is arranged to be bidirectional, with enterprise experts entering campus classrooms on the one hand, and faculty members invited to enterprises' R&D or production lines on the other. The purpose is to cultivate double-type-capacity of faculty members, namely the substantive competence both in theoretical knowledge and application.

The fourth category is the co-development of higher-quality infrastructure for praxis education by both the industrial and academic sectors. Universities and colleges are expected to leverage industrial resources (e.g., hardware, software, laboratories, practical education bases) to make up their own natural shortfalls in the delivery of practical education for students. Furthermore, higher education institutions are expected to learn from the companies in terms of talent cultivation efficiency, labor division, artifacts, and subjects.

The fifth and sixth categories are to deepen the reform of innovation and entrepreneurship education carried out in universities and colleges. In recent years, entrepreneurship education has been conceived of as an important strategy to boost student employment and even revitalize the economy. In order for such entrepreneurship education to be more pertinent, visionary, and pragmatic, the industrial sector now provides expertise, funding, and investment to help universities pinpoint the crux of student start-ups and incubate potential student projects. A market mechanism is introduced to match social resources with student entrepreneurship projects that are mature, successful, and potentially rewarding.

4.3. Question 3: What Is the Preliminary Impact of China's Effort thus Far?

4.3.1. Deepened and Extensive Participation in Higher Education Quality Improvement by Multiple Types and Tiers of Stakeholders

Unlike many other initiatives where only a small proportion of universities, mostly premium universities, take an active part, the participation in the development of the higher education innovation ecosystem over the past few years has been in its entirety, including various types of stakeholders across different tiers. For the government bodies, participating institutions include not only the State Council, state-level ministries, and commissions, but also provincial and local government bodies that issue more concrete province or city-wide implementation plans to provide supportive resources and facilitate boundary spanning exchanges and integration. For enterprises from the industrial sector, those participating ones involve not just internationally renowned cross-national companies (e.g., Google, Intel, Microsoft) and leading Chinese IT companies (e.g., Huawei, Tencent, Baidu, Ali), but a large multiplicity of small and medium-sized enterprises and emerging technology-focused training companies as well. These companies cover a wide range of areas that constitute the main pillar of the Chinese economy, such as information technology, software, education, manufacturing, R&D, and the service sector. For higher education institutions, not only do those first-tier institutions striving for the status of world-class university or world-class discipline join the ecosystem establishment and advancement, but also many more second-tier and third-tier institutions have collaboration opportunities with the industry sector in myriad forms. As a matter of fact, 75% of the top-20 higher education institutions that have the most educational collaboration projects with enterprises from 2015 to 2020 are less known ordinary universities and colleges in China according to the MOE internal journal, which is the second type of data analyzed (MOE Internal Journal, No. 3, Table 2).

Apart from the broadness of the stakeholders involved, the justification of the higher education innovation ecosystem is also underpinned by the large territorial scope where such educational collaboration and innovation takes place. The MOE internal journal

reveals that from 2015 to 2020, there are a total of 61,582 educational collaboration projects successfully established across 33 provinces, municipalities, and special administrative regions (Tables 4 and 5). Participating higher education institutions cover 33 provinces, municipalities, and special administrative regions (Table 4), while the number of participating enterprises is 28 (Table 5). That means for several provinces, no enterprise has been involved in such an innovation ecosystem, indicating the relative backwardness of economic development in such places.

Table 4. HEI's Participation in University-industry Educational Collaboration Projects by Region from 2015 to 2020 [30].

No	Province/Municipality/SAR	Participating Higher Education Institution Number	Number of Projects Involving Local HEIs
1	Shandong	82	8603
2	Jiangsu	82	4150
3	Hubei	68	4121
4	Liaoning	62	3683
5	Zhejiang	64	3485
6	Shaanxi	61	3274
7	Guangdong	73	3047
8	Beijing	76	2985
9	Sichuan	57	2968
10	Henan	62	2928
11	Hunan	44	2824
12	Chongqing	26	1762
13	Fujian	45	1718
14	Hebei	63	1659
15	Shanghai	44	1532
16	Jiangxi	42	1526
17	Jilin	42	1513
18	Anhui	43	1461
19	Heilongjiang	42	1440
20	Tianjin	28	1312
21	Gansu	23	1071
22	Yunnan	33	956
23	Guangxi	38	858
24	Shanxi	28	841
25	Inner Mongolia	20	655
26	Guizhou	29	482
27	Xinjiang	19	294
28	Ningxia	8	203
29	Hainan	8	139
30	Qinghai	3	51
31	Tibet	3	36
32	Hong Kong	4	4
33	Macau	1	1
	Total		61,582

Table 5. Enterprises' Participation in University-industry Educational Collaboration Projects by Region from 2015 to 2020 [30].

No	Province/Municipality/SAR	Participating Enterprises	Number of Projects Involving Local Enterprises
1	Beijing	319	24,957
2	Guangdong	119	8019
3	Shanghai	120	5608
4	Shandong	97	4285
5	Jiangsu	86	3729
6	Zhejiang	75	3519
7	Hubei	45	2161
8	Fujian	36	1525
9	Tianjin	20	1177
10	Hunan	17	757
11	Sichuan	19	750
12	Hainan	1	749
13	Henan	16	734
14	Shaanxi	15	702
15	Anhui	12	655
16	Chongqing	14	631
17	Liaoning	22	526
18	Jilin	5	438
19	Jiangxi	4	204
20	Inner Mongolia	1	182
21	Shanxi	3	86
22	Hebei	1	57
23	Guizhou	4	50
24	Heilongjiang	2	33
25	Xinjiang	1	19
26	Guangxi	2	17
27	Ningxia	2	9
28	Yunnan	1	3
	Total		61,582

4.3.2. Change of Instructors' Teaching and Students' Learning at Individual Level

Apart from the changes in the relationship ties of different stakeholders, from previously fairly loosely connected to the current inextricably intertwined, the most salient changes resulting from the establishment and operation of the innovation ecosystem are manifest in instructors' teaching and students' learning. Such changes have in fact been the telos of all the efforts made by the national government and other non-education stakeholders during the process of synergy and collaboration.

Problem-based learning, project-based learning (PBLs), and cross-disciplinary education have become prevalent in many higher education programs with the assistance of industrial forces according to our second type of data. For instance, the University of Electronics Science and Technology of China works closely with an AI-focused high-tech company, Cloudwalk, in Chengdu to redesign their course structure and deepen the teaching reforms (MOE Internal Journal, No. 17, Table 2). Traditionally, students were asked to fulfill designated steps in praxis courses, inculcated with stereotyped experiment schemes. The process more often than not precipitated students to be passive learners, without motivating them to take an active role in integrating the phenomenon they saw

with the theories they had learned. Moreover, the emphasis on outcomes rather than the experiment process failed to assess students' real learning. Now with Cloudwalk stepping in, both parts have extracted key technologies into typical cases from authentic industrial projects. Imitating the authentic design procedures in the industry, students are allowed to design their own schemes, collect data on their own, test their hypotheses, search for the experiment results, and report outcomes based on the division of labor. Furthermore, with the help of the frontline package instruments frequently used in the company, such as OpenCV and Python, students are working on projects that have substantive meanings to the social context, such as campus-wide cross-camera capturing of human body movement, rather than working on merely simulated prototypes. A similar implementation of PBLs abounds in other media outlets when it comes to the impact of the synergy between the industry and the higher education sector, given the current ecosystem.

The increasing delivery of cross-disciplinary education is another jewel of the ecosystem established, which is aimed at addressing the long-standing disciplinary barriers documented to prevent students from being exposed to different areas and having a comprehensive understanding of their knowledge utility. Xi'an Jiaotong University offers a typical example of aggregating cross-disciplinary forces for student learning improvement (MOE Internal Journal, No. 4, Table 2). It launches a special type of class named Jingying Class, for which the university mobilizes extensive resources internally from different schools and externally from the business sector and R&D departments. In the spirit of cross-disciplinary education, Xi'an Jiaotong University sets up a total of eight cross-disciplinary innovation praxis platforms, named "mechatronics", "smart mini-grid", "new energy", "smart aircraft", "information control", "new material", "smart architecture", and "biomedicine" respectively. Each of the eight platforms is beyond what one or two individual disciplines can underpin, but is afforded by talents, resources, and manpower from at least four different disciplines. Each platform also provides a number of different modules to train students' project design competence, inter-disciplinary mindsets, and the application of knowledge across different fields.

4.3.3. Increased Shared Governance Practices at Institutional Level for Education-Focused Collaboration

Out of the need to develop synergy for educational collaboration with different stakeholders, many higher education institutions have embarked on reforms to their governance structure and included industrial representatives to take up formal institutional positions. It is a consensus at the institutional level that a higher degree of shared governance bears the advantage of giving rise to lasting change premised upon widespread engagement and multiple resource support.

An example is Dongguan University of Technology which has instituted a special Management Office for Modern Industrial Institute to be responsible for the collaboration affairs with the industrial sector and the government. The board of trustees of this office consists of both faculty members, institutional administrative members, and representatives from relevant enterprises and industrial associations. Such a diverse body of committee members work together on plenty of substantive engineering education at the university, such as co-developing the overall student attribute outlines, quality assurance mechanisms, course development, and so forth. Both university representatives and industry representatives have a say in charting the direction of the faculty community and developing different levels of student projects that encompass authentic engineering settings, workplace demands, and real R&D cases. Furthermore, according to its institutional governance structure, representatives from a collaborative enterprise take up the position of vice director for the Modern Industrial Institute (MOE Internal Journal, No. 14, Table 2).

4.3.4. Reflections on the Sustainability System

The content analysis of the various types of data also reveals that the public responses in China towards the current stages of the development higher education innovation

ecosystem is not merely self-congratulatory or enthusiastic, but also self-reflective and attuned to the existing and potential problems.

For instance, the MOE internal journal, the second type of data we collected, unfolds several "unevenness" regarding the current participation of different stakeholders in the collective ecosystem building. The first "unevenness" is reported to be the uneven intensity of the focus on the six categories of collaboration. Among the aforementioned six categories of university-industry collaboration, the first, fifth, and sixth categories have been less attractive for enterprises to be engaged with than the other three categories. This shortfall is believed to derive from the insufficient catering to important national strategies on the part of enterprises. The second "unevenness" concerns the geographic unevenness of participating higher education institutions and enterprises. Most participating higher education institutions are reported to concentrate in several provinces such as Shandong, Jiangsu, Zhejiang, and Guangdong. A similar situation applies to enterprises as well, with most supporting enterprises located in eastern developed regions. Those located in less developed Southwest and Northwest regions of China have participated little in the national ecosystem development project. This is deemed as a result of insufficient resource support and dissemination of the effective implementation of the university-industry collaboration and the higher education ecosystem at large. The third "unevenness" is about the domains of specialty of participating enterprises from the industrial sector. Currently, most participating enterprises are reported to have a high concentration in information technology, but companies from other major economy-underpinning areas such as chemical engineering, medical engineering, or mining are believed to be able to play greater roles in the future. This shortfall is attributed to insufficient research on the distinctive features and characteristics of different industries as well as their compatibility with participating higher education institutions.

5. Discussion

The present study has analyzed Chinese efforts to establish a sustainable higher education sector over the past few years by covering the rationale, the constituents, and the preliminary impact of the sustainable higher education sector. The data analysis in the study corroborates the essential elements of a sustainable entrepreneurial university identified in the literature. The following sections will discuss the findings in relation to how China's effort to strengthen its sustainability-oriented higher education embodies the elements of a sustainable entrepreneurial university. At the same time, the Chinese practices, while partially fitting the notion of the sustainable entrepreneurial university, have their unique characteristics, based upon which we will unravel how China attempts to build a higher education innovation ecosystem to underpin such a sustainability goal.

5.1. The Application of the Sustainable Entrepreneurial University in the Chinese Context

Recent years have witnessed the emergence and application of the sustainable entrepreneurial university to denote the comprehensive transformations of university reforms, mostly in the European context [20]. The European effort, through highlighting the responsive roles of universities in catering to the multi-dimensional societal needs (e.g., ethical need, environmental need, industrial need, economic need) based upon the involvement of multiple stakeholders, has been transforming the higher education sector and the broader society towards an innovation ecosystem. In fact, such an idea of university transformations is also visible in the Chinese context where a broad range of stakeholders have been coordinated through policy efforts to prompt changes at macro and micro levels in higher education.

In the first place, it is a conspicuous awareness for China that the gap between the higher education sector and the broader societal needs means unsustainability for the overall societal progress in the new times. On the contrary, shrinking the gap and bridging different stakeholders for the collective education purpose are viewed as means to achieve sustainability. The emphasis placed on quality in relation to an array of aspects, such as student attributes, employability, teaching and learning culture, and assessment has

demonstrated that pursuing sustainability in a comprehensive manner is now regarded as a fundamental means to serve the purpose of the overall societal aspirations by adopting a multiple stakeholders' interaction and mutual support-featured approach.

Identifying with the feature of SEU from technology transfer to knowledge exchange and co-creation [26,31], the Chinese effort in recent years has placed a strong emphasis on knowledge creation by stakeholders across sectors, not just limiting to academia as the traditional knowledge creation body. The content analysis of China's national policies in this study reveals that bringing in industrial and social stakeholders has been cast as an important strategy to update the knowledge and facilitate instructional development on campus. As revealed in the data, co-developing student talent outline, education infrastructure, and course contents have been taken up by both universities and collaborative enterprises, with government bodies issuing supportive policies and mechanisms to fuel such ties across sectors.

The current university-industry interaction patterns as revealed in the data speak to the idea of bi-directional knowledge flow described by Geuna and Muscio [32]. Within such a framework, knowledge is not merely transferred from one part to another but flows between different sides for value co-creation. For instance, in the Chinese practices, enterprises have infused the higher education sector with state-of-the-art technological expertise on the one hand, and also revised and updated their product based upon the feedback from the university side in terms of the compatibility between what enterprises can offer and the course structure at universities. Moreover, there has also been capital flows from the government and society to both enterprises and universities to fuel such knowledge and value co-creation.

5.2. Sustaining the Higher Education Sector through Building a Higher Education Innovation Ecosystem

Apart from embodying elements of the conceptualized sustainable entrepreneurial university, the Chinese efforts have signaled the national attempts to build a higher education innovation ecosystem at large to sustain the higher education sector. Among various conceptions of the concept, one of the most widely used definitions of the innovation ecosystem is "the collaborative arrangements through which firms combine their individual offerings into a coherent, customer-facing solution" [33], which is derived from the related concept of the business ecosystems, in which an innovation ecosystem is used to refer to a loosely interconnected network of entities across sectors that coevolve capabilities around a shared set of technologies, knowledge, or skills, and work for the development of new products and services. A decade later, the innovation ecosystem evolved to stand for the "inter-organizational, political, economic, environmental, and technological systems of innovation through which a milieu conducive to business growth is catalyzed, sustained and supported" [34], characterized by a continual realignment of synergistic relationships in response to the changing internal and external forces [9]. Dependences among organizations' different members, a shared set of objectives and goals, and a common and complementary set of knowledge, skills, technologies, and capabilities are identified as key defining characteristics of an innovation ecosystem [35–37].

In this study, we unravel a "higher education innovation ecosystem" from the Chinese policies to express a situated uptake of the innovation ecosystem in the context of Chinese higher education. The concept signals a Chinese approach to creating synergistic relationships through forging interconnected networks of entities across sectors for the shared set of goals and objectives in educational development at the post-secondary level. In this ecosystem, dependences among different stakeholders based on their complementary skills and capabilities are substantive, pragmatic, and illuminated. It is about the way in which resources, capital, and expertise are mobilized to form mutual support among the government, enterprises, higher education institutions, and social forces for a collective educational goal and a win-win educational outcome.

Viewing the university-industry collaboration in the global context, collaboration for educational purposes has been sparse compared with collaboration in research or

other aspects that tend to yield visible and rapid results [14], except for a few existing studies that have evidenced such practices across the globe in the past decade [38–40]. This study presents the latest landscape of the Chinese higher education sector, where different stakeholders such as the government, businesses, universities and colleges, and social forces have strengthened collaborative ties for the sake of educational purposes. There is a higher education innovation ecosystem gradually established as the government, industry and higher education sectors focus their attention on Chinese university students' learning.

Compared with China's own history of higher education, the extent to which synergy occurs among different stakeholders for enhancing higher education quality has been unprecedented. Such a landscape echoes existing literature that the successful innovation ecosystem depends upon the overall innovation performance resulting from the collaboration among focal stakeholders, component partners, and complimentary partners [9]. In the Chinese context, the higher education institutions across tiers are the focal stakeholders researched, whereas the government, enterprises, and social forces serve as component partners, supporters, fund-raisers, and also beneficiaries during the whole collaboration process. The interaction patterns among these stakeholders are not simply the sum of individual members' performances. The collaborative arrangements oriented towards a shared higher education telos have been salient, with political, economic, inter-organizational, and technological elements collectively involved to sustain a higher education innovation ecosystem [35,36].

The most important essence of the Chinese innovation ecosystem of higher education is the intensive infusion of elements and resources outside higher education into the traditional university course system to change the milieu of the traditional teaching featured with lecture-based pedagogy and textbook-based education instruments [38,41]. Such elements and resources include intellectual expertise, financial investment, technical guidance, and other types of professional contributions, which underpin the feasibility and part of the sustainability of the current overall innovation milieu. Over the past few years, along with the rapid increase in the quantity of relevant collaborative projects, the initiative has had the most impact on students' learning experiences at individual and course levels, to a large extent promoting college and university students' praxis education, exposure to authentic workplace settings and projects, use of the state-of-the-art package software and applications, knowledge of what the industrial sector truly demands, and increased motivation for learning obsolete and abstract technical and theoretical knowledge in the field of engineering, agriculture, medicine, and humanities. As shared assets, standards, and interfaces, as well as complementary innovators, are critical underpinnings of an activity system that strives for innovation for collective aims and goals [42,43], the different stakeholders in the Chinese context have provided new value to each other basically on the unified platform, built by MOE, where each stakeholder can get complete access to relevant policy contents and potential partners' information prior to and during the different phases of collaboration.

At the same time, the Chinese reflections on their own shortfalls in creating and sustaining the higher education innovation ecosystem identify some factors that are perceived to lead to cooperative innovation performance in empirical studies, such as structural dynamic, location of members, and members' heterogeneity [9]. The uneven geographic distribution of participating enterprises, universities, and colleges is what China aims to further resolve in their future endeavors on the innovation ecosystem, and so is the intention to include players from a broader range of industries for more heterogeneity. As collaboration, communication, choice, consideration, continuity, and community combined provide solutions to complexity in a professional synergistic relationship [44], how to sustain the collaborative ties among different stakeholders with the above necessary elements comes to occupy a prominent place in making future endeavors of the higher education innovation ecosystem.

6. Conclusions

This paper conducts an analysis of the policies, implementations, and effects of the recently developed Chinese higher education innovation ecosystem. With respect to why China is striving to establish a sustainable higher education sector, quality improvement dominates the rationale for building up the sustainable higher education sector, with quality being a high-frequency keyword across a total of 16 sampler official policy documents. To achieve such a quality goal, China has realized the need for building a higher education innovation ecosystem in which multiple stakeholders co-work in a synergistic approach to fueling the higher education quality at various levels. Regarding the path to achieving a sustainable higher education sector, various national policies have stipulated roles of different stakeholders based on collaboration and division of labor, with a major purpose to reduce the gap between the provision of education on campus and the demands on the part of the industry. Such collaboration and division of labor are based upon capital flow and resource mobility rather than mere slogans or policy intents, which motivates the industry to inject technological expertise into the university system to prop up higher education sustainability. MOE has distinguished a total of six categories of collaboration at macro and micro levels to promote synergy between industry and universities. As for the preliminary impact of China's effort so far, deepened and extensive participation in higher education quality improvement by multiple types of stakeholders has unfolded. Thousands of higher education institutions and businesses have forged such relationships of collaboration, and such stakeholders also spread across different tiers, including both premier business and higher education players and less-known ones. Furthermore, instructors' teaching and students' learning at the individual level have witnessed pattern changes, and social forces have been more engaged in institutional governance issues compared with Chinese higher education's own past. At the same time, it is worth noting that the public responses in China towards the current stages of the higher education innovation ecosystem are also filled with reflections, particularly on the unevenness across the six stipulated categories of collaboration and the geographic unevenness.

Overwhelmingly, there has been pronounced progress made regarding the synergy and collaboration between the government, the industry sector, the higher education sector, and the social forces compared with China's own past. It is especially worth mentioning that such synergy and collaboration are education, teaching, and learning-focused, with its impact unsurprisingly manifest not only at macro policy levels but also at micro course levels. Against such a backdrop, student learning can be touched, and the quality issue, which constitutes a central concern of almost every piece of higher education literature, is partly catered to. There have also been governance reforms in some higher education institutions to better cater to the demand of collaborating with other stakeholders.

The findings in the present study contribute to the theme of sustainable higher education in several ways. Firstly, through scrutinizing China's development of the sustainable higher education sector, we have applied the emerging conceptualization of sustainable entrepreneurial university, which derives from the European context, in China where the political and institutional environment is different. As an ideal type of university to embody the new societal engagement roles expected of higher education institutions, the concept of a sustainable entrepreneurial university has been validated to apply not only in the European context [20] but also in the Chinese context where different types of stakeholders are coordinated to play their socially responsive roles in co-creating sustainability in higher education. Secondly, we have put forward another concept of a higher education innovation ecosystem to enlarge the extant body of literature on innovation ecosystems that have mostly been applied in the business sector. As the analysis of the cluster policies conveys, a higher education innovation ecosystem featured with interconnected networks of entities across sectors gradually unfolds. Thirdly, the study has provided its empirical value in unraveling how the higher education innovation ecosystem has been strengthened through extensive government coordination and substantive resource affordance. The capital flow, for example,

as the invisible hand in making possible the cooperation between different stakeholders provides empirical insights into the essence of substantive cross-departmental collaboration.

One limitation of the paper should be noted for its adoption of content analysis as the only way of the research method. Detailed policy intents and preliminary impact have been rendered visible, and yet the challenges in the process of implementation have not been addressed. Nationally, the sheer size of China's effort to develop the sustainable higher education sector and the higher education innovation ecosystem is part of its overall national project for the development of world-class universities and world-class disciplines as shown in a wealth of literature. Internationally, China's attempts have resulted from the global technological advancement in the times of Industry 4.0 and its new demands for higher education quality. As such, the country realizes that to achieve a real sustainable higher education sector, the measures it needs to take should be a system and ecosystem-oriented overhaul of the higher education system, rather than tinkering with the current system with mere superficial changes. However, given the temporal proximity since the issuing of relevant policies analyzed in this study, which mostly yields the visible progress in size and quantity terms, the challenges in the implementation of these full-scaled teaching and education-focused collaborations between various stakeholders are yet to be investigated as well in future studies. Thus, based upon the findings of the present study that indicates the increase in different stakeholders' engagement and participation in higher education affairs, future research points to the employment of more empirical methods such as interviews and ethnographic observation to unravel the possible challenges that may exist in the interaction between the broad range of stakeholders in co-developing the higher education innovation ecosystem.

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Education Partnership Assistance to Promote the Balanced and Sustainable Development of Higher Education: Lessons from China

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Abstract: The Education Partnership Assistance (EPA) is an institutional arrangement that has played an important role in the balanced and sustainable development of higher education in China, in which universities of East China provide the paired universities in West China with various assistance. EPA is part of the political commitment made by the Chinese government to fulfil sustainable and balanced development. By applying a policy process framework and qualitative text analysis to the government and universities' official documents, we find EPA is primarily based on the Communist Party of China (CPC)'s ideological cornerstones of "common prosperity". Over the past two decades, by conducting leadership secondment, faculty and student training, and ICT and library development, EPA has improved the development of universities in West China, and the central government's current emphasis remains on the continuation of EPA. However, this paper argues that EPA cannot be going on indefinitely and that true sustainability is contingent on the capacity building of the recipient universities, rather than on the endless assistance from supporting universities. EPA is a localized action to achieve the Sustainable Development Goals (SDGs) in China. It sheds light on the connections between domestic aid and the SDGs from a supplementary perspective.

Keywords: education partnership assistance; common prosperity; balanced and sustainable development; sustainability; higher education; capacity building

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1. Introduction

The 17 global SDGs initiated by the United Nations in 2015 unfolded a new era of common commitment by the world, which would subsequently stimulate actions over the forthcoming 15 years in areas of critical importance for humanity and the planet [1]. Education is identified as a key area of the 17 goals, "to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all," referred to as the SDG 4. Although global goals for education in the period of Millennium Development Goals (MDGs) and Education for All (EFA) focused on basic education, higher education is expected to play its driving role for the achievement of the full set of SDGs in addition to calls for equal access for all women and men to affordable and quality higher education in the SDG 4, through their contribution to human formation, knowledge production and innovation [2–6]. It is thus clear that the importance of the sustainability of the higher education system is two-fold: as part of the SDG 4; and as a power system for the realization of other SDGs.

Although the SDG 4 does not explicitly define what sustainability is in higher education, it is described using adjectives such as equal, affordable, and quality. They are seemingly different, and in many cases conflicting targets, but are essentially interconnected. After all, the ultimate vision is more than education for all, but quality education

for all. From this perspective, the balance of educational resources distribution, not just schooling opportunity, is a key issue for the sustainability of higher education within the framework of the SDGs. Nevertheless, in contrast to the attention on the balanced development of basic education, the balance of higher education has gone unnoticed, despite its relevance to sustainability, and discussions on equity mainly concentrate on individual opportunity [7–10]. Therefore, reflecting on and promoting the international sharing of relevant practices have implications for the realization of the SDGs.

China is a relevant case when we discuss global goals for education, considering its population size and the achievements in education development, which have contributed tremendously to eradicating poverty and boosting prosperity in the past decades [11]. In recent years, both politicians and academics from different countries including China, and international organizations, have become increasingly interested in summarizing the lessons of Chinese education development. As far as higher education is concerned, there is still a gap for China compared its Western counterparts, but if we consider China's history of modern higher education is just over 100 years, we may have to give its achievements a more generous rating [12,13]. Although China's efforts in building world-class universities, from Project 211, Project 985 (Project 211 is a national strategy aimed at strengthening 100 higher education institutions and key disciplinary areas for the 21st century. The project was initiated in 1995 and 116 HEIs were selected. Project 985 is a constructive project for founding world-class universities in the 21st century. It was initiated in 1998 and 39 HEIs were selected.) to the current Double World-Class Project, and the expansion of higher education and its impact have received a lot of attention [14–17], in international publications, a limited amount of literature could be found directly on the *Education Partnership Assistance* (EPA) of China, one of the local actions to promote the sustainable development of higher education by promoting a balanced supply of quality higher education resources.

EPA refers to an education assistance model, rather than a specific project, initiated by the Chinese government to establish partnerships between higher education institutions in developed and underdeveloped regions, bringing in material and intellectual resources from the former to the latter. By doing so, China intends to improve education in underdeveloped regions, to optimize the allocation of educational resources, to promote educational equity, and to eradicate poverty. It is an institutional arrangement to promote the balanced and sustainable development of higher education in China, which represents a localized action of SDGs. This paper studies the policy process of EPA, specifically to answer the following questions: what political ideology framed and shaped EPA? How is EPA being implemented at the university level? What implications does EPA have on the realization of SDGs?

2. Literature Review

The issue this study concerned has been discussed, often indirectly, in three groups of literature. Although all of these studies do not directly address this article's research subject, they shed useful light on our research in different aspects. In the first group, studies have mostly focused on international education assistance and its role in achieving SDGs. Even the most severe critics acknowledge aid successes, and many of those have been in the education sector. Recent studies suggest that aid has contributed to positive educational achievements over the past decades [18]. However, effectiveness and sustainability of foreign aid in promoting education development in developing countries still remains questionable. Heyneman and Lee are particularly dissatisfied with policy-based assistance education, and they assert that it has developed a reputation for being invasive in the sense that the conditions are often set by a process characterized by unequal access to information and methods of analysis between lender and recipient [19]. There is also research pointing out the considerable gap between what aid does and what it could potentially achieve, especially in relation to its contribution to improvements in educational quality [20]. These critiques resulted in increased attention on new partnerships and domestic resource mobilisations that are to complement foreign aid in achieving SDGs [21,22]. It

implies the significance to pay attention to domestic initiatives like EPA. Moreover, in view of Niño-Zarazúa, for aid to be effective at improving the quality of education a system-wide approach is required, but this is challenging as donors are driven by the desire for quick and demonstrable results, which oftentimes leads to the heavy reliance on short-lived projects that limit the capacity of aid agencies to build sustainable institutional capacity. This insight makes sense equally when we reflect on EPA's effectiveness in promoting sustainability of higher education.

The second category related to this study, accordingly, are those centered on domestic assistance for higher education. The current literature has provided commentary on higher education grant and tuition policies, student bursary and loan systems, and their impact on the access of disadvantaged groups [23–26]. There are also studies that explore potential solutions from a fundraising perspective, based on increased domestic resource mobilisation to fill the growing financing gap to achieve SDGs [27,28]. These studies recognize higher education as a quasi-public good and thus emphasize the indispensable role of the government in providing and redistributing resources for higher education, while also arguing for leaving a necessary place for the free market. It reminds us to carefully examine whether both the government and the market are playing their rightful role in the operation of EPA.

The third group features studies centered on partnerships at the institutional level. Although it is common to develop partnerships among universities within a country, academic commentaries cannot be found proportionally. Woldegiorgis found that although African universities have been working in collaboration with universities outside of the continent for decades, since the 1940s, recently a slight shift in trends with diversifying partnerships among African universities can be seen. Such a shift is a significant new paradigm in higher education cooperation that facilitates regionalization and harmonization of higher education systems within Africa. Woldegiorgis warned, however, that the partnership should avoid developing into a donor-recipient kind of relationship, which eventually creates dependency of one institution towards the other [29]. This assertion touched on the key to sustainability of partnerships themselves but implied a pessimistic view on assistance relationships. It makes sense if the ultimate goals of a partnership are to cut down operating costs and to gain competitive advantage in the higher education's marketplace [30], though Woldegiorgis recognized the terms of partnership in higher education are more comprehensive and diversified than in business. Inspired by these insights, although EPA can be seen as a partnership that emphasizes social responsibility with the goal of a balanced development of the higher education sector as a whole, rather than a win-win benefit-based exchange relationship, while analyzing the role of EPA in promoting the sustainability of higher education, we should not neglect the sustainability of EPA itself.

Although we acknowledge the contribution and relevance of the sources described above to this study, evident knowledge gaps can be identified. International education assistance discussed in the first type of literature is fundamentally different from the EPA we discuss in this article. The latter, as a domestic aid, at least does not have as many sovereignty concerns as international aid. Therefore, the discussion of international aid to education cannot fully explain the entirety of EPA. Although the second type pulls the view back to the domestic context, EPA is not a direct government support to universities by transferring payments or leveraging tax policies, but a government-driven initiative expenses borne by universities. Moreover, EPA is not only about financial aid, or more precisely not mainly about financial aid. Lastly, the partnerships examined in the third category of studies are based on reciprocal cooperation, whereas EPA is more of a type of one-way assistance, although discourses like cooperation are always literally mentioned in Chinese policy texts, the obvious division between donor and recipient has determined that they are not reciprocal in an actual sense. This makes the sustainability of EPA even more questionable.

A chapter contribution published in 2014 did pioneering work by overviewing EPA as an attempt to promote balanced development in higher education between eastern and

western China [31]. Nevertheless, they mainly give a description of EPA, without the application of a specific analytical framework, and present some main findings of a survey on the effect of EPA done by the Ministry of Education in 2007. Therefore, the underlying logic and recent development of EPA have not gained attention, let alone discussions on its implication to promote the SDGs.

3. Conceptual Framework

To explore the under-researched EPA, we intend to investigate the policy process and its implications regarding the SDGs. The policy process analysis will further develop the pioneering EPA study in 2014 by tracking the political context and latest development of EPA (research questions 1&2). The implications discussion will make contribution to international literature on the SDGs (research question 3). We adopt a perspective of policy process that focuses on key stages of the policy reform plan. The Stages Heuristic (Stages Model or Textbook Approach termed in other literature) in policy analysis was firstly introduced by Harold Lasswell with seven steps, and proponents have since developed this framework into five steps during the 1970s to the 1980s: agenda setting, policy formulation, legitimation, implementation, and evaluation [32]. This framework is insightful to explore EPA due to its focused attention on the context and development of a policy. Considering both the fact that EPA is still being implemented as well as the Chinese context, this study mainly draws on "agenda setting-policy formulation-implementation" to analyse the policy process of EPA. As a sub-division of a greater national strategy, the legitimation process of EPA has been predetermined, which will be explained in the policy formulation section. Based on the limited formative information regarding the results and the outputs of EPA in previous evaluative studies, this study presents some basic facets of policy evaluation in the sections of policy formulation and implementation.

To better understand the policy process, a more recent and localized framework proposed by Xu is insightful. Based on reviewing the political reform in China since the 1980s, Xu believes that the following issues are of significance to explore: (1) the role of ideology on the rationalization and legitimacy of reform policy; (2) the role of political leadership; (3) the bureaucratic and organizational policy preferences; and (4) various levels of social group participation [33]. Thus, this study presents findings in a three-stage sequential manner in accordance with the Stages Heuristic framework. In each stage, the role of political leadership and ideology, social group participation, and the policy preferences Xu proposed were integrated. Within the Chinese background, the conceptual framework of this study can be graphed as below:

In Figure 1, the horizontal (left to right) arrows represent the three stages of policy process. The dotted box in the middle represents the policy factors that deserve exploration in the Chinese context as Xu proposed. The longitudinal arrows (up to down) indicate how the conceptual framework guides us to locate the main topics in different stages.

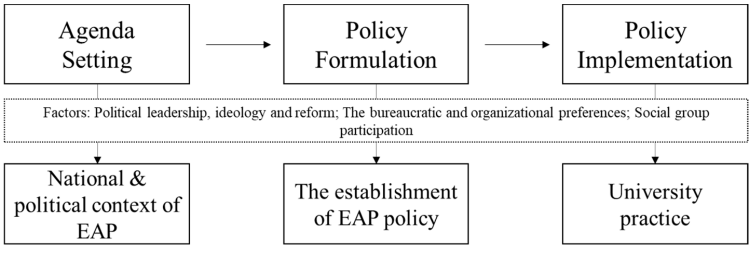

Figure 1. A policy process conceptual framework of this study. Source: authors make by integrating Lasswell [32] and Xu's [33] frameworks.

Specifically, in the stage of Agenda Setting, we explore the partisan ideology and key leadership ideas that may have influenced EPA, namely the CPC governance idea, Deng

Xiaoping theory, and Xi Jinping thought. In the policy formulation stage, we analyse the bureaucratic and organizational preferences that shaped EPA at the transition from the 20th to the 21st Century, especially the CPC Central Committee, the State Council, and the Ministry of Education. In the next stage, universities are the protagonist in policy implementation. In fact, the central government did not specify what kind of assistance universities should carry out in EPA. Therefore, the practical measures of universities further demonstrate how the policy works, and also explain the participation and organization preferences of universities.

4. Methodology

We took a thematic qualitative approach to deal with the text data [34]. Government and universities' documents comprise the data source for our study, so the qualitative text analysis is appropriate. Firstly, in an open-coding similar way, we generated a new topical category by reviewing the CPC government documents, which is labelled as the political ideology of "common prosperity". Then, using "common prosperity" as the previous knowledge [35], we present how the political ideology affects EPA in different stages by coding the specific EPA-related policy documents.

4.1. Data Collection

Data collection is based on reviewing official policy documents and universities' practices. The policy documents this paper has reviewed are listed in Table 1. University working documents are mainly presented as news articles and were retrieved from their websites, as Table 2 shows.

Table 1. List of the Major Policies on EPA.

Year.	Issuing Agency	Policy Title	Abbreviation
2000	General Office of the CPC Central Committee & General Office of the State Council	Notice on Partnership Assistance for Schools Between the Eastern and Western Regions	2000 Notice
2000	Ministry of Education	Guiding Opinions on Partnership Assistance for Schools Between the Eastern and Western Regions	2000 Guiding Opinions
2001	Ministry of Education	Notice on the Implementation of the Partnership Assistance Project for Colleges and Universities in the Western Region	2001 Notice
2006	Ministry of Education	Opinions on Further Carrying out Partnership Assistance for Colleges and Universities in the Western Region	2006 Opinions
2010	Ministry of Education	Opinions on Further Promoting Partnership Assistance for Colleges and Universities in the Western Region	2010 Opinions
2013	Ministry of Education, National Development and Reform Commission, Ministry of Finance	Higher Education Vitalization Plan in Central and Western China (2012–2020)	2013 Plan
2016	Ministry of Education	Opinions on Strengthening EPA to Tibet and Tibetan Areas in Four Provinces during the 13th Five-Year Plan Period	2016 Opinions
2020	the CPC Central Committee, the State Council	Guiding Opinions on Promoting the Western Development Strategy and Forming a New Pattern in the New Era	2020 Guiding Opinions

Source: authors.

Table 2. List of Universities Document.

Year	Universities	Document Title
2008	Beijing Normal University (BNU) and North-western Normal University (NWNU)	EPA Agreenment between BNU and NWNU *
2016	Peking University (PKU) and Shihezi University (SHZU)	Peking University and Shihezi University: 15 Years of Continuous Friendship #
2021	PKU and SHZU	The 20th anniversary summary meeting of Peking University's counterpart support to Shihezi *
2021	Yunnan University (YUN) and Fudan University (Fudan)	The Joint Degree Programs of YUN and Fudan #

Source: authors. Notes: * are retrieved from university websites; # are retrieved from news media.

4.2. Data Analysis

To lay foundations for the understanding of EPA agenda setting, we introduce the national background of regional imbalance and its unsustainable consequences in higher education. We then discuss the political ideology of "common properity" the CPC put forward and the consequent "East-West Pairing-off Cooperation" policy since Reform and Openning-up in 1978. These national and political contexts explain explicitly the agenda-setting background of EPA. In the analysis of the policy formulation stage, we use the idea of common prosperity (and its homologous concept "national balanced development") as a main topical category to code the policy documents in Table 1, so as to illustrate how the political ideology affects EPA. Table 3 shows some examples of our coding process, the whole coding process is conducted in Chinese. Through coding the documents, it turns out that the Western Development Strategy (WDS) is a strategic decision under the idea of common prosperity, which also sets a foundation for the policy formulation of EPA. The coding process also reveals a key characteristic that the policy documents are with a single-partisan value. Therefore, we focus on how the political ideology has been conveyed in the policy documents, instead of creating new topical categories based on coding.

Table 3. Coding Examples.

Policy Abbreviation	Main Topical Category	Text Coding [Identifying Statement that Reflect the Catoegory]
2000 Notice	common prosperity (//national balanced development)	Due to historical reasons, the educational level in the western poor areas is relatively backward and the educational foundation is relatively weak, which is difficult to meet the WDS.
2000 Guiding Opinions		The eastern region and large and medium-sized cities in the West should contribute to the development of education in poor areas in the West.
2001 Notice		Actively developing higher education in the western region and accelerating the training of senior professionals are important tasks for the implementation of the WDS.
2006 Opinions		Partnership assistance is the concrete embodiment of striving to realize the comprehensive and balanced development of higher education. It is an important measure to implement the WDS in higher education.
2010 Opinions		Supporting universities should recognize that partnership assistance is not only a political task, but also their own social responsibility and historical mission.

Source: authors.

In the analysis of the policy implementation stage, we raked over the university news reports (it should be noted that the number of this sort of data is limited), and we summarize the major paths of implementing EPA by universities. We found four major paths to carry out partnership assistance, which also represent the universities preferences and cognition of EPA policies. Based on the policies and practice facts, we move to the discussion of the EPA implications on the SDGs.

5. Findings

5.1. Agenda Setting of EPA

As the biggest developing country with the largest population in the world, China has been facing substantive challenges of unbalanced development. A prime example is that all 832 poverty-stricken counties identified by the government in 2013 were located in western and central China [36]. With regard to the development of higher education, the picture is rather similar. In terms of the per capita public spending for higher education, the majority of regions where spending was lowest are also in western and central China. Meanwhile, approximately half of the 211/985 projects universities are located in eastern China. The regional disparities are clearly showed in Table 4.

Table 4. Regional Disparities in Higher Education Development in the Chinese Mainland.

Number of	Central	Western	North-Eastern	Eastern
provinces	6	12	3	10
population proportion (%) ★	25.83	27.12	6.98	39.93
provinces with per capita public spending for higher education below the national median *	6	4	2	2
universities selected for 211 project	17	25	11	63
universities selected for 985 project	6	7	4	22
provinces without universities selected for 985 project	3	8	0	2

Sources: National Bureau of Statistics, 2021; MoE, 2016. Notes: ★ According to the Seventh National Population Census. * Data for 2015.

To narrow this wide gap is a political commitment made by the CPC. Since the founding of the People's Republic of China in 1949, the CPC has been making political commitments to achieve common prosperity, despite the many detours taken in the early three decades. At the beginning of *Reform and Opening-up* in 1978, Deng Xiaoping, the then paramount leader of China, formally put forward the concept of common prosperity, and marked it as the fundamental principle of socialism with Chinese characteristics. In 1988, Deng affirmed that Socialism is characterized not by poverty but by prosperity—the common prosperity of all [37]. Unlike the egalitarian approach of People's Commune Movement in the 1950s and 1960s, Deng believed that common prosperity should be achieved gradually, and advocated allowing some regions with viable conditions to develop first, and they would then help the lagged ones to catch up, then China will eventually achieve common prosperity [38]. In 2017, the CPC held its 19th National Congress, President Xi Jinping strengthened the idea of common prosperity by announcing that socialism with Chinese characteristics has entered a new era. He also stated that the principal contradiction facing Chinese society now is the disparities caused by unbalanced and inadequate development and the people's ever-growing needs for a better life [39].

Since 1978, various policies have come towards a policy package for the goal of common prosperity, one of which is the "East-West Pairing-off Cooperation" that links provinces at different levels together for more equitable development and resources distribution [36]. From 2015 to 2020, nine eastern provincial regions have invested more than 100 billion yuan to their paired provincial regions in poverty alleviation areas and mobilized more than 22,000 local enterprises to invest 1.1 trillion yuan. Additionally, the exchanged officials and technical personnel amounted to 131,000 [40] (p. 56).

Education, as Dewey put forward, is fundamental for social progress and reform [41]. The CPC also highly values the role of education as a fundamental facilitator when designing its national balanced development strategy. Education assistance is part of Official Development Assistance (ODA), defined by the OECD Development Assistance Committee as government aid that promotes and specifically targets the economic development and welfare of developing countries [42]. Improving education in impoverished areas has been identified as one of the five measures (The other four measures include: boosting the economy to provide more job opportunities, relocating poor people from inhospitable areas, compensating for economic losses associated with reducing ecological damage, and providing subsistence allowances for those unable to shake off poverty through their own efforts alone.) for poverty eradication by the CPC [40] (pp. 37–43).

As Deng explained, common prosperity is more than material affluence, but also includes spiritual and cultural enrichment as well as the improvement of people's civilization [43]. President Xi also described the common prosperity as "a general concept that involves all aspects of the society, . . . is for all, affluence both in material and spiritual life . . . " [44]. Therefore, achieving quality and balanced education for all would be regarded both as an important approach and an indispensable goal for achieving common prosperity. Furthermore, EPA, an initiative of "East-West Pairing-off Cooperation" in education, has been valued and promoted by the CPC and became a complementary redistribution arrangement to the national public education resource allocation system.

5.2. Policy Formulation of EPA

5.2.1. Policy for EPA

The origin of EPA can be traced back to the 1950s, and it continued to grow significantly in the 1980s and 1990s [45]. At the turn of the century, with the implementation of the WDS, EPA has been systematically integrated into the national framework of sustainable and balanced development in China. The WDS was officially approved in 2000 by the National People's Congress (NPC), and its adjustments were repeatedly reinforced by the NPC as well in the following decades. Approvement by the NPC is a major mechanism to gain legitimacy for any national policies in China. Since the approval of WDS in 2000, the central government has been able to issue EPA policies without consultancy with the NPC.

In 2000, the central authority initiated EPA by issuing the 2000 Notice. In the beginning of the 2000 Notice, it read that the CPC Central Committee and the State Council have decided to carry out EPA. Then, the 2000 Notice elaborated on the rationale underlying the EPA projects: the successful implementation of the WDS depends largely on the improvement of the quality of the workforce and on the quantity and quality of education and training of various types of talents [46]. The necessity of putting higher education in a key position of WDS is self-evident. Without substantial talent resources and intellectual support, the strategic plan of the WDS is likely to be difficult to implement. Considering the direct connection between WDS and common prosperity, EPA as an educational component of WDS resonates such a political ideology.

According to the 2000 Notice, EPA is comprised of two sub-projects. The first pairs up schools of the Western provinces vs. schools of the Eastern provinces throughout China; and the second focuses on schools in large- and medium-sized cities vs. schools in poorer, more rural areas within a single Western province. This study focuses on the former. The 2000 Notice set out a blueprint for EPA. Thereafter, according to the logic of Chinese governance, the primary responsibility for EPA implementation rested with the Ministry of Education (MoE). Two weeks after the 2000 Notice, the MoE issued the 2000 Guiding Opinions. It is noticeable that the 2000 Guiding Opinions represents multi-participation of bureaucratic organizations, which reflects the complexity and difficulties in carrying out such an ambitious plan. As it stated, the national EPA is led by the MoE, assisted by the State Council Leading Group for Poverty Alleviation and Development, with the participation of the Organization Department of the CPC Central Committee, the National Development Planning Commission, the Ministry of Finance, and the Ministry of

Personnel. In terms of policy content, the 2000 Guiding Opinions specified that EPA should be centered on compulsory schools. In addition, the supporting parts are encouraged to assist in vocational education and higher education as much as they can [47]. Although the 2000 Guiding Opinions has focused its attention on basic education, it has also provided a basic framework for the later development of EPA in higher education.

5.2.2. Policy for EPA in Higher Education

The first specific policy for EPA in the higher education sector was the 2001 Notice issued by the MoE. According to the academic expertise and willingness of recipient universities in the western region, 13 universities in the eastern region, including Peking University and Tsinghua University, have been designated as supporting universities. Supporting universities take a one-to-one approach to build up all-round cooperation with the recipient universities and implement assistance. Responding to the 2000 Notice rationale, the core task of EPA is to educate various types of talents. Other key tasks are subject and discipline construction, personnel building, as well as management and administration system establishment [48]. Through selecting the pairing universities and setting out assistance principles, the 2001 Notice has marked the official launch of EPA in higher education.

The 2001 Notice set five years as the time frame for the first round of EPA. Five years later, the MoE issued the 2006 Opinions to continue EPA. On top of affirming the positive results gained, the 2006 Opinions was highlighted with three new clauses. First, the 2006 Opinions advocated for the use of modern information and communications technology in promoting EPA; second, the recipient universities were encouraged to expand international exchanges and cooperation; and third, the central government stressed the sustainability of EPA by pointing out that establishing a long-term mechanism to realize the long-term, stable, and healthy development of partnership assistance is necessary [49]. In 2010, the MoE issued the last specific policy on EPA in higher education—the 2010 Opinions. Compared to the 2006 Opinions, developing faculty professions and educating various young talents were further emphasized [49], otherwise the new policy imparts the old policy without big breakthrough.

Up through 2020, initiated by the CPC Central Committee and the State Council, mainly driven by the MoE, EPA has established a policy system with Chinese characteristics. With the top-level government as the leader, the distribution of higher education resources has been gradually optimized, which reflects the superiority of the socialist system [50]. In the exploration and practice of more than a decade, EPA has become a model that is suitable for China's national conditions, which has strongly promoted the leapfrog development of universities in the western region and improved the higher education system in China as a whole [51]. In a word, the "Chinese characteristics" and "the superiority of the socialist system" stated above refer to as the east–west pairing-off development in education, and then to accelerate the realization of common prosperity.

More recently, although EPA is still being implemented, the central government has not issued specific policies. However, as shown in Table 1, the three pertinent policy documents issued in 2013, 2016, 2020 have all emphasized the significance of EPA in higher education. For instance, in the 2020 Guiding Opinions, the CPC Central Committee and the State Council pointed out that China will continuously promote the partnership assistance in higher education between the eastern and western regions [52].

5.3. Implementation of EPA

Established by the 2001 Notice, the first batch of universities in EPA is as shown below in Table 5. Just a few years later, an increasing number of colleges and universities had joined the project, and there has been a steady trend of gradual increases. From 2001 to 2007, the total number of EPA participants included 25 supporting universities and 31 recipient universities [53]. In 2013, nearly 20 higher education institutions of Beijing took part in

the project, and the total number of supporting vs. recipient universities hit 99 and 73, respectively [54].

Table 5. List of the Start-up EPA Institutions in 2001.

Supporting University		Recipient University (Location #)
Beijing	Peking U, Tsinghua U, China Agricultural U, Beijing Normal U	Shihezi U (Xinjiang), Qinghai U, Inner Mongolia Agricultural U, Northwestern Normal U (Gansu)
Shanghai	Fudan U, Shanghai Jiao Tong U	Yunnan U, Ningxia U
Jiangsu	Nanjing U	Northwest U (Shaanxi *)
Zhejiang	Zhejiang U	Guizhou U
Guangdong	South China U of Technology	Guangxi U
Anhui ★	U of Science and Technology of China	Southwest U of Science and Technology (Sichuan *)
Hubei	Huazhong U of Science and Technology	Chongqing Medical U
Sichuan *	Southwest Jiaotong U	Tibet U
Shaanxi *	Xi'an Jiaotong U	Xinjiang U

Source: MoE, 2001. Note: ★ Anhui is a central province. * Sichuan and Shaanxi are western provinces, but the two supporting universities from which are leading ones in their academic fields. # Without indications in parentheses, the recipient universities are named after their respective provinces.

The four milestones (2000 Notice–2001 Notice–2006–Opinions–2010 Opinions) have set up an agenda for EPA. Student cultivation has always been the core of assistance, and in addition, other key tasks comprise academic facility construction, faculty and staff team building, administration system establishment, and internationalization. The paired universities would first stipulate the assistance fields by signing an agreement. Leadership exchange, faculty and student training, and ICT and library development are the most common approaches.

5.3.1. Agreement Signing

To lay the foundation for assistance, leadership exchanges of paired universities is usually the first step, which includes the university leaders visiting the partnership university, assistance agreement signing, and so forth. A more detailed assistance to-do-list will be confirmed in the agreement. For instance, according to the agreement between Beijing Normal University (BNU) and Northwestern Normal University (NWNU), each year, BNU offers a number of graduate enrolment places for NWNU young faculty to pursue higher-level degrees, hosts a number of visiting scholars from NWNU, sends professors to work at NWNU for a short period of time regularly, opens online resources and laboratories to NWNU, and supports NWNU in applying for national research funds and other key research works when necessary [55]. The BNU–NWNU agreement covers the most common assistance fields in EPA. Other forms of assistance may include the exchange program for faculty and the direct donation of education equipment and facilities.

5.3.2. Leadership Secondment

To better implement the assistance project, the supporting university would usually send a leader or a professor to hold a temporary leading post (one to three years) at the recipient university. Tsinghua University and Qinghai University, Zhejing University and Guizhou University, Peking University and Shihezi University, and Southwest Jiaotong University and Tibet University, have all consecutively sent and hosted the exchanging leadership. Some are administrative posts at university level, and others include academic leadership posts at school level, which have made noticeable contributions to the administration and academic research of the recipient universities [56]. The leadership secondment is also an effective approach to help the recipient universities improve administration and management.

5.3.3. Faculty and Students Training

As the above BNU–NWNU agreement shows, faculty professional development of recipient universities might include upgrading degrees and collaborations in teaching and research. For the core task of student cultivation, the supporting universities open positions for visiting students and offer joint-degree programs for undergraduate students. Fudan University and Yunnan University started the joint degree program in ten academic areas from 2010. In the past decade, more than 400 students were beneficiaries. The employment rate of students participating in joint programs reached 100%, of which more than 50% were recommended to Fudan University, Zhejiang University, and other well-known universities for postgraduate study [57]. EPA has also helped the recipient university attract students. According to Shihezi University, Peking University's support made itself a desirable destination for Chinese students. Shihezi University's freshman enrolment covers 31 provinces every year, among which 58% of students not native to Xinjiang choose to stay upon graduation [58]. Attracting a group of talents originally from other regions for the western provinces is a sustainable contribution made by the universities through EPA.

5.3.4. ICT and Library Development

In the implementation of EPA, internet technology plays an increasingly important role when eastern universities open resources to western universities, be it joint-degree operation, scholars exchange, visiting programs operation, or academic resources sharing. With the issue of the 2006 Opinions, the use of information and communications technology (ICT) has become a key field in assistance, for library-network in the western universities play a critical role [59]. The significance of ICT is two-fold, and ICT is first an integral part of the assistance. For instance, in 2001–2006, Tsinghua University and Peking University had donated 41,834 and 7846 books each to their paired universities. Librarian workshops and training programs among the EPA universities have also become routine [60]. Second, with the support of ICT, other approaches of partnership assistance can be largely accelerated. In the end, when reviewing studies with regards to EPA, library has been an explicitly emerging sub-field.

Before the 2006 Opinions advocated using modern information and communications technology in EPA, the digital divide between western and eastern regions were underlined by academia. In prospect, facing the goal of modernized Chinese education in 2035, promoting the common sharing of high-quality digital education resources is an important area for the development of higher education [61]. Such an orientation will thus influence EPA as well. Since building E-campus, E-classroom, and E-education services have become EPA components, the functions of the university library and the ICT will be more fundamental and multidimensional.

6. Discussion

EPA is part of the policy package made by the Chinese government to fulfil the political commitment of sustainable and balanced development in education. It is primarily based on the CPC's ideological cornerstones of common prosperity put forward by Deng Xiaoping in the late 1970s, which permits a certain range of asynchrony and disparity among different regions and groups for a period of history but requires the more developed help the less developed ones. Taking the WDS as a starting point, EPA has been preparing and implementing in China for more than 20 years. The less developed regions have received substantial developmental assistance both materially and intellectually through EPA. China has thereby enhanced the overall development of higher education as well as socio-economic balance.

The Western Interstate Commission for Higher Education (WICHE) in the United States and the merger and reorganization in universities in France used to hold a similar intention to the Chinese EPA. However, neither relying on legislative guarantees nor following any market mechanism, the EPA model of "universities to universities aid" in China is characterized by political mobilization and free assistance [62]. EPA is essentially

an unconventional political task given by the government to supporting universities [63,64]. On the summary conference of the 20th anniversary of EPA between Peking University and Shihezi University, a Xinjiang political leader stressed that assisting Xinjiang is a major strategic decision of the CPC Central Committee in his address [65]. Peking University has always taken this as an honorable and significant political task, mentioned the president of PKU too. The representative of the MoE required all the supporting universities to hold a higher and stronger sense of political responsibility and continue to do a good job in supporting the western counterparts [65]. These discourses vividly reflect how the political ideology and forces have influenced the formation and implementation of EPA. The practice of relevant universities shows how this policy is implemented. EPA is a Chinese localized action to achieve the SDGs. It sheds lights on the connections between domestic aid and the SDGs. When it is widely believed that foreign aid is important for the SDGs, China's EPA generates implications from a supplementary perspective.

Despite concerns about the policy durability, there is no sign that EPA is nearing its termination. No matter how we extol the Chinese government's ambitions and efforts to promote balanced development, it is a fact that imbalance still plagues the country. Although President Xi declared that China triumphed in the battle against poverty in 2021, EPA will continue for a foreseeable period. However, the sustainability is predictably still one of, if not the most, disputable issues. Political mobilization rather than inner cooperation intention between paired universities drives EPA, and could immediately produce visible effects, especially in the Chinese context. However, it is at risk of lacking stamina for long-term development, given that supporting universities need to pay out of their own pocket to finance the EPA. Moreover, if the university leaders lack sufficient sense of national responsibility and only see EPA as a political task, they will likely muddle through without putting forth the extra effort to make the project sustainable. Much of the literature has stressed this concern, and policy makers are aware of this problem as well. As mentioned above, the importance of EPA sustainability has been clearly emphasized in the 2006 Opinions and reinforced again and again in the following policies. Nevertheless, instead of offering advice on how to make EPA more sustainable, we argue that EPA cannot continue forever and that the true sustainability depends on the capacity building of the recipient universities, rather than on the endless assistance from supporting universities.

A fundamental question in the implementation of EPA is how to define the sustainability of EPA. At present, the central authority still emphasizes the sustainability of the EPA assistance. In the long run, a traditional Chinese philosophy is probably insightful to redefine sustainability. The old saying goes, "it is better to teach a man fishing than to give a man a fish." Chinese educators have always believed in this ancient motto. Fishing is sustainable whereas a single fish is not. As the EPA projects move on, the definition of sustainability is likely to be shifted.

7. Conclusions

Based on the analytical framework of Policy Process, this paper reviewed three stages of EPA in the Chinese higher education sector. In the stage of agenda-setting, the political ideology of common prosperity with Chinese socialism characteristics promoted the development of "East-West Pairing-off Cooperation" and WDS. To better achieve the ambitious goals of balanced and sustainable development coined in WDS, Chinese central authorities have selected education as a facilitator. In the stage of policy formulation, the central authority has provided a clear framework for EPA in compulsory education and encouraged the higher education practitioners to create similar projects. Thereafter, a series of more specific action plans of EPA in higher education were issued by the central authorities. Human resources related tasks including student cultivation and faulty professional development are at the heart of EPA, which reflect the policy preferences. In the stage of policy implementation, the paired universities usually legitimize cooperation by signing agreements. Leadership exchange, faculty and students training, and ICT and library development are the most common approaches. The implementation stage indicates the

multi-participation with various levels of bureaucratic departments and social groups in EPA. However, universities are the responsible entity, other bureaucratic and social groups participation is symbolic. The common cooperative areas also demonstrate the organizational preferences at university level. Although the central government has announced that they will continue EPA without a set time limit, this study suggests that the sustainability of EPA is the internal ability of the recipient university rather than the continuous assistance of the supporting university.

When international aid prevails current research on SDGs, this study provides a supplementary perspective by presenting domestic aid within the Chinese Mainland. In addition, the existing literature enlightens us to examine the government' role in EPA and the sustainability of EPA itself, to which our study makes contributions. Findings from this study hold policy implications for the Chinese government, especially the realization from *fish* to *fishing* deserves political and professional attention, in terms of sustainability. There are some limitations of the study. Our analysis is mainly based on policy documents and university official news posts. Since EPA is still being implemented and its attributes of political tasks, we have not yet touched upon the stage of evaluation, namely the actual effect and effectiveness of EPA, which merits more research. Future research is advised to investigate the paired universities' covert recognition on EPA through rigorous qualitative field study, for instance, to collect various assistance artifacts and to interview relevant staff.

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What Characterises an Effective Mindset Intervention in Enhancing Students' Learning? A Systematic Literature Review

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Abstract: In recent years, increasing attention has been paid to interventions designed to enhance individuals' sustainable development in learning by priming a growth mindset. The current study systematically explored the characteristics of message transformation in growth mindset interventions from the perspective of teaching and learning. According to a three-phase literature search (database, prominent researchers, and backtracking references), thirty-eight empirical studies investigating the efficacy of mindset interventions for adolescents of school age constitute the sample for the current literature review. The results indicate that a supportive but not-completely-saturated learning environment paves the way to implementing a mindset intervention. The three pedagogical characteristics that ensure successful interventions are: (1) Mutual interaction among the person, the context, and the theory to generate the message; (2) Iterative processes to ensure the message is delivered; and (3) a persuasive yet stealthy approach to facilitating its internalization. The findings inspire educators to design effective mindset interventions to enhance students' learning. Theoretical and practical implications, limitations, and future directions are discussed.

Keywords: mindset intervention; interaction; iterative process; persuasive; stealthy

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1. Introduction

Due to the launch of the Unites Nations 'Sustainable Development Goals (SDGs)' in 2015, students' academic and social performance towards sustainable development at the educational level has increasingly attracted attention. With increasing studies investigating educational processes to improve learning efficacy [1–3], mindset theory has proved in both educational and psychological settings as a tool for improving learning patterns through strengthening self-affirmation. Mindset, also known as implicit theory, is the belief people hold about the malleability of their human attributes [4]. Individuals with *a growth mindset* believe these attributes are malleable with effort, whereas for those with a *fixed mindset* they are immutable. In academia, for example, an academic mindset has proved to stimulate students' learning experiences including but not limited to academic perseverance [5], enjoyment, and engagement [6]. Consequently, it has been found to give academic grades a significant boost [7–9]. Accordingly, more and more mindset interventions have come to light in the last two decades, exploring effective approaches to cultivating a growth mindset among individuals to enhance achievement [6,10,11].

It is worth noting that the efficacy of mindset thinking has been doubted given the very small even null effects found. For example, a meta-analysis (k = 273, N = 365,915) yielded weak overall effects of mindset and mindset intervention on academic achievement [12], which raised doubts as to whether a growth mindset did help to improve adaptive behavioral patterns. However, the poor results could have been attributable to the lack of scientificness and efficacy in how teachers transferred growth-mindset messages to students [13]. In other words, growth-mindset pedagogy was lacking [14]. Interestingly, benefits from mindset interventions have been broadly supported for marginalized individuals such as those with low socioeconomic status or at risk academically [12]. Furthermore, research involving a nationally representative sample in the US (k = 65, N = 12,490) has shown

that mindset intervention increases student enrolment overall for advanced mathematics courses [15].

Mindset interventions differ in terms of design. The accumulative time of the sessions ranges from several minutes [16] to couple of hours [17], and the number of operating sessions varies from one [18–20] to dozens [21]. Most sessions include activities such as reading [18,22,23], discussion [24,25], and writing exercises [26–28]. Intervention proceeds on-site or online, or even in combination [29]. Brainology, an online program with animation-based interaction to encourage a growth mindset [30], is one example of an intervention [21,31]. Given the availability of such computer-based approaches, mindset interventions have ranged from small-scale field research to scalable investigations [10]. Measures such as complementing the experiment group with a control group that does non-mindset exercises (e.g., coping skills, see [32]; health issues, see [33]) or has no treatment [7,34,35] have been introduced to verify the efficacy of mindset intervention. Other motivational factors, such as sense of purpose [10], social belonging [36], and social norms [23], have been combined with growth-mindset messages to see if intervention efficacy would be additive. However, several empirical investigations discouraged such a prediction [10,36].

In addition to the various empirical investigations in either laboratory or real-world settings, there have been a limited number of theoretical studies focusing on the characteristics of mindset interventions [5,37] or their effectiveness [12]. Farrington et al. [5], for example, emphasize the interaction between individuals and the social-cultural context through recursive processes in which people and context are mutually reinforced or discouraged in a repeating feedback loop. Hence, without removing objective adversities, how individuals interpret adversity could determine whether it hurts the outcome [37]. The implication is that the mindset is a product of interaction between individuals and the surrounding environment rather than a set of predetermined characteristics [5].

Notably, more review and commentary studies have focused on the traits of general social-psychological interventions rather than on mindset intervention [38–40]. Some of the theoretical underpinnings in these studies, related to social-psychological attributes, for example, could be applied to the current review, given the theoretical commonalities across different perceptual points that fall within the scale of social-psychological intervention. Cohen et al. [38] and Wilson et al. [39], emphasize the importance of the surrounding environment. It is also acknowledged that underlying theoretical knowledge of its mechanisms facilitates the development of well-designed interventions and their timely revision [40].

In sum, in the educational context of SDGs, most existing reviews of or commentaries on interventions in educational psychology concentrate on social-psychological interventions in general, and very few studies specifically focus on the mindset. Second, most of the studies on mindset-relevant intervention were conducted by the same group of researchers from the United States, and to our knowledge, the latest review with discussions of characteristics of intervention goes back ten years. Third, none of the existing reviews incorporates a scientific and systematic search of the relevant literature to explore the characteristics of growth-message transmission in effective mindset intervention. Fourth, none of the existing research adequately explores person-context-theory interaction in conducting mindset interventions. Thus, there is a clear need for a scientific and systematic review of empirical studies conducted by non-US researchers and with a focus on transformation mechanisms. On the one hand, "broader evidence ... ... would strengthen the claims from these authors" [5] (p. 31); on the other hand, up-to-date data will facilitate the understanding of the efficacy of mindset intervention. The aim of the current systematic review is to synthesize existing empirical studies published in the last decade, thereby exploring the following research questions:

- RQ1: How effective are mindset interventions in enhancing students' learning?
- RQ2: What characterises effective mindset interventions in enhancing students' learning?

2. Materials and Methods

2.1. Phase 1 of the Literature Search–Databases

As Figure 1 demonstrates, we first searched for terms combined with mindset (implicit theory of intelligence, incremental theory, entity theory, self-theory, implicit person theory, implicit person scale) and intervention (experimental study, experimental design) in three databases: Web of Science, PsycINFO, ERIC (Education Resources Information Center). We searched in April 2021. The current review focuses on studies published between 2012 and 2021. The first-phase search yielded a total of 1484 titles, of which 1451 remained after de-duplication.

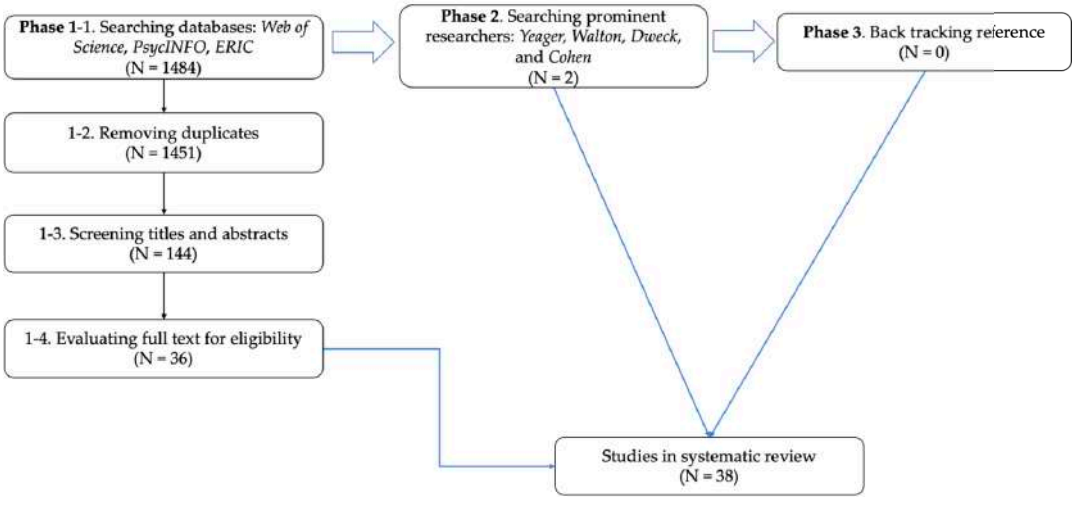

Figure 1. Flowchart of the literature search.

Inclusion and exclusion criteria. To select empirical studies for the current systematic review, we screened the titles and abstracts of all 1451 articles following a seven-item set of inclusion and exclusion criteria (see Table 1).

In line with the criteria, we excluded 1307 of the titles, leaving us with 144 articles. Of these, we excluded five because the full text was not available online and the we received no response to request for it from authors. We screened the full texts of the remaining 139 articles for eligibility, applying the same inclusion and exclusion criteria: 36 met all the inclusion criteria and 88 were deemed ineligible.

2.2. Phase 2 of the Literature Search–Prominent Researchers

To locate the relevant literature more precisely as the evidence base, aside from the database search, we studied the curricula vitae of prominent researchers in terms of conducting social-psychological interventions with a focus on mindset, including *Carol Dweck, David S. Yeager, Gregory M. Walton, and Geoffrey L. Cohen*. We applied the same inclusion and exclusion criteria to their studies published between 2012 and 2021. During this second round, we added two more articles [36,41] to our literature base.

Table 1. Inclusion criteria in the literature search.

Criterion	Inclusion	Note
Participants	Students	Adolescents of school age were included (e.g., [27]).
Methodology	Quantitative studies	Qualitative investigations were excluded.
Language	English	The author is fluent in English, and international readers can check the selected studies.
Research aim	Effective mindset intervention in enhancing students' learning	Students' learning, following the goal of sustainable development, included both academic performances (e.g., academic grades, see [15]) and reported social behaviours (e.g., challenge-seeking behaviour, see [42]). If the intervention efficacy was merely rooted in the change-of-mindset scale before and after the intervention (e.g., [43]), it was excluded. Effectiveness is reliant on significance and effect size. For example, the study of Donohoe et al. [44] was excluded because it discouraged the prediction that mindset intervention boosted students' learning behaviours. In Burnette et al.'s study [19], mindset intervention did not significantly enhance learning directly, but it did so indirectly and was thus included.
Data overlap	Sample independent of the samples in other included studies	In case of data overlap, our preference was the published study with the larger sample or the more recent work (e.g., we included [45], but excluded [46]), or with more details (e.g., we included [27], but excluded [47]).
Mindset scale	Dweck's implicit theory of intelligence (or ability) or personality.	Studies measuring mindset in general, namely the implicit theory of intelligence or ability, were included, as were those measuring domain-specific mindset (e.g., implicit theory of computer science ability, see [33]; chemistry intelligence, see [48]), and accurately specifying an implicit theory of personality [22,32]. However, the mindset with other socially relevant attributes (e.g., implicit theory of morality, see [49]; malleability of happiness, see [50]; malleability of creativity, see [51]) was excluded. Other mindsets (e.g., deliberate & implemental) differed from Dweck's concept, and hence were also excluded [52].
Research design	At least two conditions: mindset group and control group.	Studies containing multiple groups other than mindset and control groups (such as social norms, or a group combining mindset and social norms, see [23]) were included. However, we excluded investigations limited to the control condition and the combined condition (e.g., reading strategies and mindset, see [53]; folklore and mindset, see [54]), those with no independent mindset condition, and those including only growth-mindset intervention without a control group (e.g., growth vs. fixed mindset, see [55,56]). We also excluded studies in which treatments for the control and experiment group were not distinguished (implicit theory of athletic ability vs. implicit theory of personality, see [57]). If the intervention group covered multiple psychological traits rather than mindset (e.g., growth mindset paired with gratitude and value affirmation, see [58]), we excluded the study because it was hard to evaluate the sole effect of a mindset intervention.

2.3. Phase 3 of the Literature Search–Backtracking Reference

Finally, we checked the reference lists of the 38 articles from phases 1 and 2 looking for more potentially relevant studies. In line with the above-mentioned inclusion and exclusion criteria, no more were added. Thus, we ended up with 38 articles (see Table 2).

Table 2. Descriptive information about the selected mindset-intervention studies.

Study	Sample	Country	Domain	Intervention Design (Pretest, Posttest, and Follow-Up Excluded)			
				Group	Session	Location	Approach
Broomhead et al. (2012)	High-school students (N = 155)	USA	Academic	1. Positive mindset 2. Control (No treatment)	Single session: 40 min	On-site	Self-persuasive speaking Breathing exercises
Yeager et al. (2013a)	S1 & 2: 7th graders (N = 88) S3: High-school student (N = 76)	USA	Motivational Academic	1. Wise criticism 2. Control 1 (Placebo) 3. Control 2 (Puzzles)	Single sessions: 15–20 min	On-site Online	Wise-criticism-based feedback
Yeager et al. (2013b)	9th and 10th graders (N = 230)	USA	Social Moral Emotional	1. Growth mindset 2. Control 1 (Coping skills) 3. Control 2 (No treatment)	6 sessions (Within 3 weeks): 50 min each	On-site	Lesson-based introduction Group discussion Reflective summarizing
Sriram (2014)	College students (N = 105)	USA	Motivational Academic	1. Growth mindset 2. Control (Study skills)	4 sessions (1 week apart): 15 min each	Online	Video watching Testimonies Reflective summarizing
Paunesku et al. (2015)	High-school student (N = 1594)	USA	Academic	1. Growth mindset 2. Sense of purpose 3. Combined 4. Control (Brain)	2 sessions (2 weeks apart): 45 min each	Online	Text reading Reflective summarizing Letter writing
Andersen et al. (2016)	2nd graders (N = 1587)	Denmark	Academic	1. Growth mindset 2. Control (No treatment)	10 sessions: NA	Online	Video watching Text reading
Hu et al. (2016)	Undergraduates (N = 152)	China	Self-perceptional	1. Growth mindset 2. Emotional management 3. Control (Generic reasoning)	Single session: 3–5 min	On-site	Text reading
Yeager et al. (2016a)	9th graders (N = 3676)	USA & Canada	Academic Self-perceptional Motivational	1. Growth mindset 2. Control (School transition)	2 sessions (1–4 weeks apart): NA	Online	Text reading Testimonies Reflective summarizing Letter writing
Yeager et al. (2016b)	College student (S2: N = 7335; S3: N = 1592)	USA	Academic	1. Growth mindset 2. Social belonging 3. Combination 4. Control (Adjustment)	Single session: 30 min	Online	Text reading Testimonies Reflective writing

Table 2. *Cont.*

Study	Sample	Country	Domain	Intervention Design (Pretest, Posttest, and Follow-Up Excluded)			
				Group	Session	Location	Approach
Yeager et al. (2016c)	High-school students (N = 265)	USA	Self-perceptional Academic	1. Growth mindset 2. Control (Environment adjusting)	Single session: 25 min	On-site	Text reading Testimonies Letter writing
Schmidt et al. (2017)	7th and 9th graders (N = 726)	USA	Self-perceptional	1. Growth mindset 2. Control (Science)	6 sessions (Each/week): 50 min each	On-site Online	Brainology
Orosz et al. (2017)	10th graders (N = 55)	Hungary	Motivational	1. Growth mindset 2. Control (Bystander effect)	5 sessions (Each/week): 45 min each	On-site	Lesson-based introduction Video watching Group discussion Reflective summarizing Letter writing
Bråten et al. (2017)	Undergraduates (N = 529)	USA & Norway	Self-perceptional	1. Growth mindset 2. Fixed mindset 3. Control (Task requirement)	Single session: <15 min	On-site	Text reading
O'Brien et al. (2017)	6th to 9th graders (N = 196)	UK	Motivational	1. Growth mindset 2. Control (No treatment)	4 sessions (Each per day): NA	On-site	Text reading Lesson-based introduction Reflective summarizing
Burnette et al. (2018)	female 10th graders (N = 222)	USA	Academic Motivational	1. Growth mindset 2. Control (Sexual health)	Single session: 45 min	On-site Online	Lesson-based introduction Testimonies Letter writing
Broda et al. (2018)	Quasi college students (N = 7686)	USA	Academic	1. Growth mindset 2. Social belonging 3. Control (Physical environment)	Single sessions: 20–25 min	Online	Text reading Reflective summarizing Letter writing
DeBacker et al. (2018)	9th and 10th graders (N = 456)	USA	Motivational	1. Growth mindset 2. Control (No treatment)	Single session: 55 min	Online	Lesson-based introduction Reflective summarizing Letter writing
Bettinger et al. (2018)	High-school students (N = 254)	Norway	Motivational	1. Growth mindset 2. Control (Brain)	3 sessions (Two weeks apart): 45 min each	Online	Text reading Reflective summarizing Letter writing

Table 2. *Cont.*

Study	Sample	Country	Domain	Intervention Design (Pretest, Posttest, and Follow-Up Excluded)			
				Group	Session	Location	Approach
Mills et al. (2018)	Undergraduates (N = 155)	USA	Academic	1. Growth mindset 2. Control (No treatment)	4 sessions (Each/week): About 30 min	On-site	Lesson-based introduction
Bostwick et al. (2018)	College students (N = 278)	USA	Academic	1. Growth mindset 2. Fixed mindset 3. Control (Neutral letter)	Single sessions: NA	On-site	Text reading Reflective summarizing
Schleider et al. (2018)	Adolescents (Aged 12–15, N = 96)	USA	Emotional Self-perceptional	1. Growth mindset 2. Control (Supportive therapy)	Single sessions: 20~30 minutes	Online	Text reading Testimonies Reflective summarizing Letter writing
Fink et al. (2018)	College freshmen (N = 565)	USA	Academic	1. Growth mindset 2. Control (Transition tips)	3 sessions (During a semester): NA	Online	Text reading Reflective summarizing
Rhew et al. (2018)	6th to 8th graders (N = 68)	USA	Motivational	1. Growth mindset 2. Control (Advising support)	40 sessions (5 days/week, 8 weeks, 10.5h in total): 15 min each	Online	Brainology
Calvete et al. (2019)	High-school students (N = 858)	Spain	Social	1. Growth mindset 2. Control (Human brain)	Single session: 50–60 min	On-site	Text reading Reflective summarizing Letter writing
Smith et al. (2019)	Undergraduates (N = 75)	USA	Emotional Academic	1. Growth mindset 2. Control (No treatment)	Single sessions: 75 min	On-site	Lesson-based introduction Testimonies Group discussion Reflective summarizing Letter writing
Goyer et al. (2019)	Middle-school students (N = 669)	USA	Social	1. Growth mindset 2. Combination 3. Control (Neutral activity)	6 sessions (Week 3/9/13/22/25/29): 15~25 min each	On-site Online	Text reading Reflective summarizing Letter writing
Covarrubias et al. (2019)	Undergraduates (N = 468)	USA	Academic	1. Growth mindset 2. Combination 3. Control (Factual information)	Single session: NA	Online	Text reading

Table 2. *Cont.*

Study	Sample	Country	Domain	Intervention Design (Pretest, Posttest, and Follow-Up Excluded)			
				Group	Session	Location	Approach
Binning et al. (2019)	7th and 9th graders (N = 598)	USA	Academic	1. Persistence mindset 2. Control (Study skills)	Single session: 45 min each Booster session: 45 min each	Online	Video watching Testimonies Reflective summarizing Letter writing
Burnette et al. (2019)	Undergraduates (N = 238)	USA	Self-perceptional Motivational	1. Growth mindset 2. Control (Attention-matched)	3 modules (2 weeks apart): about 15 min each	Online	Video watching Text reading Reflective summarizing Letter writing
Yeager et al. (2019)	9th graders (N = 12,490)	USA	Academic	1. Growth mindset 2. Control (Brain)	2 sessions (20 days apart): 25 min each	Online	Text reading Testimonies Reflective summarizing Letter writing
Fernández-González et al. (2020)	High-school students (N = 123)	Spain	Social	1. Growth mindset 2. Control (Brain)	Single session: 1 h	On-site	Text reading Reflective writing Testimonies Letter writing
Zeeb et al. (2020)	7th graders (N = 59)	Germany	Motivational	1. Growth mindset 2. Control (No treatment)	10 sessions: 45 min each	On-site	Growth-mindset feedback Text reading Group discussion Reflective summarizing Letter writing
Schmidt et al. (2020)	Secondary-school students (N = 707)	USA	Motivational Self-perceptional	1. Growth mindset 2. Control (Science writing)	6 sessions (Each/week): 50 min each	Online	Brainology
Burnette et al. (2020)	College students (N = 491)	USA	Motivational	1. Growth mindset 2. Control (Health issue)	4 sessions (Every 2 weeks): 5–6 min each	Online	Lesson-based introduction
Porter et al. (2020)	8th to 10th graders (N = 354)	South Africa	Academic	1. Growth mindset 2. Control (Animals and nature)	3 core sessions (Every 2 days): 30 min each 2 booster sessions (2 and 23 weeks after 3rd session): NA	Online	Video watching Reflective summarizing Letter writing

Table 2. *Cont.*

Study	Sample	Country	Domain	Intervention Design (Pretest, Posttest, and Follow-Up Excluded)			
				Group	Session	Location	Approach
Rege et al. (2020)	High-school students (N = 19,719)	USA & Norway	Social Academic	1. Growth mindset 2. Control (Graphic art)	2 sessions (1 to 4 weeks apart): 25 min each	Online	NA
Weisz et al. (2020)	College students (N = 146)	USA	Self-perceptional	1. Growth mindset 2. Social norm 3. Combination 4. Control (Academic difficulty)	3 sessions (Within 10 days): 1h each	On-site	Testimonies Text reading Letter writing Letter reading aloud and reciting
Perkins et al. (2021)	Adolescents (Aged 16–18, N = 80)	UK	Self-perceptional Emotional	1. Growth mindset 2. Control (No treatment)	Single session: 30 min	Online	Video watching Reflective summarizing Letter writing

3. Result

3.1. Descriptive Findings: How Effective Are Mindset Interventions in Enhancing Students' Learning?

Effective mindset intervention in the current review connotes positive intervention that significantly enhanced students' learning. Students' learning incorporates both objective performances (e.g., GPA, see [9,59] and reported attitudes or attributions (e.g., learning goals and academic stress, see [31]). The reports were from the participants themselves (i.e., self-reported) or others (e.g., parent-reported, see [27]). Table 2 gives demographic information related to the selected 38 articles. In terms of domain, mindset intervention enhanced students' learning mainly in five domains (k = 39, N = 52): academic (N = 19, 36.54%), motivational (N = 13, 25.00%), self-perceptional (N = 10, 19.23%), social (N = 5, 9.62%), emotional (N = 4, 7.69%) and moral (N = 1, 1.92%). Hence, the academic and motivational domains were the most common indicators of learning that benefited from mindset intervention.

Within the sample, mindset interventions worked particularly effectively among students at secondary school (65.79%, N = 25), followed by undergraduates (31.58%, N = 12) and pupils in primary school (2.63%, N = 1). Moreover, 65.79 per cent (N = 256) were independently conducted in the United States, 13.16 per cent (N = 5) in combination with American samples (N = 3, see [18,26,60]) or in collaboration with American scholars (N = 2, see [9,61]). As few as 21.05 per cent (N = 8) were independently conducted outside of America or included no American scholars, of which 18.42 per cent (N = 7) were conducted in Europe and 2.63 per cent (N = 1) in Asia. Thus, as the cradle of mindset theory, the United States was the most important arena in terms of conducting mindset interventions.

In terms of design, 44.74 per cent (N = 17) of the selected mindset interventions comprised single sessions, 34.21 per cent (N = 13) comprised between two and four sessions, and merely 21.05 per cent (N = 8) had five sessions or more. More than half (52.63%, N = 20) of the interventions were conducted online or on-site (e.g., classroom or lab) and blended locations represented 36.84 (N = 14) and 10.53 (N = 4) per cent, respectively. In terms of intervention approaches, 73.68 per cent (N = 28) adopted hybrid methods, namely combinations of human-interaction-based (e.g., lesson, interactive feedback), reading-based (e.g., text reading), writing-based (e.g., letter writing), computer-assisted (e.g., video watching), and speaking-based (e.g., self-persuasive speaking). Among the hybrid approaches, "writing-based + reading-based" seemed to be the most popular method adopted (50.00%, N = 14, e.g., see [10]). A mere 26.32 pr cent (N = 10) of the interventions used only one approach: Computer-assisted (i.e., Brainology, N = 3, see [17,21,31], human-interaction-based (N = 3, see [33,34,41]), reading-based (N = 3, see [16,18,20] and speaking-based (N = 1, see [35]).

Interestingly, most of the positively effective mindset interventions produced selective benefits. In other words, only some participants were likely to benefit more from the operation. Most beneficiaries were from socially marginalized groups such as Latino/a [59] or Blacks [41], females [20], negatively stereotyped boys [29], and lower-achieving students [15].

3.2. Main Findings: What Characterises an Effective Mindset Intervention in Enhancing Students' Learning

3.2.1. Precondition: A Supportive Learning Environment

In the terminology of academia, students need to learn, teachers need to teach, and a place is needed to support the teaching and the learning. The key point about mindset intervention is the malleability of how people perceive themselves and the social world, but that any psychological shifting needs a platform. Students benefit not only from transforming their mindset but also from shifting the learning environment in a growth-mindset-oriented direction. Thus, in addition to offering "sufficient materials and human resources" [29] (p. 255), the educational environment should "better embody growth mindset principles and practices" [33] (p. 113). A supportive learning environment with

the basic tools required to foster improvement, including but not limited to classrooms or labs, human resources for teaching, and learning materials, are prerequisites to ensure positive outcomes of psychological intervention. Specifically, the learning opportunities afforded by the school environment enable the transformed messages to interact with student motivation to promote adaptive behaviours [42]. Teachers should ensure that they can communicate a growth mindset to their students, for example [25].

From an outside perspective, however, several contextualized disruptions such as community unrest, gang violence, or strikes may explain why mindset intervention does not significantly foster adaptive learning [9]. According to Porter et al., only 47 per cent of students under treatment attended all three of the core intervention sessions, and only 17 per cent attended all five: The low level of compliance may have diluted the intervention effects. In another empirical study, the failure of a Hungary-based mindset intervention to achieve lasting effects was potentially attributed to the lack of growth-mindset pedagogy both in the school climate and in the teaching practice, given that the training of teachers as intervention experimenters only lasted for four hours [24]. The authors concluded that more efforts were needed to reinforce the school's resources for what was the "performance arena" of mindset intervention.

It is worth noting that intervention might be most effective in an "adequately resourced context with room for improvement" [29] (p. 255). For example, if the school had imparted sufficiently relevant knowledge to the participants before they received the growth-oriented message, they would have been less likely to engage in the interventions [20]. Furthermore, if racial bias is deeply entrenched, intervention might be ineffective or even counterproductive [29].

3.2.2. Message Generating: Interaction Interaction between Person, Theory, and Context

Persons: Participants, stakeholders, experimenters

The persons involved were, first, the targets of the intervention, namely students [15,23]. In terms of the academic setting, the students varied from the lower-secondary [27] and higher-secondary [42] to the college level [28]. Marginal students for whom intervention was particularly effective [15] such as those with learning difficulties [21] and low-SES [29], and ethnic minorities [31], were typically targeted.

Second, "stakeholders" either received suggestions from the participants regarding the intervention or reinforced the intervention messages with their experiences. For example, educationally struggling younger adolescents needed the participating students' encouragement to help them cope with setbacks [27], regardless of whether they were from the real world [23] or hypothetical [25,28,62], and older peers shared their own experiences with the participants. If the intervention was computer-based, animated characters interacting with the participants to facilitate progress had important roles: Chris and Dahlia helped the participants to cope with challenges in learning, for example, and Dr. Cerebrus introduced brain science in Brainology.

Third, researchers and experimenters conducting the intervention were equally important. They generally had a basic theoretical understanding of intervention procedures and local contexts, and were therefore capable of designing the intervention and making any changes in its ongoing implementation. Some investigations employed locals [21] to help, a practice that could bring the content closer to the participants and compensate for the shortage of specialists. Before the intervention, the experimenters typically received training about the manipulation contents and procedures [32] to complement their existing psychological expertise [21] and context familiarity [32]. In some cases, professional research companies were contracted to collect data and to process the analyses to ensure repeatability and scalability, as well as to strengthen the independence of the intervention results [15].

Theory: Subjective construal

Mindset intervention was rooted in a "solid theoretical background" [24] (p. 8) and contributed to the "subjective creation of meaning" [45] (p. 13). In particular, it enabled

participating adolescents facing rejection and aggression from others to "interpret these experiences in a more benign manner, which inhibit retaliatory reactions" [45] (p. 13).

When design-thinking was applied in revising the growth-mindset intervention, it was acknowledged that theoretical guidelines were crucial to increasing the likelihood that it would be more effective for a predefined population [60]. Three theoretical elements guided the revision procedures in that study, namely: (a) How a growth mindset affected the behaviour of individuals; (b) How different cultural values responded to the same growth-mindset messages; and (c) How students could be persuaded to endorse the delivered message. As a result, the revised intervention, which included quotes from celebrities and tailored information to fit the participants' situations, outperformed a standard intervention with a focus on general malleable messaging and interactive exercises [19,60].

The intervention worked best when the specific needs of the participants' context were met on the one hand, and when psychological processes were accurately mediated on the other. Furthermore, to validate and sustain the intervention to cope with future challenges, it was designed to target the plasticity of intelligence and personality by focusing on developing strategies such as effort, resilience and self-efficacy among participants experiencing both prosperity and adversity [26]. Thus, it could be productive to incorporate goal-relevant messages into the intervention process. Empirically, although interventions aimed at merely persuading students by means of incremental theory, with no detailed suggestions about how to act, could potentially lead to adaptive behaviours, the adoption of detailed strategies could trigger more positive results [16].

Context: Situational and cultural level

Contextual expertise was an essential element in assessing the efficacy of mindset intervention. For instance, participating students with anxiety and depression [27] might have more interest in engaging and may behave adaptively if the value of specific relevant content were to be emphasized in the transforming message [17]. That was another reason why, in some successful intervention experiments assessing the measures or delivering the mindset message, the original implicit theory of intelligence or ability scale was replaced in domain-specific settings (e.g., the implicit theory of entrepreneurial ability, see [28]; the implicit theory of computer science ability, see [33]; views on chemistry intelligence, see [48]). Additionally, participants doing the active "saying is believing" exercise were encouraged to discuss how their domain-specific mindset influenced their studying for upcoming domain-specific exams (e.g., chemistry, see [48]).

It is worth pointing out that context refers not only to the specific local situation of participants but also to the general culture in a broader sense. Even if the materials and the procedure are the same, an intervention conducted across different cultures (e.g., Norway and the US) could differ significantly in effectiveness (effective in Norway, but not in the US, see [18]). Similarly, Brainology intervention (e.g., [31]) and Yeager et al.'s revised mindset intervention [15,60], which originated and worked well in the US, had no significant impact in Scotland [41] or The Netherlands [63]. This could be attributable to the different underlying cultural features in the populations, namely "national and cultural aspects, and educational setting" [63] (p. 827). The commonly utilized approach to mindset intervention was prevalent in the United States, but when applied in other countries the material and format needed tailoring to fit the local culture and context. As Bettinger et al. [61] note, for instance, research teams employed professional translators, and interviewed several focus groups of participant peers before the intervention, in carefully adapting the original intervention of Yeager et al. [60] to the Norwegian language, culture and context.

Thus, more attention should be paid to the cross-cultural applicability of mindset teaching. More specifically, interventions should be contextually situated [29], problem-specific and customized for a context-specific population [60]. When the manipulation message considers the participants' backgrounds and is tailored to "align the challenges of the specific contexts" [64] (p. 275), positive outcomes are likely. For instance, to help targeted students who just started a new school, the intervention content changed from

the iterative process of gaining feedback from teachers and students used in the pilot test. Additionally, each dose of two mindset interventions served a unique purpose: The first intervention focused on growth-mindset message during a transition time, and the second intervention booster these messages after participants had experienced some setbacks within a new environment [64].

3.2.3. Message Delivering: An Iterative Process

Saying is believing

According to the "saying is believing" theory [65], the more people advocate their positions in their own words, the more they are likely to endorse the message of what they were persuaded to receive. The approach was designed to foster the development of a growth mindset, allowing participants to make the messages more understandable and personalized [9,36]. As a self-persuasive tool, "Saying is believing" was thought to be effective because, by mentally rehearsing the information, communicating it to others, and making it more self-relevant, participants would find it easier to convince themselves [23,60].

After reviewing the intervention contents, participants are generally encouraged to summarize the core conclusions [19,33,59,66], respond to reflective questions [9,67], and describe strategies for applying growth-mindset principles to their own lives [27,45,68]. They may also be encouraged to write letters to peers (e.g., a friend struggling in school, see [61] or other students with similar experiences, see [45,68]) or to younger generations [22,59,69].

Interestingly, although "saying is believing" was the common approach adopted to increase the credibility of the intervention messages, very few mindset-intervention studies that did not adopt it reported somewhat positive academic achievements [70]. One plausible explanation for this is that the intervention was conducted at critical time points of high academic challenge (immediately after the midterm exam, see [70], or immediately before the chemistry exam, see [48]). Hence, it was well-timed to engage students with the growth-mindset concept and to motivate effort when participants have enough opportunities to make the effort worthwhile. Thus, the easy and quick mindset intervention could also have "created a recursive process leading to lasting changes" [70] (p. 189).

Repeating the message to accumulate its effects

Traces of incremental theory were present in a variety of ways in the messages conveyed to participants during the intervention, which enhanced their scientific validity. The intervention typically delivered the messages in at least three ways: Text presentation (e.g., slideshows, see [62]), text reading [10], video presentation (see [64]), testimonials (e.g., from older peers, see [27]), and "saying is believing" writing exercises. Before advocating a position, the participants usually had a basic understanding of the intervention from watching video clips and listening to lectures about the brain of the malleability of the intelligence [66]. After the "saying is believing" exercise they were guided in repeat-practicing the materials, such as rewriting letters with examples from their own lives to encourage other adolescents, then synthesizing the two letters and turning them into speech, audiotaping them and listening to the recordings [23]. After all this, it was reasonable to assume that the growth-mindset message had been effectively delivered.

The accumulative effects of message repeating were also reflected in "the number of direct interventions" and the processes "catalyzed by previous session" [24] (p. 9). Many authors refer to single-session intervention [27,35], but a large number of studies report two or more sessions (see [10,15,36,42,60] for two sessions; [23] for three sessions; [66] for four sessions; [9,32] for five or more sessions). It is possible to deliver the mindset message repeatedly even in single-session intervention, in up to eight steps from a quiz-based introduction to letter writing (four presentations plus three interactive activities in the classroom, see [62]). Alternatively, the message could be refreshed and activated via post-intervention reminders containing intervention materials [9]. The accumulating effects are also reflected in blended approaches. For example, up-to-six-session online workshops

were paired with teacher reinforcement in the form of supplementary classroom activities to enhance incremental message delivery [17].

3.2.4. Message Internalising: Persuasively Yet Stealthily

Mindset intervention aimed at persuading participants to view themselves and others as well as the surrounding environment in a positive light. Its effectiveness relied, to some extent, on the persuasive delivery of the intention, namely to facilitate and support rather than directly to "instill". "Formulating a persuasive message to another person often strengthens one's persuasion" [25] (p. 6). As "a persuasive technique" [28] (p. 5), growth-mindset messaging is meant to bolster change in an individual's perception, especially among participants who may not have had sufficient mastery experience. For instance, in addition to summarizing what the mindset-intervention messages gave them, adolescents were asked to complete self-persuasive writing exercises in which they described a time they felt rejected, withdrawn, or disappointed by others, and gave advice to another student with similar experiences [45,68].

Stealthy delivery, in turn, is intended to enhance the validity of transformed messages. Thus, participants were not informed in detail about the intervention process, including the fact that they were the target of an experiment. All 38 articles in the current systematic review adopted a blindly randomized design, meaning that the students were randomly assigned to the experimental or control group. Moreover, double-blind randomness was applied in that allocation was concealed to both participants and investigators [17,33,45,48,68,70]. Specifically, the intervention materials were incorporated into the students' regular-track curriculum during normal class time (e.g., science classes, see [17]; entrepreneurship classes, see [28]; mathematics classes, see [34]; computer-science classes, see [33]). Hence, the students believed that they were engaging in regular classroom activities [64].

Another way in which the mindset intervention was sometimes implemented was as a course requirement, such that teachers embedded relevant ideas into ordinary courses to boost a growth mindset and motivation among the students. For example, the incremental theory has been integrated into chemistry homework assignments immediately before students have their incoming unit check [48], and given-mindset strategies have been highlighted for outdoor-expedition courses [26].

Figure 2 demonstrated the characteristics of effective mindset interventions in enhancing students' learning.

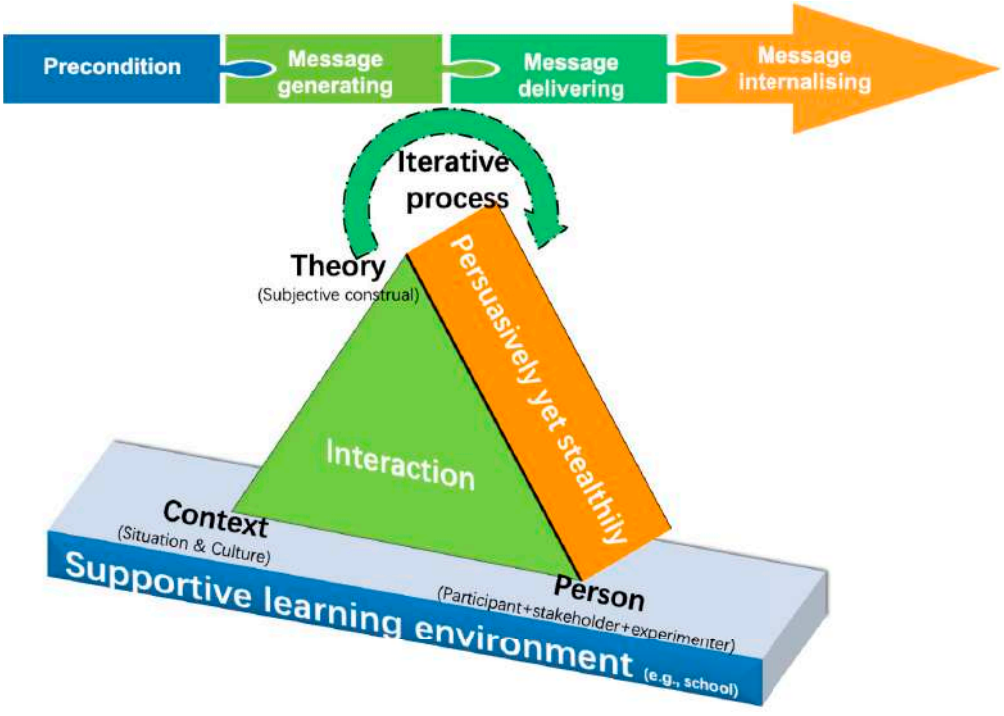

Figure 2. The characteristics of effective mindset intervention.

4. Discussion

In the context of SDGs at the educational level for students, our work aimed to answer a set of questions concerning (1) the effectiveness of mindset interventions in enhancing students' learning and (2) the characteristics of effective mindset interventions. In terms of effectiveness, mindset interventions benefitted students in the academic domain of sustainable development most, in particular, the majority of them having been conducted in the United States among students at secondary schools. A single-session design with hybrid approaches, especially a combination of reading-based and writing-based methods, was commonly adopted. First, in terms of characteristics, a supportive learning environment with sufficient resources but not-completely-saturated psychological support (i.e., a psychological need for a growth mindset among the targeted groups) is not only a prerequisite, but also reflects the need to implement a mindset intervention. Second, an effective intervention is reliant on three procedures: (1) Mutual interaction involving the person, the context, and the theory to generate the message; (2) Iterative processes to deliver the message; (3) Persuasive yet stealthy facilitation of its internalization.

4.1. Theoretical Foundations Underlying the Current Review

According to the person-environment fit theory from the developmental perspective, people flourish in environmental settings that are compatible with their developmental growth, including their skills, interests and values, for example [71]. "Subjective meanings do not work in a vacuum but within complex systems" [72] (p. 620), and the social circle's diversity "enhances individual absorptive capacity" [73] (p. 11). This makes it easier to understand why a supportive learning environment as a precondition guarantees the success of an intervention [38,39].

As a social activity, learning is an internal-development process in which individuals interact with others in the environment [74]. Accordingly, the mindset is constructed in an

interaction process, reflecting our statement of interaction needed to generate the growth message. This emphasis on the person and the context also reflects person-environment-fit theory [71], concerning the matching of environments to the psychological needs of individuals. Meanwhile, we followed theoretical guidelines to guarantee that the delivered message precisely targeted the participants in the given context [37,40]. Bodies of psychological research support the notion of a mindset [5], including but not limited to attribution theory [75,76], goal theory [77,78], self-determination theory [79], and expectancy-value theory [80]. Accordingly, rather than via objective numbers or attributes [32,81], one reason why a social-psychological intervention such as mindset intervention was impactful in guiding individuals' behaviour was that it precisely targeted the participants' subjective construal [40]. The accessibility of the mental concept may affect how people think about themselves and others, and how they interpret the social experience [82].

Rather than directly conveying ideas to participants who passively receive them, encouraging them actively to engage in an operation may be more effective in helping them to internalise the information [83]. Additionally, stealthy delivery enhances the validity of transformed messages [40,84]: Participants are less likely to reject ideas if "they do not feel controlling . . . . . they minimize resistance and reactance to the message" [40] (p. 284). This quiet and careful approach echoes the targeting of participants' subjective construal of intervention [40], in that the forces that drive it are hard to see [85], and the negative stereotyping or social marginalization of participants is avoided [40]. This could also explain why a seemingly small intervention may produce a large effect [38].

In synthesizing predecessors' findings in the social-psychological domain [40,86,87], Orosz et al. [24] summarized the core elements required to conduct an effective mindset intervention, which verifies the precision of our currently proposed characteristics to some degree. First, the "psychologically precise theory and tool" (p. 9) is consistent with our targeting of psychologically subjective construal (theory). Second, "targets a specific group" and "appropriate context" (p. 9) match another two of our message-generating components: Person (Particularly the subject of the intervention) and context. Third, an iterative process is what we emphasize in our systematic review. Fourth, "not using direct persuasive appeal" and "not help but give an opportunity" (p. 9) refer to our notion of persuasive yet stealthy message delivery.

4.2. Reflecting on the Mindset Intervention and Rethinking the Meaning of Mindset

Regarding the mindset intervention, first, in accordance with our notion of stealthy delivery, one reason for the null difference between the experiment and the control group might be that the participants were aware of their participation in the test. Sometimes, the intervention visit included several surveys, hence they recognized that they were being tested. Consequently, the students may have been demonstrating resistance to the intervention. In addition, group allocation might lead to cross-contamination in that growth-mindset messages "can be difficult to confine to students in the intervention condition" [33] (p. 113), particularly if intervention-group students shared the "active" ingredients with their control-group peers. Peer cultures and classroom contexts proved to construct the meaning system of mindset among adolescents [88].

Second, the message repetition in the iterative process was not dull, and it was done as flexibly and with as much enjoyment as possible. In line with the core salience of messages, the delivery style and specific content varied. For example, a professional graphic designer animated the content of the growth-mindset intervention, and all sections were narrated, to make the intervention enjoyable so that students would find it engaging [64]. Paradoxically, long-term interventions with multiple sessions did not necessarily reinforce the iterative processes, because excessive information allows "room for diverse interpretations" [24] (p. 9). Although it is still not clear how many sessions are required or how long it takes for the intervention to yield optimal efficacy, to some degree, in the case of social-psychological intervention, less is more.

Regarding the meaning of mindset, there may be a need to rethink it. In the case of social psychology, interventions aimed at changing people's self- and social perceptions, attribution of performance, and sense of social connectedness [39], for example. Critically, instead of the malleability of personal characteristics, the tenets of the meaning system of mindset, conceptualizing such characteristics in academic or social terms distinguish different categories of mindset [88]. Specifically, fixed theorists emphasize academic performance while growth theorists on social skills and mixed ones on interpersonal behaviours within the academic context. The current review prefers the social behavioral patterns within given cultural contexts. Rather than the view of the malleability of self-intelligence or personality [4] the mindset was also the construal of social perception. Even though the intervention did not remove the objective adversities in the individuals' situating environment, mind shifts throughout the process would enable them to change their interpretation of adversity, and then to decide whether they were affected by them [37]. Hence, "it can be as important to change people's construal—their interpretations of the social world and their place in it—as it is to change the objective environment" [39] (p. 1252).

4.3. Implications

On the theoretical level, the current research is the first systematic review to explore the manipulation mechanism of empirical investigations into mindset interventions. The characteristics we discuss are rooted in message generation, delivery and internalization. Our review enhances understanding of how mindset intervention works and how it could work more effectively. Based on a supportive learning environment, the design is reliant on both theoretical and contextual expertise, iterative processes and persuasive but stealthy delivery. The growth-transmission mechanism mentioned above applies not only to mindset intervention but also to a wider range of social-psychological interventions. Thus, the present study enriches and extends the existing literature on how these interventions work and how they could work more effectively.

On the practical level, we propose a relatively scientific design for mindset intervention. Specifically, effective intervention typically involves, first, exposing individuals to theoretical and scientific information (by means of article reading, video watching, slideshows, for example) about the malleability of intelligence and personality; Second, using persuasive testimonials and case studies from celebrities or neighboring models; Third, encouraging self-persuasive writing (generally linked to personal experiences) addressed to oneself or someone else (typically struggling peers). Growth-mindset information is also incorporated into the participants' routine activities in which they are randomly assigned to different conditions and engage in the intervention as naturally and actively as possible. Well-designed interventions that precisely target the participants' psychological construal, and in which context is situated, the pattern of growth-mindset delivery is well-timed and flexibly altered, could be beneficial to students in school, children in families, and trainees in companies, among others, affecting a wide range of adaptive behaviours.

4.4. Limitations and Future Directions

This review is limited in several respects. First, although we used a three-phase search method including databases, prominent researchers and reference backtracking, our sample consists mainly of published journal articles and book chapters. We might therefore have left aside other literature such as dissertations, conference presentations, and even unpublished articles. Second, our seven-item inclusion criteria excluded potentially valuable studies, such as mindset interventions targeted at other socially relevant attributes (e.g., the implicit theory of morality, see [49], for more details see the "Mindset scale" in Table 1), and empirical investigation involving fixed- and growth-mindset conditions but no control group (e.g., [55], for more details see "Research design" in Table 1). The omitted articles might have been informative and could have enriched and extended, even challenged our findings. Third, we failed to discuss the efficacy of the dichotomous

scales used in empirical mindset intervention from a scientific perspective, such as in meta-analyses.

Accordingly, to find the best balance between high efficacy and low cost in mindset intervention, the following questions should be asked. What mindset scale (general vs. domain-specific) might be appropriate to yield higher efficacy? How long (long-term vs. short-term) should the intervention take? What kind of sessions (on-site vs. online, single vs. multiple, sole mindset vs. combined with other traits) should be given? What is the best way of generalizing the benefits of intervention to a wider range of participants instead of minorities? What is the best way of achieving lasting rather than a temporary effect immediately after an intervention? Finding answers to these questions would require further empirical investigation, with a specific focus on the comparative perspective. Moreover, given that context plays a crucial role in the implementation of interventions, and those existing empirical investigations of mindset intervention referred mainly to western countries, more evidence from other contexts, such as Asia, is required to strengthen and enrich these claims. A much deeper and stronger foundation would yield better instruments and benefit a broader population from the perspective of cross-cultural applicability.

5. Conclusions

While increasingly empirical interventions of mindset have proved to enhance individuals' behavioral patterns, none of the existing research has systematically investigated the formation and transmission of growth messages in these interventions. The current study is, to the best of our knowledge, the first systematic review to explore the characteristics of mindset intervention from the perspective of message-transforming mechanisms. Through synthesizing and compiling empirical research published between 2012 and 2021, the current review consists of thirty-eight studies focusing on mindset interventions. Due to the origination and cost-effective rules of mindset theory, most mindset interventions are conducted in the United States and are effective particularly for secondary-school students. A single session with the "saying is believing" exercise is commonly adopted. To maximize the efficacy of growth-message transmission from instructors to recipients, a supportive learning environment provided the "arena" of mindset intervention, then reciprocal interaction and iterative processes with persuasive and stealthy way facilitate the generation, delivery, and internalization of growth messages. The findings not only theoretically enriched the mindset theory from the perspective of intervention mechanism, but also practically inspire scholars and teachers to design effective instruments of mindset intervention. However, the current review failed to discuss the specific efficacy of the dichotomous scale from a statistically scientific perspective including the number, length, location, and approach of the intervention sessions. Thus, future research might focus on the balance of efficacy and cost to figure out a well-designed paradigm of growth mindset intervention. Meanwhile, the cross-cultural applicability of mindset intervention is yet explored to benefit a broader population.

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Supporting K-12 Students to Learn Social-Emotional and Self-Management Skills for Their Sustainable Growth with the Solution-Focused Kids'Skills Method

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Abstract: There is an increasing need in schools and/or at home, as well as in society at large, to find ways to help students develop social-emotional and self-management skills, particularly in cases when they exhibit emotional or behavioral problems. This study aims at exploring how Kids'Skills (KS), a method based on solution-focused psychology, can be used to help students overcome emotional or behavioral problems through learning relevant skills. We collected 23 case descriptions during a two-year period (2017 to 2019) from KS practitioners who had used the method in their workplace, at school, at a kindergarten, or at home. We used content analysis for the qualitative data analysis. The analysis results demonstrate how the KS method can be used to support students in learning social-emotional and self-management skills to overcome their difficulties. This study found four key components of the KS method that appear to be critical for producing desired changes in children. These are (1) helping students to identify specific social-emotional and/or self-management skills that they need to learn to overcome their difficulties; (2) supporting students in learning their identified skills by helping them understand what the skill entails and become aware of their strengths and resources; (3) assisting students in acquiring their identified skills; and (4) reinforcing the learned skills to ensure sustainable effects. We conclude that the KS method offers support for students in learning self-management and social-emotional skills to ensure their sustainable growth.

Keywords: sustainable growth; social-emotional skills; self-management skills; solution-focused; Kids'Skills method

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1. Introduction

At some stage of their development, almost all children, or students, experience emotional or behavioral problems that they do not know how to overcome on their own. It is therefore important for adults to find effective ways to help children discover strategies to manage their problems and to develop social-emotional and self-management skills for their sustainable growth.

Most established methods or approaches that aim at helping children with emotional or behavioral problems are based on a problem-solving paradigm [1–4], which in turn relies on discovering the underlying causes of their problems and on making an attempt to eliminate or alleviate those causes. Over the last few decades, different kinds of approaches have been developed that are less focused on identifying underlying causes and more focused on developing solutions.

One such approach is known as the solution-focused approach. It was originally developed in the field of psychotherapy but has in recent years been increasingly applied and practiced by educational psychologists [5–10] in supporting students to overcome social-emotional and behavioral problems. Unlike most problem-focused approaches, the solution-focused approach is not focused on identifying the probable causes of problems,

but on the desired outcome, or goal, to be achieved, and on discovering ways to help children utilize their strengths and resources to achieve those desired outcomes.

The concept of sustainability can be defined from different angles. On the macro level, the United Nations Educational, Scientific and Cultural Organization (UNESCO) [11] has defined a set of sustainability development goals to address global challenges such as climate change, poverty, hunger inequalities, low quality education, and other serious global problems or crises. At the meso level, UNESCO addresses local challenges and problems for sustainable development. In this paper we will focus on the micro level, on the sustainable development of individuals. Education for sustainable development includes social development for sustainable personal growth through the development of relevant skills and competencies [12,13]. Social-emotional and self-management skills are important future skills. Students exercise agency by learning or reinforcing skills to overcome problems and difficulties. Future skills, also called 21st century skills, have been discussed widely over the last ten years [14–16]. Such skills have also been referred to as generic skills, meta-skills, transferable skills, or transversal competencies. Learning social-emotional and self-management skills prepares students for their future. Such skills are useful for studies, for work, and for life in general. Hence, learning social-emotional and self-management skills is important for students' sustainable growth and in helping them to become active agents of their own lives.

1.1. Theretical Framework of the Study

In this study, we investigate how the Kids'Skills (KS) method has been used and what are its main procedural components used in supporting children to learn self-management and social emotional skills relevant for overcoming problems and difficulties. The KS method is a collaborative step-by-step procedure aimed at helping children overcome emotional and behavioral problems and difficulties. The approach was developed in Finland in the 1990s by Dr. Ben Furman and his team in collaboration with Sirpa Birn and Tuija Terävä, two special education teachers who were responsible for the teaching and care of a group of special needs children [17,18] exhibiting diverse emotional or behavioral problems. Over the years, KS has grown in popularity and is currently used by numerous educational and health care professionals in many countries around the world.

The KS method was initially developed at daycare centers to help children who had emotional and/or behavior problems. It was constructed from practical real-life situations. This method has been widely used and appraised by school psychologists and counselors, children's therapists, and practitioners, and it has attracted many researchers to study this method. Research studies have emerged [19–21] in which KS is evaluated as an intervention to enhance and support children's psycho-emotional growth and development. A recent study by Hautakangas et al. [19] looked at 28 children aged 4–7 with poor self-regulation skills who took part in a KS intervention program. They found that the children who participated in the program showed significant progress when compared with a control group comprised of 15 children. Similar findings have also been reported in a study by Philipp et al. [20], in which pupils receiving KS counseling demonstrated significant improvements in their subjective feelings of empathy, self-efficacy, and self-worth. These findings are further confirmed in Niu & Niemi's study [21]; the authors examined the effects of a class-wide application of KS. In their study, they found that children who participated in the project significantly improved their social-emotional and self-management skills in a classroom learning environment.

The KS method is founded on the principles of Solution-Focused Brief Therapy (SFBT). SFBT was developed by a group of therapists working in a small private clinic in Milwaukee during the 1980s [22–24]. Both Pichot [25] and Lutz [26] emphasized that SFBT is a goal-oriented, client-centered and collaborative approach where clients are helped to set their own goals and are empowered by pertinent questions to make desirable changes in their lives. De Shazer et al. [27] pointed out that a central key aspect of SFBT is that the therapist helps the client define a concrete vision of their preferred future.

KS emphasizes children's own agency through the employment of motivation theory. Watkins et al. [28] have shown that learning is most effective when learners are actively engaged in the learning process and actively participate in constructing their own meaning. Autonomy and competence have been shown to be key motivation factors in learning [29,30]. Furthermore, Bandura [31] stated that agency was "the power to originate action" that leads individuals to take an active role and adopt purposeful intentions in their actions. All the steps of the KS method explicitly or implicitly emphasize students' active participation, autonomy, competencies, and agency. The students get to decide what skills they want to learn, what they want to call their skills, who their supporters are, how they want their supporters to help them, how they wish to celebrate learning the skill, etc. This gives students ownership of what they want to learn and how to learn it. The KS method enables children to take an active role and to assume agency while learning social-emotional and self-management skills. It is important for students to become active agents in their own lives for their sustainable future growth.

The KS method is a protocol comprising 15 concrete steps (see Table 1). It aims to help students identify and acquire skills to overcome social-emotional and behavioral problems. In SFBT [22–27], the basic idea is to help clients overcome problems by helping them define their preferred future and assisting them in discovering what they need to learn or change to achieve their preferred future outcomes. Another important feature of SFBT is associated with the idea that "no man is an island." For example, DeJong [22] has emphasized the role that various people in the clients' life can play in supporting them to make desired changes in their lives. This SFBT principle is explicitly or implicitly portrayed in steps 5, 6, 8, 10, 12, 13, and 14 of the KS method. These seven steps are aimed at boosting the student's motivation and reinforcing their social support when learning their skill. In addition, Berg [32] and Newsome [33] have suggested that SFBT is designed to help clients identify strengths and skills that they already possess that they can utilize to overcome their problems or difficulties. This SFBT principle is apparent in steps 7 and 9 of the KS method, two of the steps aimed at building up students' confidence in learning skills. The solution-focused brief therapy approach has managed to gain acceptance as an evidence-based psychological therapy intervention [34,35]. During the past few decades, it has also gradually been adopted to use by educators, notably by teachers, school psychologists, and school counselors [36–39].

The importance of social interaction and supporters is emphasized in all the steps of the KS method. Vygotsky [40] and social-cultural theorists have emphasized the importance of social interaction in learning, and highlighted the influence of culture, society, language, and symbols on human cognitive development. He believed that the community plays a central role in mediating children's learning and development [40]. Social interaction, students' learning community, KS practitioners, and the student's supporters play an important role in the implementation of the KS method.

Table 1. Steps in the KS method.

Steps	Name of the Steps	Description of the Steps
Step 1	Converting problems into skills	- Convert the child's problem into a skill that the child can learn
Step 2	Agreeing on the skill to learn	- Make an agreement with the child about the skill to learn
Step 3	Exploring the benefits of the skill	- Help the child see the benefits of learning the skill
Step 4	Naming the skill	- Let the child give a name to his/her skill
Step 5	Choosing a power creature	- Let the child pick an imaginary creature to help them learn the skill
Step 6	Obtaining supporters	- Let the child decide who will support him/her in learning the skill
Step 7	Building confidence	- Build the child's self-confidence about being able to learn the skill
Step 8	Planning a celebration	- Offer the child an opportunity to plan a celebration in advance

Table 1. *Cont.*

Steps	Name of the Steps	Description of the Steps	
Step 9	Defining the skill	-	Let the child role-play the skill to ensure that the skill is concrete enough that it is possible for the child to practice it
Step 10	Going public	-	Let the children inform their social network about the skill they have set out to learn
Step 11	Practicing the skill	-	Make an agreement with the children about how others can, when needed, remind them of the skill in case they forget this skill
Step 12	Creating a reminder	-	Make an agreement with the children about how others can, when needed, remind them of the skill
Step 13	Celebrating success	-	Once the child has acquired the skill, arrange the planned celebration and encourage the child to thank all his/her supporters for their help
Step 14	Teaching the skill to others	-	Where possible, arrange that the children have an opportunity to teach their newly acquired skills to someone else
Step 15	Learning the next skill	-	Invite the child to pick another skill to learn and start the same procedures again

1.2. Study Design and Research Questions

In this study, we aim to investigate how to the KS method is used to support children in learning social-emotional and self-management skills to overcome their difficulties. The design of this study is illustrated in Figure 1.

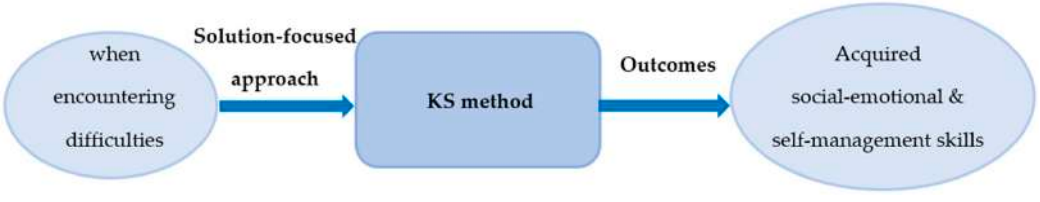

Figure 1. The design of the study.

We intend to investigate the following research questions:

- How are the steps of the KS method used to support students in learning social-emotional and self-management skills to overcome their problems?
- What are the key components and functions of these components in the implementation of the KS method?

2. Materials and Methods

We collected 23 cases between 2017 and 2019 from KS practitioners in schools, kindergartens, or at home where the KS method has been used to support children to overcome problems and difficulties. The participants included 23 KS practitioners from nine countries all of whom had participated in a workshop or training program to learn the KS method. The word KS practitioner refers to parents, school counselors, school psychologists, and teachers. The practitioners used the KS method with K-12 students aged 4–18 years old in their own countries. Table 2 illustrates the demographics of this study.

We informed the KS practitioners that participation was voluntary. Confidentiality and autonomy were explained to them when collecting the data. We also interviewed five KS practitioners to verify the data. Additionally, we viewed four video interviews with students in which they explained how they learned their skills by using the KS method. This study followed the Finnish National Advisory Board on Research Ethics (2009). No participants' or individuals' names, or personal information, were mentioned, and no one can be identified from the data provided by this study.

Table 2. The demographics of the participants in the study.

Cases	Countries [1]	Participants: KS Practitioners	Participant's Gender	Case Involved Student Gender	Case Involved Student Age
1	China	Mother	Female	Boy	8
2	China	School counselor	Female	Boy	7
3	China	School counselor	Female	Boy	7
4	China	Teacher	Female	Boy	18
5	China	School counselor	Female	Girl	8
6	Czech Republic	Father	Male	Boy	5
7	Finland	Mother	Female	Girl	4
8	Finland	Daycare teacher	Female	Boy	5
9	Finland	Father	Male	Boy	6
10	Finland	Mother	Female	Boy	7
11	Finland	Teacher	Female	Girl	8
12	Germany	School counselor	Male	Girl	12
13	Germany	Teacher	Female	Boy	9
14	India	School psychologist	Male	Boy	13
15	Ireland	Mother	Female	Boy	6
16	Japan	Father	Male	Boy	5
17	Japan	Teacher	Female	Girl	7
18	Japan	Mother	Female	Boy	4
19	Japan	School counselor	Female	Girl	10
20	Japan	School counselor	Female	Girl	15
21	Japan	School counselor	Female	Girl	7
22	Romania	School counselor	Male	Boy	11
23	UK	Teacher	Female	Boy	9

[1] Cases listed according to the country's name in alphabetical order.

We asked the participants for the following data: (1) participant's background information; (2) child's age and gender; (3) what kind of problem or difficulty did the child have; (4) how specifically did the KS practitioner work together with the child using the KS method and what steps described in the method did they use; (5) what was the outcome; (6) what observations or reflections did the practitioner have from implementing the KS method.

Content analysis was used for qualitative data analysis of the 23 cases. The data analysis process follows the 15 steps in the KS method. The 15 steps of the KS method were allocated into four subgroups according to their key functions. The data analysis is shown in Table 3.

Table 3. Data analysis of the 15 steps of KS and the four subgroups with data examples.

Grouping the Steps	Implemented Steps	One Data Example in Case 22
Subgroup 1: Identifying specific skills to be learned	Step 1: Turn the problem into a skill	- Problem of "easily getting upset" turned into the skill of "controlling one's temper"
	Step 2: Agree on the skill to learn	
Subgroup 2: Enabling students to learn the identified skills	Step 3: Exploring the benefits	- Child can continue to play with others
	Step 4: Naming the skill	- "Cooling down" skill
	Step 6: Choosing a power creature	- A superhero from the child's favorite computer game
	Step 5: Obtaining supporters	- Father, mother, sister, teacher, classmates
	Step 7: Building confidence	- Good at learning, playing chess, football, etc.
	Step 8: Planning a celebration	- Going out with the child's two classroom supporters for McDonalds and a movie
	Step 9: Defining the skill	- Walking away, alone for a moment, then going back
Subgroup 3: Acquiring the identified skills	Step 10: Going public	- Announcing the child's skill at school and at home
	Step 11: Practicing the skill	- Mike put a lot of effort into learning his skill Mike made rapid progress.

Table 3. *Cont.*

Grouping the Steps	Implemented Steps	One Data Example in Case 22
	Step 12: Creating reminder	- Others could remind him by saying "snow" should he forget his skill
Subgroup 4: Reinforcing the skills	Step 13: Celebrating success	- Mike invited his two classroom supporters out for McDonald's and a movie
	Step 14: Teaching the skill to others	- Mike shared his experience with his friends
	Step 15: Learning the next skill	- Started another "waiting my turn" skill

3. Results

In this section, we analyze the data from the 23 cases by examining the steps used in each case. We also strive to identify the main component and function of the four subgroups. We present the findings in accordance with the research questions proposed in this study.

3.1. The Steps Used in the KS Method

Based on the data analysis from the 23 cases we examined which of the 15 steps of the method were used in the 23 cases. The presence of the various steps in each case is shown in Table 4.

Table 4. The frequencies of steps used in the KS method identified from the 23 cases.

Steps Used in All Cases (23 Out of 23 Cases)	Most Often Used Steps (22–16 Out of 23 Cases)	Less Used Steps (10–11 Out of 23 Cases)
Step 1: Converting problem into a skill (23/23); Step 2: Agreeing on a skill (23/23); Step 4: Naming the skill (23/23); Step 6: Obtaining supporters (23/23); Step 9: Defining the skill (23/23); Step 11: Practicing the skill (23/23).	Step 3: Exploring benefits (22/23); Step 10: Going public (21/23); Step 7: Building confidence (19/23); Step 12: Creating a reminder (19/23); Step 13: Celebrating success (19/23); Step 8: Planning a celebration (17/23); Step 5: Choosing a power creature (16/23).	Step 15: Learning the next skill (11/23); Step 14: Teaching the skill to others (10/23).

We found that six of the steps were used in all the cases, and that there were seven most often used steps and two less-used steps. The majority of steps were used in most cases. There were six steps that seem crucial for students to acquire skills: the problem is converted into a specific skill that the student can learn (Step 1); the student agrees to learn that skill (Step 2); and the student gives a name to the skill (Step 4). In all the cases, supporters were recruited to help and assist the student in learning the skill. Forming a support group or learning community for the student is an important element in the KS method. Once this has been done, the student needs to practice their skill (Step 11). Before practicing the skill, it is important is to define the skill (Step 9). The students can do this by demonstrating the skill in role-lay, and by ensuring that the skill is concrete, feasible, and clear enough for the student to be able to perform the skill. The prevalence of the various steps in the 23 cases illustrates that the KS method can be applied flexibly depending on the case. There were, however, certain steps that were used globally indicating that these steps are vital for the process.

3.2. Grouping the Steps in the KS Method According to Their Main Components and Functions

In this section, we analyzed the data from the 23 cases following the analyzing process in Table 3. We presented the findings of the four grouped steps, which indicate the four main components and their functions. The four components and their functions in the KS method were reported in the following order: (1) Component I—Helping students to identify the specific skills to be learned in order to overcome their problems; (2) Component II—Enabling students to learn their identified skill; (3) Component III—Assisting students to acquire their identified skills; (4) Component IV—Reinforcing the skills. We report these components in the following four sub-sections.

3.2.1. Component I—Helping Students to Identify the Specific Skills to Be Learned

The first component in the KS method is helping students to identify specific skills to be learned by turning problems into opportunities for learning social-emotional and/or self-management skills. Looking into the first group set, Steps 1 and 2, we investigate how these steps were used to identify social-emotional problems or the self-management skills that the students needed to learn to solve them.

Table 5 shows in the 23 cases what the students' problems were, what their skills were, and whether their skills were social-emotional skills and/or self-management skills. For example, in Case 1, this student's problem was that he was often late for school. His preferred future outcomes or goals was that he should be on time for school. Therefore, the identified specific skill for him was to learn the self-management skill of "being in time for school". Cases 8 and 13 showed that one problem could be turned into several smaller skills. This indicates that dividing a bigger skill into smaller skills is a strategy that should be adopted in some cases. The data in Table 5 indicated that all the students' problems can be turned into opportunities for learning specific social-emotional and/or self-management skills. When examining the identified skills, we noted that all the skills were concrete skills that can be carried out and accomplished.

Table 5. Component I: Identifying specific skills to learn with Steps 1 and 2.

Case		Problems		Specific Skill to Be Learned (Step 1, 2) to Achieve Preferred Future Outcomes	Category of Skills
1	-	Often late to school	-	Be in time at school	Self-management skill
2	-	Difficult to get along with others, fights with his peers, uses violence against other children	-	Stop and calm down when getting angry	Social-emotional skill/ Self-management skill
3	-	Biting his nails	-	Take good care of his nails	Self-management skill
4	-	Low self-confidence, worried about failing, difficulty in learning English	-	Passing English examination	Social-emotional skill
5	-	Does not listen well in the class, cannot concentrate for a longer time	-	Practice juggling ball to concentrate	Self-management skill
6	-	Refuses to go to kindergarten because he felt anger and helplessness when one of his friends tells him not to play with anyone else but him.	-	Be brave and tell his friend not to order him around	Social-emotional skill
7	-	Very selective with food	-	Taste new foods	Self-management skill
8	-	Extremely picky with food, refuses to come to the table to eat, and does not want to go to the toilet with the result that he often soiled his pants	- Skill 1: Learn to lay the table with others - Skill 2: Learn to sit at the table with others - Skill 3: Learn to put food on the plate - Skill 4: Learn to eat together with others - Skill 5: Learn to go to the toilet regularly		Self-management skill
9	-	Often wets his pants	-	Go to the toilet	Self-management skill
10	-	Afraid of dogs	-	Let dogs come closer and sniff him	Social-emotional skill
11	-	Low self-esteem	-	Learn the skill of saying good things about herself, see the good acts which she did everyday	Social-emotional skill
12	-	Short attention span, too impatient, complaining, ADHD	-	To learn to wait until it is her turn	Social-emotional skill/ Self-management skill
13	-	Shouting in a loud voice whatever thoughts happen to come to his mind. Interrupts, argues, fights with others. Cannot concentrate on listening, refusing help	- Skill 1: Take note when he has things to say - Skill 2: Listen to teachers' instructions - Skill 3: Accept help from others		Social-emotional skill/ Self-management skill
14	-	Gets angry easily, skips school, fights with others	-	Learn the skill of calming down	Social-emotional skill/ Self-management skill
15	-	Wets his pants at school	-	Remember to go to the toilet	Self-management skill
16	-	Did not put away his toys after playing	-	Put each toy into the toy box after playing	Self-management skill
17	-	Worried and anxious after seeing a sick man lying on the train station on her way home from school	-	Needs to smile more	Social-emotional skill
18	-	Pushes his 10-month-old younger sister really hard when he is annoyed	-	Hug his mother instead of pushing his younger sister when he is annoyed	Self-management skill
19	-	Doing her homework in the last few minutes	-	Do homework every morning for 10 min	Self-management skill
20	-	Often absent from school	-	Go to school	Self-management skill

Table 5. *Cont.*

Case	Problems	Specific Skill to Be Learned (Step 1, 2) to Achieve Preferred Future Outcomes	Category of Skills
21	- Skips school, feels anxious when her mother is out of sight	- Learn to enjoy school without thinking about her mother	Social-emotional skill
22	- Easily gets furious if things do not go his way, shouts, hits his friends, throws things around	- When things do not go his way, learn to walk away, to be alone for a while	Social-emotional skill/ Self-management skill
23	- Difficulty falling sleep, struggles with paying attention at school, short attention span	- Skill of having a good restful sleep	Social-emotional skill

In order to illustrate how the steps were implemented, we used an actual case (Case 22) to demonstrate the main component I and its function underlying group I of Steps 1 and 2. All the names in this case have been changed and personal information has been omitted.

> *Mike was a 9-year-old boy . . . His problem was that when things didn't go his way . . . he tended to get furious . . . he would shout, hit his friends, throw things around or rip apart books, etc.*

His teacher Eija decided to try use the KS method to work with Mike. Eija knew Mike would need to learn to control his temper, but she was not sure what skill he needed. She decided that it was best to discuss with Mike the skill he would like to learn.

> *"What happens to you, Mike, when things don't go the way you want?" . . . "What would you want your friends to think about you instead?" Mike gave thoughtful answers to these questions.*
>
> *Eija then asked: "What would you like to learn to get along better with your friends?" Mike said that he needed to learn the skill of "cooling down" . . .*

Eija and Mike then had an interactive conversation and successfully completed Step 1 by converting the problem into the skill of "cooling down." Mike decided what skill to learn, demonstrating the student's agency and active role in his learning. Steps 1 and 2 indicate that the first main component in the KS method is identifying a specific skill for the child to learn, and its function is to assist students in converting problems into opportunities or goals for learning social-emotional or self-management in order to achieve the preferred future outcomes.

3.2.2. Component II—Supporting Students in Learning Their Identified Skill

The second component in the KS method is enabling students to learn their identified skill. Looking into the second set of steps (Steps 3–9), we investigate how these steps were used in the KS method (see Table 6). This group of steps indicated that component II and its function is to enable students to learn skills by discovering their motivations and strengths as well as building confidence and concrete skills.

Table 6. Component II: Enabling students to learn their identified skills with Steps 3–9.

Case	Exploring Benefits (Step 3) Planning a Celebration (Step 8)	Naming the Skills (Step 4)	Getting Support (Step 5, 6) People, Power Creature	Finding Strengths (Step 7)	Defining the Skill (Step 9)
1	- Others like him more	"Rooster crowing"	Parents, Rooster soft toy	- Happy and easy to be with	Discussed/performed
2	- Has more friends - Less worry	"China Bobby" (a traffic policeman)	Teacher, classmates, mother, "Spider"	- Very sweet and helpful, massages mother's shoulders and washes dishes.	Discussed/performed
3	- Can have a celebration - Cuts his own nails	"Chameleon" (a cartoon character)	Parents, brothers, aunt, etc. chameleon in children's book	- Smart, good imagination	Discussed/performed

Table 6. *Cont.*

Case	Exploring Benefits (Step 3) Planning a Celebration (Step 8)	Naming the Skills (Step 4)	Getting Support (Step 5, 6) People, Power Creature	Finding Strengths (Step 7)	Defining the Skill (Step 9)
4	- Feels better in his studies - Going out for a celebration	"English exam"	Teachers, classmates, a cartoon character	- Good at science, engineering, etc.	Discussed/performed
5	- Her classmates admire her - A party of "Juggling Ball"	"Juggling ball"	Parents, little sister, friends Harry Potter	- Plays badminton, piano	Discussed/performed
6	- Feels happy, proud, - brave, etc.	"Harry Potter"	Parents, teachers Sniff from Moomin valley	- Can ride a bicycle, swim, etc.	Role-played
7	- Able to taste new food, - find new delicious foods	"Yum Yum"	Parents, brothers, teacher "Poop-king" Lego character	- Bravery in tasting something new	Discussed/performed
8	- Tummy feels better - Nicer to be in a kindergarten	"Poop-king"	Parents, teacher, etc. Batman	- Can do many other things quickly	Discussed/performed
9	- Smells better - A costume party	"Ants in the pants"	Parents, brother, grandparents, friend, aunt, cousins		Discussed/performed
10	- Able to go to parties at friend's place where there are dogs	"Fido skill"	Parents, grandparents, friends		Discussed/performed
11	- Be happier, have friends	"Princess skills"	Teachers	- Good at writing	Discussed/performed
12	- More respect from friends, - get some new friends	"Waiting tone"	Parents, friends, teachers, etc., horse Cindy	- Good at math	Role-played & video recorded
13	- Calmer - Remembers thoughts better	"Note skill" "Robot skill" "Help skill"	Teachers, peer students	- Interested in robots	Discussed/performed
14	- Accepted better in friends' group, parents won't fight	"Calming down"	Parents, teachers, friends	- Good at football and other sport events	Role-played
15	- Feeling good, staying dry	"Remembering"	Parents, grandparents, teachers, brothers	- Learning reading	Discussed/performed
16	- Able to find his toys quickly	"Kitsune Kozo" (the Fox Kid)	Parents, Fox Kid wearing a cape	- Can tidy up things	Discussed/performed
17	- Smiles more, has fun, - not afraid	"Audrey" (Japanese comedy)	Mother, best friends, teachers, etc. "Audrey"	- Can smile	Role-played
18	- Gets hugs from mother	"Band-aid"	Mother	- Draws pictures, etc.	Discussed/performed
19	- Has more time to enjoy weekends, etc.	"Study Victory Plan"	Teacher, "SMAP" a popular band in Japan	- Likes music	Discussed/performed
20	- Spends time with classmates, - enter the high school	"School Go!"	Parents, teachers, classmates, counselor, iPad, cell phone		Discussed/performed
21	- Enjoys school more	"Kitty"	Teachers, parents, classmates Poster of "Kitty"		Discussed/performed
22	- Friends think better of him, not angry at him, happier,	"Cooling down"	Parents, sister, classmates, teachers, a superhero from a computer game	- Learned math multiplication, plays chess very well, very good at football	Role-played
23	- Wakes up early for school; more time to watch TV	"Good restful sleep"	Parents "Dwarf" from Snow White		Discussed/performed

Table 6 illustrates Steps 3–9 in the 23 cases. Step 3, exploring the benefits, and Step 8, planning and imagining the success of a celebration, together motivate students into thinking, "I want to learn this skill." Step 4, where students name the skills they need, gives them firm ownership of their identified skills. The students became actively engaged in their skills creation processes in which similar kinds of skills had various names that were decided by the students themselves. Step 5 and 6 created a learning community and supporting function for the students in which the students knew that they were not alone. They could get support from others and could think: "I know I can get support when I am learning this skill." Step 7 created confidence in students by looking at their strengths, what they were good at, and the skills they had already learned. Step 9 helped students see clearly what their skills were, and that they were able to perform them: "I know how to perform this skill."

The conversation below from Case 22 illustrates how the teacher and student used these steps in the second group. First, the teacher Eija explored the benefits of the skill (Step 3) with Mike.

Eija: How will that be good for you? What benefits do you get from learning that skill?

Mike: The others will not be cross with me.

Eija: What else?

Mike: I can continue to play with the others.

Eija: That's great. Anything else?

Mike (smiling): I will be happy again.

Eija initiated the idea of supporters, which was Step 6, and Mike decided who his supporters would be and how they could support him. Additionally, Mike chose an imaginary supporter in Steps 5 and 6. Eija told Mike: *"You can decide who you want to ask to support you in learning the 'cool down' skill."* Mike named his supporters as his mother, his father, and his little sister. Eija then asked: *"And how would you want them to support you?"* Mike said that when needed, his supporters should remind him of his "cooling down" skill simply by saying "snow." Mike wanted his imaginary supporter to be a superhero from his favorite computer game.

Eija built up Mike's confidence (Step 7) by stating what he was good at and what good things other people said about him:

"Mike, you are very good at learning things. I notice that you've learned math multiplication very well already and your father says that you have learned how to play chess with him at home, and I also heard that you are a very good player in your football team."

Eija went on to say, "When you have learned your 'cooling down' skill, of course, it's very nice to celebrate by doing something nice together with your supporters . . . " Eija and Mike then together imagined how Mike would celebrate (Step 8) when he acquired his skill. Mike gave a detailed plan of his future celebration, coming up with the idea that he would want to invite his two supporter classmates out to McDonalds and a movie.

As Mike clearly knew how to perform his skill, Eija and Mike together discussed and imagined what this skill would look like:

Eija: "What could help you to calm yourself down when you're about to become furious, Mike? What could you do instead of what you have been doing so far in these situations?"

Mike: "I think I need to learn to walk away, to be by myself for a moment and then go back."

They then did a role-play together several times so that Mike could demonstrate this skill (Step 9).

3.2.3. Component III—Assisting Students in Acquiring the Identified Skills

After identifying the specific skills, and discovering the students' strengths and supporting resources, as well as the benefits and details of the skills that enabled the students to learn the identified skills, it is then time to start to practice and acquire the identified skills.

The third component in the KS method is acquiring the identified skills in order to achieve the desired outcomes. Looking into the third set of groups (Steps 10–12), we investigate how these steps were used in the KS method. In all the 23 cases, students announced their skills to their social supporters (Step 10) and actively practice their skills (Step 11). In most of the cases (19 out of 23 cases), students had used reminders to support their learning in case they forgot their skills.

In Case 22, Eija discussed with Mike that it was possible there would be setbacks and they talked together how to prepare for setbacks with Step 12 as a reminder.

> *Eija: "Mike, when you try to learn a skill—any skill—sometimes you might forget the skill. When that happens, you will need others to help you one way or another. Do you have any idea of how we—your supporters—can help you in those situations?"*

Mike replied that he did not want anyone to remind him by criticizing him if he forgets. He just wanted them to say to say "snow."

Mike announced his skill to his social networks at home and at school (Step 10) and started to practice his skills (Step 11) with his supporters to support him in case of setbacks (Step 12). Mike's learning of the "cooling down" skill was announced at school and at home. During the next few weeks, Mike put a great deal of effort into learning his skill. Whenever Eija or either one of his classmate supporters used the code word "snow" to remind him to calm down, he knew what to do. In four weeks, he had made enough progress that everyone agreed that it was time to celebrate.

The evidence in the 23 cases when using Steps 10–12 leads to Component III and its function in the KS method, namely assisting students in practicing and acquiring their skills with the function of achieving the desired future outcomes/goals.

3.2.4. Component IV—Reinforcing the Learned Skills

After students have acquired their specific skills, it is important to reinforce the skills that have been learned. The fourth component in the KS method is helping students to reinforce their skills learned so that the skills and positive behaviors can last. Looking into the fourth set of groups (Steps 13–15), we investigate how these steps were used in the KS method. In most of the cases (19 out of 23), students shared their celebrations after they acquired their skills (Step 13). In about half of the cases, the students taught their skills to others (Step 14) and then started to learn the next skills (Step 15).

All the steps in this group aimed to reinforce the students' skills which they had acquired. This is also illustrated in Case 22. Mike celebrated his success (Step 13) with his two supporter friends. After his success in learning his first skill, he was keen to share his experiences (Step 14) with others and was ready to learn the next skill (Step 15). The following notes were made on Mike's achievement:

> *. . . as planned, Mike invited his two classmate supporters out one evening for McDonald's and a movie . . . the evening was a great success*

> *Mike is very excited about his success in learning his "cooling down" skill. And his friends were also impressed by his changes. He shares his experience with his friends and also eagerly wants to start another skill, "waiting my turn."*

The evidence of using Step 13–15 in the 23 cases leads to Component IV and its function in the KS method, which helps students to reinforce their skills for long-lasting effects.

3.3. Practitioners' Reflections and Feedback When Using the KS Method

In this section, we present the main points based on the practitioners' reflections and feedback when using the KS method.

3.3.1. Children Are Keen to Learn Skills Rather than Talking about Their Problems

Several practitioners stated that converting problems into learning skills is a unique turning point. It is much easier for children to accept the ideas of learning skills, especially if the children decide what skill they want to learn and can give names to their skills. The process, as stated by the practitioners, should be fun and rewarding:

> "I have used the KS method with several children. I find that children are keen to learn skills, but the learning must be fun and rewarding for them." (Case 1)

> "This approach [the KS method] has challenged me hugely to push aside focusing on problems and to stick to the agenda of looking at the solution or skill to be learned. The child in my case was very keen to do this and in fact took most of the ownership for it himself. He was very driven by the notion of a celebration and his strength of character shone through in his own determination. The solution was within the child himself." (Case 15)

3.3.2. All Children Have Solutions and Unique Strength

Several practitioners stated that the more they used the KS method, the more they felt that children are resourceful, and that children have their own solutions and their own unique strengths. As one practitioner put it in:

> "From this case, I can draw the conclusion that everyone has their own unique strengths . . . the point is to find a correct and appropriate way to bring these strengths into play. The child I was helping told me: 'I discovered something new in myself . . . [that] the new way and method offered me a different thinking and learning dimension, which makes me feel confident in my study.' Therefore, there is no one so-called best solution, but only the most appropriate one for that child!" (Case 4)

> "I was impressed that my son could think like this and was able to have such a positive conversation with me at his age. I was also amazed about his ability to think of a skill to learn and about the name he wanted to give to his skill. When having Kids'Skills conversations with children, I'm often impressed by their ability to collaborate. I conclude that children have their own unique ways of solving problems if only we speak their language and take the time to talk with them." (Case 18)

3.3.3. The Importance of Supporters

Almost all practitioners pointed out the important role of supporters and the support from the child's social network. The supporters can give positive feedback, encouraging words, as well as providing friendly reminders to the learners. Quite often the supporters started to learn skills themselves and the children become their supporters. When the child and an adult were learning skills together and they were both paying attention to each other's progress and praising each other, their relationship improved, and the atmosphere became better. The previously habitual communication style characterized by paying attention to problems and what was not working diminished.

> "Supporters are very important for children" (Case 2)

In Case 5, the practitioner reflected on the times when she asked the child how she could support her learning concentration. The child said that she wanted her mother to support her. Then when she was asked in what way she could be supported, she said that she wanted her mother to learn the skill of "closing her mouth," because the mother was always telling the child she should do this, or she should do that: "I did this wrong, I did that wrong. She's always complaining about me." The child eventually offered to be her mother's supporter. Her mother happily accepted the suggestion and agreed to learn skills together with her daughter. They also celebrated together when they both acquired their new skills.

In Case 23, we have this report: "The child was very cooperative throughout. Getting his parents to change was more challenging. In my view it was important for them to learn not to shout at him, to be more patient with him, to mind their language and dedicate more time to their children . . . I kept in touch with the family and learned that not only had their relationship with the child improved, but also his younger brother had started to learn a new skill."

3.3.4. Experiencing Setbacks

The learning process, however, is not always smooth. Sometimes children experienced setbacks, forgot their skills, cannot make any progress, or totally lose their interests in learning skills.

> "Sometimes children experienced setbacks. I remembered in this case there was slow progress in learning the skill. At some point the child totally lost interest in learning a skill. The loss of motivation was related to his mother's unhappiness with his slow progress. It is very important for children to feel that they are appreciated, encouraged, and praised by their supporters for their small successes as well as for any efforts to learn a skill . . . I suggested to many mothers that they learn how to encourage and praise their child to help them learn skills." (Case 2)

Some practitioners stated that the process could be rocky. Sometimes it was difficult to convert the problem into a relevant skill, and sometimes children wanted to learn a skill that was unrelated to their problem or difficulty. When there was lack of progress, the learning process needed to be reviewed to identify which steps could be modified or improved. When reviewing the project, the following questions can be presented: Is the skill the child is learning too difficult? Has it taken too long for the child to learn the skill? Is there a need to celebrate small successes? How are the child's supporters helping the child, and can they do something more?

Several of the practitioners stated that the more they used the KS method, the more confident they became in using it.

4. Discussions

This study aimed to investigate how the 15 steps of the KS method were used and what were the main components and their functions in supporting students to overcome their problems by learning social-emotional and self-management skills. We used a content analysis method to investigate the 23 cases. In the discussion, we followed the research questions to discuss the findings.

This study indicated that four main components and their functions were identified in the KS method by grouping certain steps together. These are (1) helping students to identify specific skills to be learned to overcome their problem by turning problems into opportunities to learn social-emotional and/or self-management with steps 1 and 2; (2) enabling students to learn their identified skill by discovering their strengths, resources, and details for their new skills with steps 3–9; (3) assisting students to acquire skills to achieve desired outcomes with steps 10–12; and (4) helping students to reinforce their skills to ensure long-lasting effects with Steps 13–15.

This study confirmed earlier studies by Hautakangas et al. [19], Philipp et al. [20], and Niu & Niemi [21] that children made significant improvements through the KS method. The steps in KS implementation indicated that the main principles in SFBT were fully utilized in the KS method. The first component, identifying the specific skills that students needed to overcome problems, aligned with the main principle in SFBT of the desired future outcome. This outcome was stated by many researchers when using SFBT [22–27]. The second component, enabling students to learn their identified skills, was also shown in focusing on students' strengths, as emphasized by Berg [32] and Newsome. Additionally, the supporting function in this second component took in the social support importance of SFBT, as mentioned by DeJong [22]. Additionally, the notions of interaction and the

learning community as found in Vygotsky's social cultural theory [40] played a critical role in the KS method. The interactions and feedback in the learning community when using the KS method is also an essential element in Vygotsky's social cultural theory [40].

This study sheds light on how the solution-focused KS method can be used to support students to learn social-emotional and self-management skills for their sustainable growth. Such aptitudes are essential for social development through the development of relevant skills and competencies [12,13]. Learning social-emotional and self-management skills can prepare students for the future. All the steps implemented in the KS method demonstrated the students' autonomy and competencies, which are important motivational factors, as stated by Deci [29] and Ryan [30]. The students made their decisions about their skills, the names of skills, whom they wanted as supporters, how to support them, and how to celebrate their success. These factors demonstrated their active role as highlighted by Watkins [28], and their agency as expressed by Bandura [31]. Learning social-emotional and self-management skills is important for students' sustainable growth in order for them to become active agents in their own lives.

The implication of this study is that problems can be turned into valuable opportunities to learn social-emotional and self-management skills. As one participant in our study stated: *"I used to see children with problems, now I only see children with skills to learn."* Moreover, when students learn social-emotional and self-management skills by using the KS method, they also become active agents in their studies and in their lives. As one student stated in his video interview: *"I become more active in my studies after I learned my skill."*

Although this study is based on second-order data from KS practitioners' reports, we did interview five practitioners and examined four students' videos to verify the data. It would be valuable to obtain the firsthand data by being involved in the process and observing how students learn their skills. Future research could also conduct longitudinal studies to detect how sustainable the students' changes are over time. This study was based on 23 cases from 9 countries. The question of cultural differences should be explored further when trying out the KS method in different countries, and the limitations of using the solution-focused KS method should also be examined.

5. Conclusions and Implications

It was our aim to explore how the Kids'Skills (KS) method, which is based on solution-focused psychology, can be used to help students overcome emotional or behavioral problems through learning relevant skills. To achieve this aim, we investigated 23 case stories using content analysis. Our main finding was that by using the KS method, it was possible to help students identify specific skills that they could learn to overcome their problems. The methods also enabled students to discover their strengths, resources, and the details needed to learn new skills. Social support was important throughout the process. The method assisted them in acquiring the relevant skills and desired outcomes. It also offered them a way to reinforce their skills to ensure long-lasting effects. We conclude that the KS method can support students in learning self-management and social-emotional skills to achieve sustainable growth. This study included 23 cases from nine countries with diverse cultural backgrounds and educational settings. This diversity seems to imply that the KS method is cross-culturally applicable, although further studies are still needed. The method can be utilized by teachers at school as well as by parents at home, but the main agency in acquiring skills and in achieving desired changes are the children themselves.

6. Patents

The name "Kids'Skills" is the English translation of the concept "Muksuoppi", the Finnish name for this method developed by Ben Furman and his team at the Helsinki Brief Therapy Institute.

Author Contributions: Conceptualization, S.J.N. and H.N.; Methodology, validation, formal analysis: S.J.N. and H.N.; Investigation, resources, data curation, B.F. and S.J.N.; Writing—original draft preparation, visualization, S.J.N.; Writing—review and editing, visualization, supervision, H.N. and B.F.; Project administration, S.J.N., H.N. and B.F. All authors have read and agreed to the published version of the manuscript.

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Higher Education to Support Sustainable Development: The Influence of Information Literacy and Online Learning Process on Chinese Postgraduates' Innovation Performance

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Abstract: Digitalization provides opportunities for sustainable development. Cultivating postgraduates' digital skills is an important task of higher education to support sustainable development (HESD). As a crucial way of cultivating digital skills, high-quality online learning processes are of great significance to achieve "Quality Education", in line with the 2030 sustainable development agenda. Based on Biggs's 3P (Presage-Process-Product) learning model, this study focused on the whole learning process and explored the relationship among postgraduates' information literacy, online platforms, online knowledge-sharing processes and their innovation performance. The analysis of a questionnaire survey of 501 Chinese postgraduates showed that (1) information literacy has a positively predictive effect on postgraduates' innovation performance; (2) different online learning processes lead to different learning results. Compared to the quantity-oriented online knowledge sharing process (Qty-KSP), the quality-oriented online knowledge sharing process (Qlty-KSP) is related to better innovation performance, which opens onto this study's third finding: (3) Qty-KSP and Qlty-KSP play a parallel mediating effect between postgraduates' information literacy and their innovation performance. Compared to Qty-KSP, Qlty-KSP is a more powerful intermediary variable, which leads to this study's fourth finding; (4) an efficient online learning environment can contribute to higher-quality online learning process, thus improving postgraduates' innovative performance. This study suggests that policy makers should develop postgraduates' digital skills for sustainable development in the digital age. This can be achieved by (1) cultivating postgraduates' information literacy; (2) encouraging them to practice high-quality online learning processes; and (3) providing an efficient sharing platform for sustainability, resilience, and digitalization in higher education.

Keywords: digital age; talents cultivation; information literacy; online learning process; innovation performance

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1. Introduction

One crucial way for higher education to support sustainable development (HESD) is to cultivate talented individuals who can create new knowledge and apply new technology to achieve Sustainable Development Goals (SDGs) (Sonetti, Brown & Naboni, 2019 [1]; Cai, Ma & Chen, 2020 [2]; Lattu & Cai, 2020 [3]). These innovative individuals are key in promoting the sustainable development of society (Acosta-Prado et al., 2020) [4].

Postgraduates are highly skilled members of the workforce who can promote national innovation and development, and they will play a leading role in future knowledge and technology enterprises (Reichert, 2019 [5]; Ministry of Education of the People's Republic of China, 2020 [6]). The innovation performance of postgraduates is of great significance for the realization of Sustainable Development Goals (SDGs), especially Goal 4 "Quality

Education" (Žalėnienė & Pereira, 2021) [7]. Therefore, exploring the factors affecting postgraduates' innovation performance and cultivating their innovative capacities are of great significance to the realization of HESD.

Because a vast amount of knowledge in the digital age is stored, communicated, and created through online platforms (Zhu & Hu, 2021 [8]; Dhawan, 2020 [9]), postgraduates face higher requirements for innovative capacities. First, the digital information is complex and not screened. The information literacy of effectively acquiring, identifying, and applying information has become an important factor affecting postgraduates' participation in sustainable online learning (Association of College and Research Libraries, 2015 [10]; Gómez-García et al., 2020 [11]). Second, due to constraints posed by the COVID-19 pandemic, academic activities increasingly rely on online learning platforms. The learning process of postgraduates via online platforms has an important impact on learning outcomes (Prasetyo et al., 2021) [12]. Therefore, information literacy and high-quality online-learning processes are very important skills in the digital age (Yuan, Liu & Kuang, 2021) [13]. These skills are related to postgraduates' innovation performance and their capacity to foster sustainable development, and are key factors affecting SDGs, especially Goal4 "Quality Education".

However, few studies pay attention to the development of postgraduates' digital skills, especially the impact of these abilities on their innovation performance. Brundiers et al. (2021) [14] regard having future-thinking competency and interpersonal competency as keys to training students in sustainable development, which is important for realizing HESD. Some scholars argue that the "self-awareness ability" (being capable of self-reflection, self-assessment, and self-regulation) is also a key ability for sustainable development (UNESCO, 2017b [15]; Brundiers & Wiek, 2017 [16]; Wamsler et al., 2018 [17]).As mentioned in the above discussions, the skills of communicating, applying, and innovating knowledge in the digital context have gradually become key to affect postgraduates' innovation performance and promote their individual self-development (Pilav-Velić et al., 2021) [18]. However, there is a dearth of academic discussion in this regard. In addition, online platforms are the medium of online learning, which is a key factor that distinguishes online learning from traditional learning (Castro-Schez et al., 2021) [19].

Based on Biggs's Presage-Process-Product (3P) learning model [20], this study hypothesizes that postgraduates' perception of environmental factors of online learning will have a significant impact on their online-learning process and innovation performance. Therefore, this study aims to answer the following research question: How do information literacy, perception of online learning platform, and online learning process affect postgraduates' innovation performance?

2. Theoretical Reference

2.1. Presage-Process-Product (3P) Learning Model

Biggs's Presage-Process-Product (3P) learning model provides a theoretical framework to answer the research question concerned in this study. It provides an enlightening overview of the key elements of the learning process and their relationships. It proposed three learning stages of Presage, Process, and Product (Biggs, 1989) [20]: (1) Presage: factors such as student characteristics and learning environment; (2) Process: learning methods used by students during the learning process; and (3) Product: learning outcomes. Existing studies have used the 3P model to explore the relationship between students' individual backgrounds such as cognitive level and subject interest (Lee & Chan, 2018) [21], environmental factors such as teaching methods perception (Deng, Benckendorff & Gannaway, 2019) [22], process factors such as learning strategies and learning methods (Biggs & Moore, 1993) [23], and product such as academic performance and learning satisfaction (Barattucci, Pagliaro, Cafagna, & Bosetto, 2017) [24].

Biggs (1989) [20] argued that personal and environmental factors (Presage) may influence students practicing a specific learning process (Process), thereby affecting the final learning outcome (Product). The 3P model is widely used in traditional learning contexts,

but few studies have applied it to explore the online learning process of postgraduates. This study applies 3P model to online environment to explore the impact of postgraduates' sustainable development skill on their innovation performance in the digital age. Specifically, Presage includes postgraduates' information literacy and their perception and evaluation of environmental factors of online learning platform. Process refers to the online learning process of postgraduates. Product refers to the innovation performance of postgraduates.

2.2. Research Hypothesis

2.2.1. Information Literacy (Presage) and Innovation Performance (Product)

Information literacy, as an important skill in the digital age, is an important prerequisite factor affecting the effect of online learning (Dong & Jiao, 2014) [25]. This article defines information literacy as "individuals' set of integrated abilities encompassing the reflective discovery of information, the understanding of how information is produced and valued, and the use of information in creating new knowledge and participating ethically in communities of learning" (Association of College and Research Libraries, 2015) [10]. It is divided into four dimensions: information awareness, information acquisition, information discrimination, and information application. It is believed that the Internet with complex information has become an important reference source for postgraduates. Therefore, the skill of selecting, evaluating, and managing information has become an important foundation for them to participate in learning activities (Gómez-García et al., 2020) [11]. Individual information literacy such as information acquisition and information management are closely related to their innovation abilities (Chang & Hsu, 2015) [26]. People with higher information literacy can achieve innovation actively, efficiently, and can critically use the resources in the environment to produce more innovative results. Based on these, this study raised the following hypotheses:

Hypothesis 1 (H1a). *Postgraduates' information awareness literacy has a positive impact on their innovation performance.*

Hypothesis 1 (H1b). *Postgraduates' information acquisition literacy has a positive impact on their innovation performance.*

Hypothesis 1 (H1c). *Postgraduates' information discrimination literacy has a positive impact on their innovation performance.*

Hypothesis 1 (H1d). *Postgraduates' information application literacy has a positive impact on their innovation performance.*

2.2.2. Information Literacy (Presage) and Online Learning Process (Process)

The notion of the online-learning process in this article is different from the mandatory online courses arranged by universities. It refers to the process in which postgraduates exert their autonomy to actively participate in online knowledge sharing outside the university curriculum arrangement. That is, postgraduates realize the process of knowledge processing, integration, and innovation by online learning methods such as browsing, liking, forwarding, commenting, posting, and through other online-learning exercises. To some extent, information literacy reflects students' skill to absorb, internalize, express, and apply information (Association of College and Research Libraries, 2015) [10]. These abilities are helpful for students to transform tacit knowledge into explicit knowledge and share it on online-learning platforms and thus to promote active forms of learning (Lu & Li, 2019 [27]; Nonaka, Von Krogh, & Voelpel, 2006 [28]). However, Hemmati (2017) [29] found that the impact of information literacy on the online learning process varies among different individuals: teachers' information literacy will positively predict their online knowledge sharing behavior, while undergraduates' information literacy has no significant correlation with their knowledge sharing and knowledge application behavior. Facing

such contradictory findings, it is necessary to further explore the impact of postgraduates' information literacy on their online learning process. Thus, this study raises the following hypothesis:

Hypothesis 2. *Postgraduates' information literacy has a positive impact on their online knowledge sharing process.*

2.2.3. Online Learning Process (Process) and Innovation Performance (Product)

Based on the different emphases of shared content, this study is concerned with the quantity-oriented and quality-oriented online knowledge sharing processes (Hereafter referred to as Qty-KSP and Qlty-KSP) (Chang, Hsu, Hsu, & Cheng, 2014) [30]. The former focuses on the number and activity of posts rather than the quality of information, while the latter focuses on the value and innovation of shared information. Studies have shown that online-learning processes, such as online knowledge sharing, provide individuals with opportunities to gain different information and experiences, and increase their knowledge, ideas, and skills. This will help them realize the externalization and socialization of knowledge in different fields, so as to improve the innovation skill and stimulate innovation behavior and increase innovation performance (Nonaka et al., 2006 [28]; Nonaka, 2007 [31]). Biggs proposed in the Process link of 3P model that students' differentiated learning process will have different effects on their learning results. Huang (2007) [32] found that both the quantity and quality of individuals' participation in the process of knowledge transfer in virtual communities have a significant impact on innovation performance. Compared to the methods that value quantity more, quality-oriented knowledge transfer methods will lead to the innovation performances with higher conversation rates. Based on this, this study raises the following hypotheses:

Hypothesis 3 (H3a). *Postgraduates' Qty-KSP has a positive impact on their innovation performance.*

Hypothesis 3 (H3b). *Postgraduates' Qlty-KSP has a positive impact on their innovation performance.*

2.2.4. Mediating Role of Online Learning Processes

Individuals with high information literacy have strong information awareness. They can participate in knowledge exchanges actively by using information technology. This interactive process will help individuals generate new ideas and knowledge for the dissemination, blending, absorption and transformation of knowledge, and thus improve their creativity and achieve more innovative performance. Jinadu and Kiran (2014) [33] found that individuals with high information literacy have more information search channels and can distinguish the effectiveness of information. At the same time, they can construct knowledge through sharing information with others. Therefore, they can obtain more experience that can be applied to innovation activities. This process will further develop individuals' related skills and promote their innovative performance. Yin (2018) [34] further found that only some of the new technologies and methods acquired through information knowledge and information capabilities directly stimulated the creativity of knowledge workers. However, other parts are further interacted, integrated, transformed, and innovated through knowledge sharing behaviors such as information collection and exchange among individual employees, thereby improving the innovation performance of enterprises. Based on this, this study raises the following hypotheses:

Hypothesis 4 (H4a). *Qty-KSP has a mediating effect between information literacy and innovation performance.*

Hypothesis 4 (H4b). *Qlty-KSP has a mediating effect between information literacy and innovation performance.*

2.2.5. Environmental Factors in Online Learning (Presage) and Innovation Performance (Product)

In addition to the individual characteristics of students, learning environments, such as interaction with peers, discussion atmosphere between peers, teaching context and positive interaction with tutors, are also important components of the predictive variables in the 3P model (Biggs, 1987) [20]. Students' perception and evaluation of the above learning environment are related to their learning process, which will eventually lead to different learning outcomes (Biggs, 1987) [20]. During online learning platform, peers with common goals and vision can help with and learn from each other. Positive peer effect is an important factor to encourage postgraduates to actively participate in the online learning process and promote their innovative achievements (Van Popta, Kral, Camp, Martens, & Simons 2017) [35]. In addition, the online knowledge-sharing process relies on the online-learning platform. Researcher (Davis, 1989) [36] identified two factors that play key roles in predicting individuals' learning process and outcomes: the Perceived Usefulness (PU) of an information system that reflects users' perceived improvement of their performance; and Perceived Ease of Use (PEU) that reflects users' perceived ease of using an information system. Therefore, the platform support is also an important environmental factor affecting students' participation in online learning process, and innovation performance. Based on this, this study regards the environmental factors perceived by postgraduates as an important "Presage Factor". These include two dimensions: platform peer support and online-platform support. Based on this, this study raises the following hypotheses:

Hypothesis 5. *Environmental factors have a positive impact on postgraduates' innovation performance.*

Hypothesis 6 (H6a). *Qty-KSP has a mediating effect between environmental factor and innovation performance.*

Hypothesis 6 (H6b). *Qlty-KSP has a mediating effect between environmental factor and innovation performance.*

Based on the above theoretical review and literature review, this study proposes a theoretical model of the influencing factors of online-learning results based on the 3P model (shown in Figure 1).

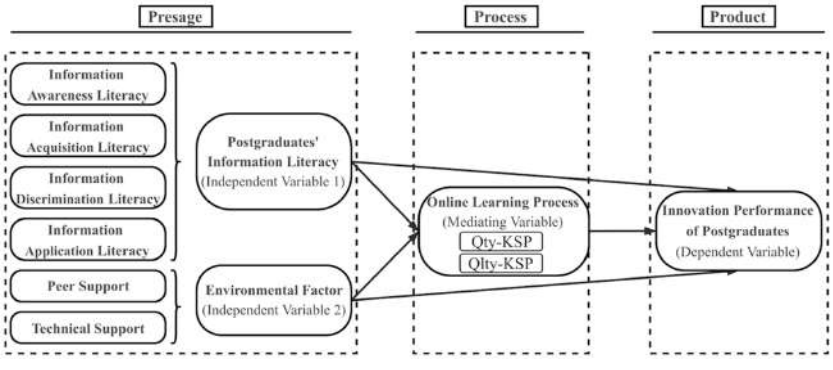

Figure 1. Process model of online-learning results based on 3P model.

3. Data and Methods

This study explores students' self-evaluation and views on information literacy, online knowledge-sharing behaviors and innovation performance through Survey.

3.1. Data Collection

Due to the lockdown during the COVID-19 pandemic, this study collected data through online platforms and face to face. Online knowledge-sharing platforms are used to advertise posts, such as Jing-guan-zhi-jia (a virtual community widely popular among Chinese postgraduates). Posts were also collected from public elective classes. Postgraduates were encouraged to answer an online or physical questionnaire that takes about 8–12 min to finish. Their participations were completely voluntary and anonymous. Students were informed that it has nothing to do with the assessment of any classroom performance, and they have the right to choose to join or quit halfway. The questionnaire provided participants with the overview of the research and researchers' contact information. After obtaining the consent of participants, they filled in the background information form and answered questions related to information literacy, online-learning process, and innovation performance (the questions were presented in random order).

3.2. Participants

The data was collected from April 2021 to June 2021; during this period of time, 642 questionnaires were collected. Through the screening of questionnaire response time and logic-related questions, 501 valid questionnaires were finally identified, with an effective recovery rate of 78.04%. The average age of participants was 25.56 years old (SD = 2.39), and the proportion of male (42.91%) and female (57.09%) was balanced, similar to that of masters (50.3%) and PhD students (49.7%). In addition, the proportion of students majoring in natural science and humanities and social sciences was 57.48% and 42.52%, respectively, with a certain representativeness of the samples.

3.3. Survey Administration

First, it summarizes the variables, specific dimensions, and data types involved in this study (shown in Table 1).

Table 1. Operational Information of Core Variables.

Variable	Dimension	Number of Question	Reference	Type
Information Literacy	Information Awareness Literacy	5	Information Literacy skill of College Students in Higher Education in Beijing by University Library Society in Beijing (2005) [37]	Six subscales of Likert; disagree (1) to agree (6).
	Information Acquisition Literacy	3		
	Information Discrimination Literacy	3		
	Information Application Literacy	3		
Environmental Factor	Peer Support	4	Mckinney, Yoon, and Zahedi (2002) [38];	
	Platform Support	4	Chiu, Hsu, and Wang (2007) [39]	
Online Knowledge Sharing Behaviour	Qty-KSP	4	Panel Studies of Chinese University Student (PSCUS) questionnaire	
	Qlty-KSP	5	Wasko and Faraj (2005) [40]	
Innovation Performance		9	Janssen and Yperen (2004) [41]; Han, Lian and Long (2007) [4]	

The information literacy scale is adapted from the index system of Information Literacy Skill of College Students in Higher Education in Beijing by the University Library Society in Beijing (2005) [37]. The index system is based on the Information Literacy Competency Standards for Higher Education (ILCSHE) [42] issued by the Association of College and

Research Libraries (ACRL) in 2000 and supplemented in combination with the current situation of information literacy education in universities in China. It consists of 7 primary indicators, 19 secondary indicators and 61 tertiary indicators. Referring to the definition of information literacy by the ALA, this study deleted and merged some secondary indicators, and obtained 14 questions covering the four dimensions of information awareness, information acquisition, information discrimination, and information application. The topics included: "I understand the ethics and laws related to online knowledge sharing", "I can compare information and knowledge from different sources on the platform and evaluate its quality, identifying bias and fraud in information", and so on.

The environmental factor scale includes a peer support subscale and platform support subscale, which are adapted from Chiu, Hsu, and Wang (2007) [39] and Mckinney, Yoon and Zahedi (2002) [38]. Given that the mother tongue of the samples in this study is Chinese, this study uses double translation technology (McGorry, 2000) [43] to translate them into Chinese problems and options, and corrects the mistranslation, omission, and ambiguity to form the final scale. The peer support subscale includes four questions, such as "the platform gathers a group of members with rich professional knowledge and skills" and "in the process of discussion, members use understandable communication modes"; and the platform support subscale includes four questions, such as "I think the system of the network sharing platform is reliable" and "I think the network sharing platform is useful".

The online-learning-process scale includes Qlty-KSP subscale and Qty-KSP subscale, which are adapted from Wasko and Faraj (2005) [40] and Panel Studies of Chinese University Student (PSCUS) questionnaire, respectively. The quality-oriented subscale has been widely cited in related fields, and its effectiveness and reliability have been verified. The author forms the final scale based on double translation technology. The sample items included five questions, such as "the knowledge I participated in online sharing is reliable" and "the knowledge I participated in online sharing is complete". The quantity-oriented subscale is adapted according to the fifth part of "social communication—knowledge sharing in a network virtual academic community" of the PSCUS launched by the Chinese Academy of Social Sciences; the subscale includes the following option for assessing respondents' use of online-learning resources: "I often use network sharing platform to browse the information I need, or express my likes regards others' information and forward them".

The innovation-performance scale is adapted from the innovation performance scale developed by Han, Lian and Long (2007) [44], which is based on Janssen and Yperen's re-search results (2004) [41] and measures the individual innovation performance of knowledge workers from three dimensions: generation of innovative thinking, the promotion of innovative thinking, and the realization of innovative thinking. Given that the respondents of this study are postgraduates, and the dependent variable assessed in the research questions of this paper focuses more on learning achievements, i.e., scientific research innovation performance, the expression of the items contained in the above scale is slightly adjusted; it contained twelve questions, such as "I am often praised for putting forward new ideas", "I can well evaluate the feasibility of innovative ideas", "in academic research, I will put some innovative ideas into practice".

3.4. Reliability and Validity Test

This study used SPSS26.0 and Mplus8.3 to test the reliability and validity of 501 valid sample data. Among them, the overall reliability coefficient of the questionnaire Cronbach's alpha is 0.970, which has passed the reliability test. Considering that the molecular weight scale used in this study is based on the adaptation and translation of existing projects and lacks strong verification from previous empirical studies, it is necessary to use Exploratory Factor Analysis (EFA) to examine the underlying factor structure and communality of items. The overall KMO value of the questionnaire is 0.970, and the Chi-square value of Bartlett's Test of Sphericity is 18,380.757 (df = 780, $p < 0.001$), which meets the prerequisites of factor analysis. To test the validity of the questionnaire, the EFA adopts the Principal Component Method to extract the factors, and the optimal oblique method is used for

rotation. The characteristic root is greater than 1, and the factor load is not less than 0.4. After excluding irrelevant items, we obtained 40 items, and the total explained variance was 70.144%. Subsequently, this study carried out EFA and Confirmatory Factor Analysis (CFA) on each subscale (shown in Table 2).

Table 2. Reliability and validity test of sub-scales.

Subscale	KMO	Chi-Square Value of Bartlett Test	Cronbach's Alpha	χ^2	df	χ^2/df	CFI	TLI	RMSEA	SRMR
Information Literacy	0.954	7138.971 (df = 91, $p < 0.001$)	0.961	240.005 **	70	3.429	0.970	0.961	0.070	0.045
Environmental Factor	0.936	2314.608 (df = 28, $p < 0.001$)	0.909	84.609 **	18	4.700	0.965	0.946	0.086	0.045
Online Knowledge Sharing Behaviour	0.870	2753.475 (df = 36, $p < 0.001$)	0.871	70.061 **	25	2.802	0.977	0.968	0.060	0.054
Innovation Performance [1]	0.936	3197.058 (df = 36, $p < 0.001$)	0.933	84.123 **	25	3.365	0.977	0.967	0.069	0.026

[1] In the early stage of research design, the environmental factor was divided into two dimensions: peer support and platform support. Yet the results of EFA showed that the environmental factor was a one-dimensional construct. ** $p < 0.05$.

According to Table 1, it is found that the KMO values of the four subscales are greater than 0.8, and have passed the Bartlett's Test, which is suitable for factor analysis. The Cronbach's alpha of the four subscales is 0.961, 0.909, 0.871, and 0.933, respectively, which indicates the subscales have high reliability. In addition, four subscales' χ^2/df are less than 5, CFI (>0.90), TLI (>0.90), RMSEA (<0.08) and SRMR (<0.08) are almost within the acceptable range, which proved that the subscales have good validity. Therefore, the next step of statistical analysis can be carried out based on the data recovered from this scale.

3.5. Data Analysis

This study aims to explore the relationship and influence path among information literacy, environmental factors, online knowledge sharing process, and postgraduates' innovation performance from a whole-process perspective. First, this study conducts descriptive statistics on the basic situation of sample subjects participating in the online learning process by Stata15.1. Second, this study uses the four dimensions of information literacy of postgraduates as independent variables 1, environmental factors as independent variables 2, and innovation performance as dependent variable, and uses the Mplus 8 to construct a structural equation model Model 1 to explore the impact of information literacy and environmental factors on innovation performance. Third, the mediating variable is added to Model 1 to form Model 2, to explore the mediating role of online knowledge sharing process in the impact of postgraduates' information literacy on their innovation performance.

4. Results

4.1. Descriptive Statistics of Samples' Basic Information

As digital aborigines in the Internet age, more than 80% of postgraduates have used the Internet for more than nine years. Influenced by the thinking mode and lifestyle in the data age, they have unique advantages in taking advantage of extracurricular online platforms such as virtual academic communities and participating in online knowledge sharing. From the perspective of basic consciousness, most postgraduates realize the importance of online learning and online knowledge sharing; 91.82% of them believe that it is necessary to participate in online knowledge sharing. From the perspective of participation behavior,

95% of postgraduates have used extracurricular online learning platforms such as a virtual academic community for more than one year. Mobile phones and mobile computers are the most used devices for them to log into online-learning platforms. Among the 501 valid samples, 466 samples participated in online knowledge sharing activities at least once a week, of which 53.49% even participated in high frequency every day. In addition, about half of the samples participated in the online-learning platform for more than one hour at a time. The basic situation of the sample objects participating in the online-learning process is shown in Table 3.

Table 3. Basic information of postgraduates participating in online-learning process (n = 501).

Variable	Category	Frequency
Years of Using Internet	<9 Years	94
	9–11 Years	161
	>12 Years	246
Years of Using Online Learning Platform	<1 Years	36
	1–3 Years	125
	>3 Years	340
Common Login Devices for Online Learning Platform	Mobile Phone	239
	Mobile Computer	231
	Desktop Computer	31
Frequency of Using Online Learning Platform	Every Day	268
	Every Week	198
	Every Month	35
Time per Use of Online Learning Platform	<30 min	35
	30 min–1 h	216
	>1 h	250
Importance of Online Knowledge Sharing	Importance	460
	Unimportance	41

4.2. The Impact of Information Literacy and Environmental Factor on Innovation Performance

This study takes the four dimensions of information literacy as independent variable 1, environmental factors as independent variable 2, and postgraduates' innovation performance as dependent variables to build a structural equation Model 1 (shown in Figure 2): χ^2 (414) = 1211.858 **, χ^2/df = 2.927 < 5, RMSEA = 0.062, CFI = 0.931, TLI = 0.923, SRMR = 0.062. The model has a good fit.

According to Figure 2, in addition to information acquisition literacy, postgraduates' information awareness literacy, information discrimination literacy, information application literacy, and environmental factors of online learning platforms positively predict postgraduates' innovation performance at the significance level of 0.01. Compared to postgraduates' information application practice literacy (γ = 0.29, p < 0.01), correct information awareness (γ = 0.47, p < 0.01) and keen information-discrimination literacy (γ = 0.338, p < 0.01) have a more significant impact on innovation performance. In addition, the environmental factors composed of peer and platform support also have a significant positive impact on postgraduates' innovation performance (γ = 0.62, p < 0.01). High level peers with a common vision actively participate in the online knowledge-sharing process, which can produce more effective information, while an efficient and stable platform accelerates the dissemination of effective information. A high quality online learning environment helps postgraduates obtain effective information, stimulate innovation behavior, and increase innovation output. The above research findings support the H1a, H1c, H1d, and H5, while H1b has not been verified.

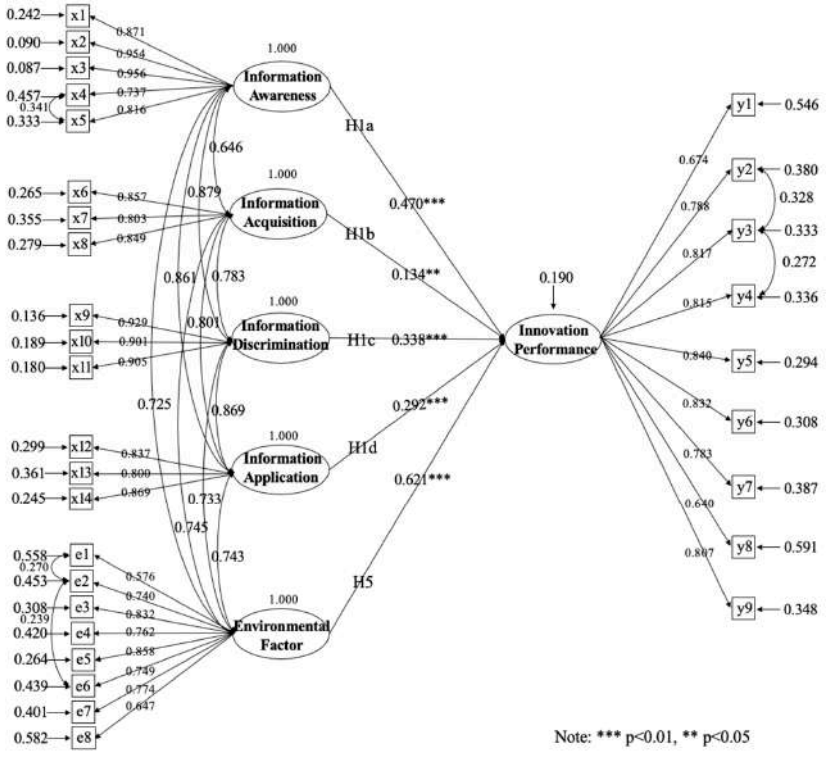

Figure 2. The impact of postgraduates' information literacy on innovation performance.

4.3. Mediating Effect Test of Online Knowledge Sharing Behaviour

After adding the mediating variable of "Qty-KSP" and "Qlty-KSP" to Model 1, this study obtains the theoretical hypothesis Model 2 of the impact mechanism of information literacy and environmental factor on postgraduates' innovation performance (shown in Figure 3): χ^2 (707) = 2219.832 **, χ^2/df = 3.140 < 5, RMSEA = 0.065, CFI = 0.917, TLI= 0.908, SRMR = 0.067. All indicators are within the acceptable range.

Figure 3 shows that postgraduates with high information awareness literacy (γ = 0.99, p < 0.01), information acquisition literacy (γ = 0.50, p < 0.01), and information discrimination literacy (γ = 0.30, p < 0.05) prefer to practice Qlty-KSP, while information application literacy (γ = 0.43, p > 0.01) has no statistically significant effect on Qlty-KSP. However, except for information acquisition literacy (γ = 0.29, p < 0.1), other information literacy has no direct relationship with Qty-KSP, and H2 has deviation. In addition, compared to the Qty-KSP (γ = 0.13, p < 0.05), the Qlty-KSP has a more significant positive prediction effect on postgraduates' innovation performance (γ = 0.35, p < 0.01), and both H3a and H3b pass the test.

This study tests the mediation effect of online knowledge sharing behavior based on bootstrap. After repeatedly sampling 5000 bootstrap samples for estimation, we found that the Qlty-KSP (M1) plays a partial mediating role between information awareness literacy (X1), information acquisition literacy (X2), information discrimination literacy (X3), information application literacy (X4), and innovation performance (Y), and there are four mediation paths: A1, B1, C1, and D1. H4b passed inspection. For example, path A1 indicates X1→M1→Y. Part of the impact of postgraduates' information literacy on their innovation performance is realized through the intermediary effect of the online-learning process of Qlty-KSP, which accounts for 42.75% of the total effect.

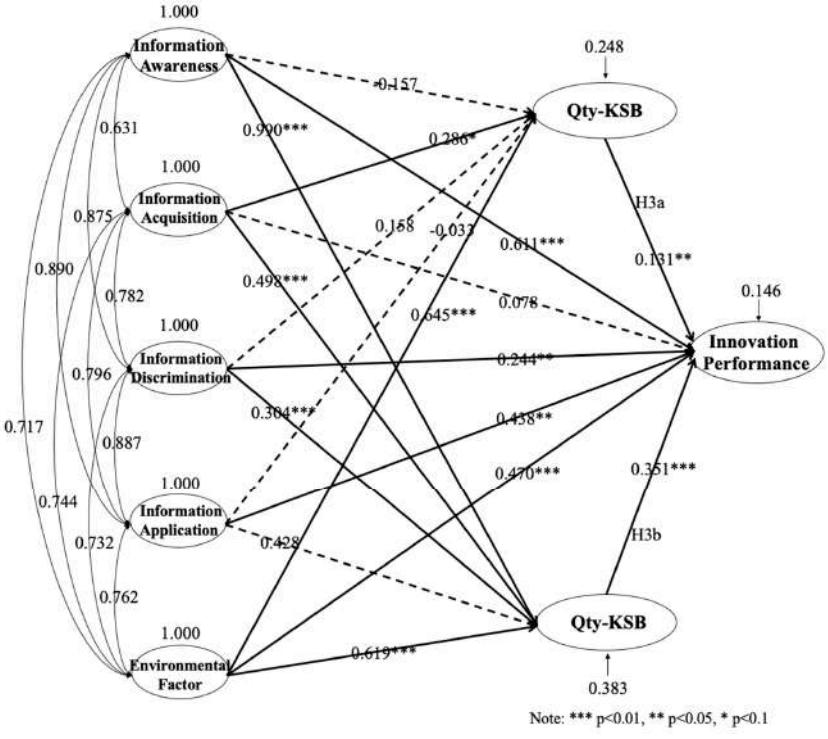

Figure 3. The impact of information literacy, environmental factors, and learning process on postgraduates' innovation performance.

Qty-KSP (M2) also plays a partial mediating role between the four dimensions of information literacy and postgraduates' innovation performance. There are four mediation paths A2, B2, C2, and D2, of which path D2 represents X4→M2→Y, the effect ratio is 1.92%, and the mediating coefficient test is significant. However, the 95% confidence intervals of the other three mediation paths contain zero, so the mediation effect is not significant, and H4a is partially established. See Table 4 for the specific mediation paths.

In addition, the results of model 2 show that the environmental factors composed of stable, safe, and efficient online learning platforms and members with shared language, common vision and mutual trust can significantly predict the online knowledge sharing behavior. Qlty-KSP plays a partial mediating role between environmental factors and innovation performance (path E1). The proportion of mediating effect is 36.43%, and the 95% confidence interval is [0.283, 0.437], excluding zero. H6b passed the test. However, the Qty-KSP fails to play a significant mediating role between environmental factors and innovation performance (path E2). The mediating effect value is −0.006, and the 95% confidence interval is [−0.030, 0.020], including zero; H6a was not tenable. Combined with Figure 3 and Table 3, compared to the Qty-KSP, the Qlty-KSP is a more powerful mediating variable and plays a positive role in the active prediction of information literacy and environmental factors on postgraduates' innovation performance.

Table 4. Total effect and details of each mediation path.

Pathways	Mediation Analysis	Effect	BootSE	95% Confidence Interval		*t*-Value	*p*-Value
				BootLLCi	BootULCI		
X1→M→Y	Total Effect	0.510	0.027	0.457	0.563	18.773	0.000
	Direct Effect	0.294	0.027	0.242	0.346	11.086	0.000
	Indirect Effect A1	0.218	0.023	0.175	0.264	X1→M1→Y	
	Indirect Effect A2	−0.002	0.006	−0.014	0.010	X1→M2→Y	
X2→M→Y	Total Effect	0.832	0.036	0.761	0.903	23.029	0.000
	Direct Effect	0.454	0.040	0.376	0.532	11.456	0.000
	Indirect Effect B1	0.382	0.036	0.314	0.454	X2→M1→Y	
	Indirect Effect B2	−0.004	0.012	−0.028	0.019	X2→M2→Y	
X3→M→Y	Total Effect	0.534	0.024	0.487	0.581	22.271	0.000
	Direct Effect	0.322	0.025	0.273	0.371	12.983	0.000
	Indirect Effect C1	0.205	0.022	0.164	0.249	X3→M1→Y	
	Indirect Effect C2	0.007	0.005	−0.003	0.020	X3→M2→Y	
X4→M→Y	Total Effect	0.780	0.036	0.709	0.851	21.500	0.000
	Direct Effect	0.437	0.035	0.368	0.507	12.407	0.000
	Indirect Effect D1	0.328	0.034	0.264	0.397	X4→M1→Y	
	Indirect Effect D2	0.015	0.007	0.003	0.030	X4→M2→Y	
X5→M→Y	Total Effect	0.980	0.034	0.914	1.047	28.857	0.000
	Direct Effect	0.629	0.044	0.542	0.716	14.254	0.000
	Indirect Effect E1	0.357	0.040	0.283	0.437	X5→M1→Y	
	Indirect Effect E2	−0.006	0.013	−0.030	0.020	X5→M2→Y	

5. Discussions

5.1. Strengthening Individual Information Literacy Helps to Improve Postgraduates' Innovation Performance

Information literacy has become an important skill for training individuals in sustainable development in the digital age. Cultivating postgraduates' information literacy is of great significance in improving their innovation performance and promoting forms of higher education oriented toward sustainable development. This empirical study found that in addition to information acquisition literacy, postgraduates' information awareness literacy, information discrimination literacy, and information application literacy all significantly and positively predict postgraduates' innovation performance. In the digital age, the information content is complex, the access is diverse, and its cost is low. The relevant access skill seems not to be the key factor affecting postgraduates' participation in innovation activities and improving the output of innovation achievements. However, for postgraduates to conduct innovative activities in the information society, it is important to understand the importance of information and abide by information-related ethics and corresponding laws. In addition, effectively identifying the content and quality of information from different sources and having the quality of extracting and forming their own knowledge from complex information will also help postgraduates improve their critical thinking and practical skill and inspire more innovative behaviors and innovative outputs. It resonates with previous studies such as Gómez-García et al. (2020) [11] and Chang & Hsu (2015) [26]. They also found that the skill to effectively obtain, evaluate, and manage information has become an important prerequisite for students to participate in learning activities in the digital age, which is closely related to their innovation ability.

5.2. Efficient Online Learning Environments Help to Improve Postgraduates' Innovation Performance

Digital transformation is becoming a necessary part of people's lives (Căpușneanu, 2021) [45]. The sustainable development of higher education is inseparable from the application of the online learning environment (Wu, 2020) [46]. Online learning environments are gradually transforming from the face-to-face interaction to a blended one (Angouri,

2021) [47]. Therefore, the stability and effectiveness of the online-learning platform itself and the positive peer effect among online-platform users have certain impacts on postgraduates' innovation performance (Tang, Lu & Naumann, 2020) [48]. In addition, the study found that some of the positive effects of environmental factors on postgraduates' innovation performance are indirectly produced through postgraduates' Qtly-KSP. This means that an efficient online platform can encourage postgraduates to practice a higher quality online-learning process and promote their innovation performance. Lastly, the two dimensions of peer support and platform support complement each other: the benign communication network, positive sharing atmosphere, and stable system construction of the platform are conducive to the aggregation effect and attract more high-quality users to participate in the collision and exchange of ideas (Akram et al., 2021) [49]. At the same time, the platform users' active sharing behavior, high-quality and effective sharing content and open discussion atmosphere will also improve the effectiveness of the platform and form a favorable circle. This exploratory factor analysis also proves that the two dimensions are inseparable, constituting the environmental factor together to encourage postgraduates' innovative output.

5.3. Engagement in High-Quality Online Learning Process Helps Postgraduates to Improve Their Innovation Performance

Different online learning processes have different impacts on postgraduates' innovation performance (Razmerita et al., 2020) [50]. Echoing Huang (2007) [32], this study finds that encouraging postgraduates to practice more quality-oriented online sharing processes may be an important way to encourage their high-quality and sustainable online learning processes and improve their innovation achievements. Biggs (1987) [20] proposed in the process link of 3P model those different motivations will result in different learning behaviors and learning methods, which will impact the learning results of the final link (Deng, Benckendorff & Gannaway, 2019) [22]. Postgraduates with Qty-KSP are greatly driven by external self-motivation and hope to obtain virtual currency or forum points through knowledge sharing (Jin et al., 2016) [51]. Their online learning process consists mainly of "spamming" (publishing many meaningless posts on online platforms) and "water paste" (meaningless reply to the discussion topic to accumulate platform points or experience values). Therefore, the online-learning process of these "information porters" is decentralized and instrumental in nature, lacking critical thinking, integration, and the reconstruction of information, thus contributing less to innovation output. It is a kind of Surface Approach (Marton & Saljo, 1976) [52]. On the contrary, the Qlty-KSP is more of a Deep Approach in the traditional learning situation. These "knowledge creators" driven by social motivation and internal self-motivation pay more attention to valuable information sharing and exchange (Wasko & Faraj, 2005) [40]. They seek the potential significance and purpose of online-learning tasks and compare the multi-party information and knowledge structure. These in-depth online-learning processes are of positive significance to improving individual's sustainable development ability and promoting the output of their innovative achievements.

5.4. Postgraduates' Online Learning Process Plays an Intermediary Role in the Impact Path of Their Information Literacy on Innovation Performance

Having a high level of information literacy and engagement in high-quality online-learning processes has gradually become an important prerequisite for postgraduates to achieve individual professional development in the digital age. Yin (2018) [34] proposed that knowledge sharing plays a mediating role between the information ability of knowledge workers and organizational innovation performance. This study further found that the Qlty-KSP plays a partial mediating role in the positive prediction of information literacy and environmental factors on innovation performance, while the Qty-KSP only has a mediation effect on the relationship between information application literacy and innovation performance. Postgraduates with high information literacy will pay more attention to the significance of information sharing rather than low-quality screen brushing. Compared

to reprinting and sharing other people's content, postgraduates with high information literacy tended to choose Qlty-KSP. They summarize the main ideas and structure from the extracted information, combine thinking, and practice to form their own knowledge and views, and then output them for sharing. Stable and efficient platform hardware support and harmonious high-level peer learning also provide an environmental basis for postgraduates' Qlty-KSP. The process of critical thinking and knowledge system reconstruction under the support of existing information literacy and environmental support will have a significantly positive impact on postgraduates' innovation behavior and innovation achievements. However, the Qty-KSP is driven by external motivation rather than by high information literacy. The mediating effect seems to be more obvious in active high-quality users such as "internet academic celebrities" and "platform big V influencers" with strong information-application integration ability.

6. Conclusions

The meaning of sustainability in higher education has changed in the digital age. This study took place China, which has the largest education system in the world. This study draws on a sample of 501 postgraduates from China. Based on Biggs' Presage-Process-Product model, this study examines the relationship and impact path among postgraduates' information literacy, online knowledge-sharing process, and innovation performance from a whole-process perspective. The study findings emphasize the importance of innovative capacities of postgraduates in promoting the sustainable development of higher education. This can be achieved by cultivating the information literacy of postgraduates and paying attention to the quality of online learning process. This may be an important course of action to achieve the sustainable development goal of "Quality Education" and promote the 2030 Agenda for Sustainable Development.

This study extends the Biggs' 3P learning model to the postgraduate online-learning context. In addition, this research focuses on the practical issues of sustainable development of higher education and skills development in the digital age. We suggest postgraduates' information literacy and extracurricular online learning processes as important paths for cultivating innovative talents in the digital age to achieve sustainable development. Through the findings of this study, it can be speculated that improving postgraduates' sustainable-development capabilities in the digital age, through an online-learning process that helps them develop information literacy, will foster an inclusive learning environment as well as high-quality learning outcomes. This provides a reference based on empirical data to encourage everyone to have the right to enjoy digital services fairly. This will contribute to the achievement of the SDGs, especially Goal 4, "Quality Education".

Based on the above research findings, this research suggests to (1) incorporate information literacy-related courses into postgraduates' learning scope, and develop their information literacy, especially information discrimination literacy and information application literacy; (2) encourage postgraduates to actively participate in the knowledge sharing of extracurricular learning platforms such as virtual academic communities and cultivate their digital capabilities for sustainable development in the digital age through high-quality sharing practices; and (3) build a user-friendly knowledge sharing platform for postgraduates, and provide a good environment for improving the sustainability, flexibility, and digitalization (Miceli et al., 2021) [53] of higher education.

This study used a variety of research designs to improve the internal validity and reliability, but some limitations remained. Deng, Benckendorff, Gannaway (2019) [22] explore the applicability of the Biggs 3P model from a cultural perspective. They find that the impact of learning methods on achievement varies according to students' gender and cultural background. Future research can explore the applicability of this study to students of different genders, educational backgrounds, and family backgrounds. Furthermore, the results were relatively subjective, although self-reported innovation performance is common. Future research could use relatively objective data such as the number of papers to measure innovation performance to validate our findings.

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Education for Sustainable Development in Higher Education Rankings: Challenges and Opportunities for Developing Internationally Comparable Indicators

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Abstract: As more higher education institutions strive to embed sustainable development principles in their teaching, it becomes increasingly important to identify indicators that can measure institutional contribution in a meaningful and internationally comparable manner. This paper shows that existing sustainability rankings, such as the UI Green Metric and THE Impact ranking, have paid relatively little attention to indicators on Education for Sustainable Development (ESD). In a quest to develop such indicators for U-Multirank—the multi-dimensional transparency and ranking tool—we reviewed the literature, consulted experts, and ran a survey amongst practitioners. This article summarises opportunities and challenges for developing internationally comparable ESD indicators in the higher education sector, discussing indicator relevance, validity, and feasibility. The results suggest that (i) ESD indicators are considered highly relevant by diverse stakeholders; (ii) the majority of HEIs surveyed are planning to collect ESD data within 3 years, signalling good prospects for data feasibility; (iii) the ESD indicators proposed so far still lack criteria that would allow one to sufficiently identify and compare these indicators across countries, inhibiting indicator validity. At least three potential definitions are used by HEIs. The results of this paper can contribute to the discussion on identifying appropriate criteria for the development of ESD indicators and their use in international rankings.

Keywords: education for sustainable development; ESD; sustainable development; SDGs; sustainability; higher education; indicators; rankings; assessment; university rankings; green universities; green campus; education; learning

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1. Introduction

Problem Statement and Rationale for ESD Indicators

Responding to urgent policy priorities [1–3] and societal concerns [4–6], a steeply growing number of higher education institutions (HEIs) have embarked on a journey to embed sustainable development in their key functions. For example, in 2021, more than 1100 institutions from 94 countries participated in the Times Higher Education (THE) Impact Ranking to show their contributions to the Sustainable Development Goals (SDGs) [7]. However, the pace at which sustainability transformations take place at HEIs varies considerably depending on the local context and capacity of each institution [8]. Internationally comparable yet locally meaningful indicators can support HEIs in learning from each other and assessing their progress.

While transformation towards sustainability in the higher education (HE) sector requires a systematic approach across all functions and the HE ecosystem [9], this article zooms in on one promising area—education and, particularly, Education for Sustainable Development (ESD). Education prepares (or underprepares) today's students to be the decision makers of tomorrow, who must deal with the current and future sustainability challenges [10,11]. ESD supports students in developing critical competencies, such as systems thinking and integrated problem solving to address these challenges [12,13].

A substantial body of literature on sustainability indicators already exists [14–20], yet widespread use of indicators is hindered by uncoordinated practices and a lack of consensus on appropriate frameworks, methodologies, and impact assessments [19,21]. Numerous researchers have proposed that stronger harmonisation is needed at a global scale [21–24]. Cooperative action is required to monitor and achieve goals and reduce inefficiencies. Moreover, a widely shared and accepted knowledge base may better inform sustainability policies and create synergies across global efforts [24]. At the same time, the indicators must remain relevant for the local context [16,25]. The objective of this article is to explore promising ESD indicators for the HE sector by learning from existing rankings, such as the UI Green Metric and THE Impact ranking.

This paper aims to address three research questions. First, it explores the extent to which ESD-related indicators are available in the existing higher education sustainability rankings. Second, it identifies challenges for developing internationally comparable ESD indicators. Lastly, it reviews and proposes the most promising ESD indicators against three commonly found criteria in the literature on indicator assessment—relevance, validity, and feasibility [26–28]. The criteria are discussed in detail in Section 3.7. The following questions are proposed:

- RQ1: To what extent are ESD-related indicators available in the existing higher education sustainability rankings?
- RQ2: What are the challenges for developing internationally comparable ESD indicators in the higher education sector?
- RQ3: What are the most promising ESD indicators in the higher education sector, assessed against relevance, validity, and feasibility?

This research was undertaken as part of the U-Multirank project. U-Multirank is a multi-dimensional ranking and transparency tool featuring over 1900 HEIs [29], aiming to provide relevant and user-driven comparisons [30]. Recognising that the needs and priorities of U-Multirank participants are shifting, in 2019, a stakeholder consultation process was started to identify promising ESD indicators to include in U-Multirank. The author of this article is a member of the U-Multirank team for identifying and proposing the indicators.

2. Relevance of Sustainability in Higher Education

2.1. ESD in Global and European Policy Priorities

To determine the relevance of sustainable development indicators, we first reviewed recent policy documents. Sustainable development in policy discourse is commonly defined as "the ability to [. . .] meet[s] the needs of the present without compromising the ability of future generations to meet their own needs" [31] (p. 16). Over the years, the concept has evolved to reflect three dimensions of sustainable development—environmental, social, and economic [1]. Although highly relevant today, sustainable development is not a novel policy priority. Already in 1987, an urgent call to action was made "to propose long-term environmental strategies for achieving sustainable development by the year 2000 and beyond" [31] (p. 5). More recently, the Agenda 2030 for Sustainable Development placed these aspirations in clear focus with 17 Sustainable Development Goals (SDGs) [1], mobilising stakeholders from all regions and diverse fields. As an essential element of transformations towards sustainable development, ESD is gaining increased recognition globally [32].

The European higher education policy documents and initiatives signal a clear priority given to sustainable development for the upcoming decade (2020–2030). Within the European Union (EU), education is seen as a critical component for building the capabilities of the EU's citizens to attain sustainable development goals. The European Commission (EC) envisions that European education institutions at all levels should embrace the SDGs, transforming into organisations where skills for sustainability are both taught and practised. To enact the vision, reforms ranging from building green campuses to adjustments in the curriculum have been proposed [33]. The Council of the European Union [34]

has recommended that, as part of the revised 'key competences for lifelong learning', all member states should mainstream sustainability education, including ESD, across entire education levels. As part of the European Green Deal, which outlines a long-term strategy for 2050, the Commission intends to support the development of a European competence framework to "assess knowledge, skills and attitudes on climate change and sustainable development" [2] (p. 19) and support teacher-training programs. One of the most notable EU initiatives in recent years is the European Universities Initiative. Launched in 2018 by the EC, it has financed 41 alliances across Europe to tackle "big issues facing Europe (such as climate protection, democracy, health, big data, migration)" [35] (p. 1). Many initiatives take place at a national level. In Finland, a forum for sustainable development in higher education has been established [36].

2.2. Education for Sustainable Development over Time

Since Education for Sustainable Development (ESD) is used as a key reference framework for indicator development in this paper, a brief overview of ESD and its development over time is provided in this section. ESD is a holistic learning approach that "empowers learners to take informed decisions and responsible actions for environmental integrity, economic viability and a just society, for present and future generations, while respecting cultural diversity" [37] (p. 4). First institutionalised in 1992 by the United Nations Educational, Scientific, and Cultural Organisation (UNESCO) [16], it is now recognised in key policy documents, including the 2030 Agenda for Sustainable Development (SDG 4.7), the Paris Agreement [32], and the EU higher education policy on key competencies [34]. ESD is also directly linked to the 17 SDGs [32] and aligned with the 2030 Agenda for Sustainable Development [38].

While ESD as a concept was first promoted by UNESCO in 1992, wider recognition of ESD increased during the UN Decade on Education for Sustainable Development (DESD, 2005–2014), followed by the Global Action Programme on ESD (GAP, 2014–2019). Both programs aimed to integrate sustainable development principles into education and learning [16], with the GAP program scaling up DESD achievements [32]. The most recent follow-up program is ESD for 2030, which "aims to build a more just and sustainable world through strengthening ESD and contributing to the achievement of the 17 SDGs" [38] (p. 14). Prior to ESD for 2030, UNESCO published a report titled 'Education for Sustainable Development Goals: learning objectives', linking ESD to all 17 SDGs [32].

Given ESD's (i) direct links to sustainable development [32,38], (ii) continued presence and growing international recognition in policy, practice, and academia over time [12,39–42], and (iii) prescriptive yet non-restrictive definition [32] (p. 7), it can serve as a valuable reference framework for building international consensus on education indicators centred around sustainable development.

2.3. Higher Education Sustainability Rankings

Higher education rankings have been widely researched and thoroughly criticised [43–47], yet have remained relatively popular. While a large number of assessment tools exist for sustainability and sustainable development in the higher education sector (e.g., AISHE 2.0, STARS, GASU, ASSC, PSIR, SAQ, SustainTool, UniSAF) [14–16,18–20], only a few international rankings so far have undertaken the task—most notably, the UI Green Metric and THE Impact Ranking. A handful of articles have reviewed the approaches used in these rankings [48–51], and several recognised the importance of ESD, but did not specifically focus on ESD. Other sustainability rankings likely exist, particularly at the national level. One such example is a Dutch student-led sustainability ranking—Sustainabul. Thus, other researchers are welcome to identify new sustainability rankings and further contribute to the discussion.

3. Methodology

3.1. Conceptualising Sustainability in Key HE Functions

Sustainability in higher education can be embedded in all key functions. According to the United Nations guidelines, an integrative, whole-school/institution approach to embedding sustainability in HEIs is preferred. Such an approach often distinguishes six major dimensions that vary slightly in their formulation: (i) education (also 'teaching and curriculum', (ii) research, (iii) societal engagement (also 'external community', 'community outreach'), (iv) campus operations (also 'facilities', 'operations') (v) organisational management (also 'governance', 'leadership'), and (vi) assessment and communication (also 'assessment and reporting', 'monitoring'). In this article, we refer to six such functions, as indicated in Figure 1, while recognising that multiple naming conventions are possible and have evolved over time [15,52,53].

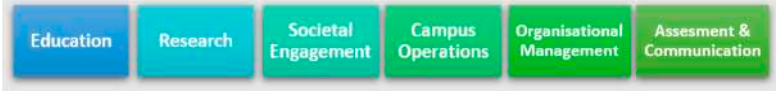

Figure 1. Key functions for promoting sustainability in higher education (integrative approach).

For example, initially, Cortese [52] proposed four dimensions: education, research, campus operations, and community outreach. Soon after, Lozano [53] added 'assessment and reporting'. More recently, Caeiro [15] used 'external community' instead of 'community outreach' and 'assessment and communication' in place of 'assessment and reporting'. In this paper, we use 'societal engagement' instead of 'external community' to indicate mutually beneficial relationships between higher education institutions and wider society [54]. Finally, in recent years, more research has been done on the role of leadership [55–57], governance [18,58], and organisational change and transformation [59–62] in promoting sustainability in higher education. Since change can come from top-down, bottom-up, and middle-out approaches, organisational management is more encompassing than the other two and aligns with Caeiro's suggestion [15]. As Lozano [53] notes, these dimensions are interdependent.

This paper focuses on sustainability through the function of education while also touching upon assessment and communication. This limitation should be acknowledged. It is our intention to further elaborate on the remaining dimensions in future.

3.2. Conceptualizing ESD Dimensions in Education

When developing indicators on education quality, it is common to distinguish between input, process, and output variables, which are sometimes called presage, process, and product variables, respectively [63,64]. Input variables exist within a university context prior to students beginning their studies, and they include resources, degree of student selectivity, the quality of students and staff. Process variables characterise the teaching and learning process, including measures of student engagement, pedagogies employed, teacher training, and learning environment. Output variables focus on student outcomes, including grades, student retention, and employment. Out of the three categories, process variables are shown to be the best predictors of the learning gain, or how much students learn at HEIs [63].

ESD is increasingly considered "an integral part of quality education" and "encompasses learning content and outcomes, pedagogy and the learning environment" [38] (p. 8). While mapping of the variables to three categories is not always straightforward [63], Figure 2 depicts how the ESD dimensions could be linked to the three commonly used dimensions for education quality—input, process, and output. The ESD dimensions cover some, but not all variables for education quality.

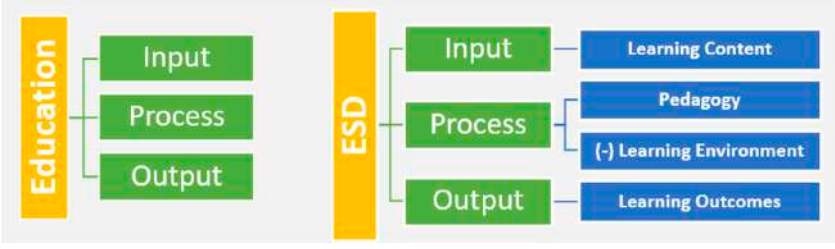

Figure 2. Comparison of education quality dimensions compared to ESD dimensions.

When aligning the education quality and ESD dimensions, ESD's learning content falls under input variables, since curricula and the corresponding learning content are often prepared prior to the teaching process. In ESD, learning content is addressed by integrating critical issues such as climate change and poverty into the learning curriculum. More recently, topics linked to 17 SDGs have been emphasised. ESD's dimensions on pedagogy and the learning environment are mapped to process variables, as these dimensions directly affect the learning process and educational gain. In ESD, these dimensions are addressed by utilising interactive, learner-centred pedagogy and providing a whole-institution approach that would enable learners to "live what they learn and learn what they live" [38] (p. 8). Finally, learning outcomes are mapped to output variables. In the ESD approach, learning outcomes are designed to empower learners to take responsibility for the present and future generations and are linked to eight key competencies, including systems thinking, anticipatory thinking, and integrated problem solving [32].

As part of U-Multirank's new indicator development process, it was decided to focus on three out of the four dimensions, eliminating the 'learning environment'. Although highly relevant, it was considered too novel and vague to be operationalised in specific indicators in the short-term future.

3.3. Overview of the Research Process

The research used an exploratory sequential mixed-method design [65], and it was carried out in three consecutive phases. First, an exploratory literature review was conducted to identify the relevance of sustainability in the higher education sector. Resources were gathered from the academic literature, recent policy documents, and higher education sustainability ranking and assessment tools (e.g., THE Impact Ranking, UI Green Metric, UniSAF). The insights obtained helped to prepare for the second phase and are summarized in Section 2. In the second phase, two semi-structured focus groups were organised in an online setting to collect qualitative feedback (n = 13). The aim of the focus groups was to discuss indicator relevance, validity, and feasibility with international experts, practitioners, and student representatives. In addition, an open consultation was held with the U-Multirank advisory board, where they were invited to comment on the proposed indicators. The insights from the semi-structured focus groups and the advisory board meeting informed the design of the quantitative indicator survey utilised in the third phase. The survey was distributed to the U-Multirank participants to obtain quantitative data on indicator validity (n = 227) and feasibility (n = 256). An overview of the stakeholders consulted is displayed in Table 1 below.

Table 1. Overview of the stakeholders consulted.

Stakeholders	Mode of Consultation	Nr. of Participants	Gender	Geographic Representation	Type of Organization
Experts and practitioners	Semi-structured focus group	6	50% female, 50% male	Europe, North America	Higher Education Institutions, Intergovernmental Organisations (UNESCO, Green Office Movement, Aurora Network, Green Hub)
U-Multirank Advisory Board	Open format consultation	16	50% female, 50% male	Worldwide Europe-centred	Higher Educations Institutions, Intergovernmental Organisations (EUA, EURASHE, OECD, ESU, CEASER, ESN, IAU)
Student representatives	Semi-structured focus group	7	57% female, 47% male	Europe	Student organisations (ESU, ESN)
U-Multirank participants	Survey	227 256	Not available	Worldwide	Higher Education Institutions

3.4. Rankings and the Assessment Tool Reviewed

To identify existing indicators that focus on either education for sustainable development (ESD) or education linked to SDGs or sustainability, we reviewed rankings that are specifically focused on sustainability in the higher education sector. As a reference point, one holistic assessment tool was also included. The rankings were selected using a convenience sample based on their (i) focus on sustainability, (ii) visibility in the higher education sector, and (iii) potential relevance for U-Multirank. The rankings reviewed were: the Impact Ranking, UI Green Metric, Sustainabul, and UniSAF framework. The UniSAF framework is a holistic assessment tool that is used as a reference due to the relatively high number of education indicators. While the list is not exhaustive and cannot claim to be representative of all sustainability rankings, and particularly not assessment tools, it highlights some of the more recent indicator trends in sustainability or SDG-related rankings. As a result of the indicator review, a preliminary list of potential new ESD indicators was compiled. This list was used as a starting point for stakeholder consultations.

3.5. Focus Groups

Between September 2020 and April 2021, the U-Multirank project team consulted a diverse group of stakeholders to evaluate the need for internationally comparable indicators on ESD. Amongst the participants were experts, practitioners, policymakers, and student representatives. Three separate consultations were carried out. First, an expert panel on Education for Sustainable Development (6 participants) provided comprehensive feedback on the relevance, validity, and feasibility of indicators. Next, the U-Multirank Advisory Board (16 participants) was invited to provide general feedback on the relevance of the indicators in an open consultation format. A wide spectrum of representatives was included in these consultations (e.g., representatives from UNESCO, AURORA network, OECD, IAU, and EUA). Lastly, a separate consultation was set up with student representatives from the European Student Union (ESU) and Erasmus Student Network (ESN) (7 participants) to obtain student perspectives on indicator relevance, yet students also shared some feedback on indicator validity and feasibility. The final report, including meeting notes, is publicly available.

While the stakeholders consulted represented several international institutions (e.g., UNESCO, OECD, IAU), the majority of the participants were engaged in European institutions, initiatives, or networks. Therefore, the insights obtained during the consultation process would be of higher importance to European countries and, to a certain extent, North America. No stakeholders from Africa, Asia, Australia, or South America were consulted. For a brief overview of the geographic coverage of stakeholders consulted, see Table 1.

3.6. Practitioners Surveyed

In order to identify ESD indicators with the highest feasibility (availability of data) and the most commonly used definitions for ESD or sustainability-related education, the U-Multirank team conducted a survey amongst HE practitioners. The survey was sent out to U-Multirank participants between February and June 2021. It was permitted to forward the survey to other colleagues at one's institution, resulting in a larger number of participants than institutions. In the survey, neither of the two questions were required, which led to a different number of answers per question. The question on indicator data availability was completed by 256 respondents, while the question on the most commonly used ESD definitions was answered by 227 respondents. Respondents held various positions, including ranking officers, sustainability coordinators, and international affairs coordinators.

3.7. Criteria for Indicator Assessment

Building on the insights from the academic literature, policy papers, and existing rankings, a preliminary list of indicators was prepared for stakeholder consultations. During the focus groups, stakeholders were invited to assess indicators on three criteria: relevance, validity, and feasibility. Such criteria are frequently used in the research literature on education indicators [26–28,66]. The same criteria were used to assess other new indicator groups for U-Multirank, such as social inclusion [66] and effective teaching and learning. The relevance criterion was seen as critical, since indicators would only be used if the phenomenon measured is considered important by the users [27]. If the relevance criterion is not met, institutional leaders and practitioners will not invest time in data collection. The following criterion—validity—evaluates if an indicator reflects the phenomenon it is meant to represent [67]. Validity is particularly important for ESD indicators, since no operational definition is available at an international level, and multiple different definitions are used, a result indicated by the feasibility survey. The third criterion, feasibility, addresses practical aspects of the data collection process and data availability, including institutions' capacity and readiness to obtain the required data considering their available resources and expertise [28].

4. Results

4.1. Rankings Reviewed (RQ1)

Section 4.1 aims to answer the first research question: (RQ1) To what extent are ESD-related indicators available in the existing higher education sustainability rankings? The rankings reviewed were the Impact Ranking, UI Green Metric, and Sustainabul. In addition, UniSAF, a holistic assessment tool, was included as a reference due to the large number of education indicators it features. Below, Table 2 provides a comparison of all four tools.

4.1.1. Indicators in the THE Impact Ranking

The Times Higher Education (THE) Impact ranking, first released in 2019, claims to be the only ranking to assess the performance of higher education institutions against the Sustainable Development Goals as defined in the Agenda 2030 for Sustainable Development. The participation in the ranking is voluntary, its coverage is global, and assessment is done at the institutional level across the SDGs, as well as separately on each SDG. To participate, institutions need to submit information on at least three SDGs in addition to SDG17 (strong institutions), which is mandatory [68].

The second edition (2020) included 768 HEIs from 85 countries [69]. SDGs were assessed across four areas—(1) research, (2) stewardship, (3) outreach, and (4) teaching. The THE Impact ranking collects information about sustainability-related education under two goals: SDG13—Climate Action and SDG17—Partnerships for the Goals. Under SDG 13, HEIs need to submit information about education programs on climate action, and for SDG 17, education must be centred around the SDGs [70,71]. Several other metrics are related to sustainable development, but extend beyond the scope of education. For example, SDG4

(Quality education) [72] reports on inclusive access, while several other SDGs (SDGs 6, 7, 14) consider outreach programs to local communities ranging from topics about good water management (SDG6) [73], [. . .] energy efficiency and clean energy (SDG7) [74], and sustainable management of fisheries [. . .] [75] (SDG 14).

Table 2. An overview of the sustainability ranking and assessment tools.

Category	THE Impact	UI Green Metric	Sustainabul	UniSAf
Focus	SDGs	Environmental Sustainability	Student-driven assessment	Holistic sustainability self-assessment
Level	Institutional	Institutional	Institutional	Institutional
Coverage	International	International	Dutch	International, EU-oriented
Release year	2019	2010	2012	Not applicable
Participants (2020)	768	912	30	Not applicable
Areas covered	17 SDGs in the areas of (1) research, (2) stewardship, (3) outreach, (4) teaching,	(1) energy and climate change (2) education and research (3) transportation (4) waste (5) setting and infrastructure (6) water	(1) education, (2) research, (3) operations,	(1) education, (2) research, (3) community, (4) operations, (5) governance
Indicators: Learning Content	(1) local education programs on climate change/SDGs; (2) community outreach programs	(1) ratio of sustainability courses to total courses/subjects	(1) sustainability-oriented education programs (2) sustainability-oriented education minors (3) SDGs in education curriculum	(E-1) courses focused on sustainability (E-2) percentage of courses (E-3) availability of courses to students (E-4) educational offerings for general public (E-5) sustainability specialisation (E-6) sustainability focused service learning (E-7) student enrolment
Indicators: Pedagogy			(4) training and support for teaching staff	(E-11) professional development of sustainability educators (E-12) links between sustainability research and education (E-13) partnerships (E-8) student involvement
Indicators: Learning Outcomes	(3) graduates in relevant fields, such as % of health graduates (SDG3)			(E-9) alumni destinations (E-10) educational outcomes

4.1.2. Indicators in the UI Green Metric

The UI Green Metric World University Ranking, launched by Universities Indonesia in 2010, aims to provide information about the sustainability of universities around the world. Participation in the ranking is voluntary, its coverage is global, and assessment is done at the institutional level. Data collection happens through online questionnaires sent to university administrators [76,77].

The ranking criteria are built around six pillars—energy and climate change (21%), education and research (18%), transportation (18%), waste (18%), setting and infrastructure (15%), and water (10%). The assignment of weights suggests that the ranking is skewed towards operational measures (82%), utilising a wide range of criteria, such as the campus location, amount of green space, energy use, transport, water use, recycling, and waste treatment. Under the "Education and Research" pillar, one out of seven indicators is dedicated to education—"ratio of sustainability courses to total courses/subjects" [78].

4.1.3. Indicators in Sustainabul

Sustainabul is a Dutch national sustainability ranking of higher education institutions (HEIs). First released in 2012, Sustainabul is an example of a bottom-up ranking, commenced and run annually by a national student network, "Studenten voor Morgen" (Eng: Students for tomorrow). "Studenten voor morgen" created the ranking to encourage institutions to become more sustainable through competition and knowledge sharing. Sustainabul assesses HEIs on three dimensions—education, research, and operational management—and gathers information about the best sustainability practices [79].

In 2020, Sustainabul featured the thirty largest Dutch HEIs in terms of student enrolments, covering both universities and universities of applied sciences. Sustainabul's methodology allocates equal weights to three key dimensions—sustainability in education, research, and operational management (maximum of 110 points per category)—while best practices can receive an additional 30 points. The education dimension consists of four measures: education programs centred on sustainability (50%), minors centred on sustainability (30%), training and support for teaching staff (15%), and integration of SDGs in the curriculum (5%) [80].

4.1.4. Indicators in the UniSAF Framework (Green Office Movement)

The Green Office Movement was launched in 2010, aiming to create a sustainability platform that empowers students and staff to embed sustainability in the curriculum, research, operations, community, and governance of their higher education institution [81].

One of the resources provided by the Green Office Movement is University Sustainability Assessment Framework (UniSAF). Although not a ranking, the UniSAf framework offers a broad spectrum of indicators for a holistic assessment of an institution. The indicator categories include education, research, community, operations, and governance. Thirteen indicators have been proposed for education, and these are split into three categories—educational offering, students, and course quality [82].

4.1.5. ESD Indicators in the Existing Sustainability Rankings and Assessment Tool

An overview of the indicators in the HE sustainability rankings allows us to answer the first question: To what extent are ESD-related indicators available in the existing higher education sustainability rankings? All three rankings have indicators on learning content—namely, programs, minors, courses, or community outreach focused on climate change, sustainability, or SDG topics. Only one of the rankings, Sustainabul, has indicators on pedagogy, referring to training and support provided for teaching staff. In addition, for learning outcomes, only one of the rankings provides an indicator—the number of health graduates.

On the other hand, the reference tool UniSAF has multiple indicators in each category. Learning content also considers not only courses, but also the availability of courses to the student population (e.g., access in terms of regulations, timing, pre-requisites) and service-learning courses. For pedagogy (course quality in UniSAf), UniSAF considers professional development and student involvement (the extent to which students feel that they can shape their learning experiences) and links to research and partnerships with external parties. Finally, for learning outcomes, UniSAF considers educational outcomes based on the sustainability competencies acquired and the alumni destinations.

Thus, it appears that the existing rankings provide little input for ESD indicators, mostly emphasising learning content, but with somewhat limited attention to pedagogies and learning outcomes. However, frameworks such as UniSAF are helpful in developing new ESD indicators, since they consider learning content, student involvement, professional development of teachers, sustainability competencies, and alumni destinations, effectively addressing most ESD dimensions (see Figure 2).

4.2. Challenges when Developing ESD Indicators (RQ2)

Section 4.2 aims to answer the second research question: (RQ2) What are the challenges for developing internationally comparable ESD indicators in the higher education sector? Building on the indicators found in the aforementioned rankings and, particularly, the UniSAf framework, a preliminary list of ESD indicators was developed for stakeholder consultations. During this stage, potential challenges for internationally comparable indicators were identified.

An overview of the potential indicators, their operationalisation, and challenges is available in Table 3. Indicators were grouped around three ESD dimensions—learning content, pedagogy, and learning outcomes. Under learning outcomes, graduate outcomes were also included, though these are technically not learning outcomes, but a broader outcome measure. In addition, a preliminary list of challenges for operationalising these indicators was identified, from which most were rooted in three main challenges. The first challenge stems from the need to agree on thresholds or guidelines to identify and, consequently, create a classification mechanism for ESD-related education/teacher training/jobs/competencies (see Table 3, challenges 1, 3, 6, 7). Since ESD is a holistic framework that encompasses multiple aspects of education, it is challenging to propose a specific yet contextually relevant definition that would allow the classification of educational offerings as ESD. Secondly, comparing workloads across different systems on a global scale is difficult (see Table 3, challenges 2, 4). At the EU level, the European Credit Transfer System (ECTS) can be used, but a conversion mechanism needs to be established at a global level. Lastly, national qualifications for teacher training differ substantially across countries. It is possible that in some systems, teachers are better prepared to teach ESD topics and teaching methods and, therefore, should not be penalised for not having additional training afterwards (see Table 3, challenge 5). This challenge was identified during the consultations, but has been included in this table for a better overview. This list is the first attempt to identify challenges and add to the existing literature. Any additions and modifications are welcome in future research.

Table 3. Preliminary ESD indicators and underlying challenges.

Indicator Category	Indicators	Challenge
Learning content	ESD course offering (% of total courses) ESD minor offering (%of total minors) ESD program offering (% of total programs)	(1) lack of criteria to *identify* education that meets ESD standards; (2) limited ability to *compare* education workload internationally
Pedagogy	ESD training for educators (% trained within last 5 years)	(3) lack of criteria to *identify* training that meets ESD standards; (4) limited ability to *compare* training workload internationally; (5) limited ability to *recognise* initial teacher training's contribution to the ESD approach
Learning Outcomes	ESD course graduates (% of total course graduates) ESD minor graduates (% of total minor graduates) ESD program graduates (% of total program graduates)	(1) lack of criteria to *identify* education that meets ESD standards; (2) limited ability to *compare* education workload internationally
	ESD competencies (alumni self-reported scores)	(6) lack of criteria to *assess* ESD competencies (eight official ESD competencies identified by UNESCO)
	ESD alumni in relevant SD-related jobs (% of total alumni)	(7) lack of criteria to *identify* SD-related jobs

4.3. Results from the Stakeholder Consultations and Feasibility Survey (RQ3)

Section 4.3 aims to answer the third research question: (RQ3) What are the most promising ESD indicators in the higher education sector, assessed against relevance, validity,

and feasibility? To answer the question, the outcomes of stakeholder consultations are discussed, summarising reflections on the proposed ESD indicators' relevance, validity, and feasibility. The procedure for stakeholder consultations consisted of focus groups and a survey, and it is described in Sections 3.5 and 3.6.

4.3.1. Relevance

Indicator relevance is one of the critical factors when developing new indicators. While the policy documents signalled clear priority for sustainability indicators, additional consultations experts, practitioners, and students provided contextualised insights on the potential use and importance of indicators. During the stakeholder consultations on indicator relevance, three questions emerged: (i) Are ESD indicators relevant? (ii) Relevant for what purpose? (iii) Relevant for whom?

All stakeholders agreed that ESD and, more broadly, education linked to sustainable development are highly relevant and critical to attaining global policy goals. Therefore, *(i)* ESD indicators are relevant, since they can help to establish a baseline, reflect progress over time, and allow one to learn from others by providing a contextualised comparison. At the same time, indicators are imperfect measures and 'what gets measured, gets noticed'. Therefore, all stakeholders should remain critical and keep examining the purpose of the indicators and parties involved.

Stakeholders noted that ESD indicators should (ii) fit the purpose, stimulating institutional learning and transparency rather than competition amongst HEIs. Higher education rankings typically create tension and competition and, therefore, are not well suited for new ESD indicators. For example, in a ranking, a higher education institution may drop in a rank even if it has improved its sustainability performance if the participant pool has changed from one year to another. Instead, ratings with transparent criteria and predetermined levels may be used. Moreover, the indicators should be (ii) holistic rather than focusing on education only, covering other functions, such as operations and governance. In addition, the indicators should also (ii) reflect student and educator experiences.

Stakeholders emphasised that indicators should be relevant (iii) for HEIs with diverse profiles, including universities of applied sciences and vocational education institutions. Still today, many rankings predominantly focus on traditional research universities. The new ESD indicators should reflect the needs and indicators relevant for all institutions, not favouring research-intensive institutions. In addition, (iii) national context should be considered as much as possible when developing indicators to make them relevant for a large number of countries and geographic regions. For example, while all ESD indicators were generally seen as relevant, it was noted that some national systems do not use a minor system, and such indicators would not be relevant in their system.

4.3.2. Validity

In addition to being relevant, indicators must be valid, representing the phenomenon that they aim to capture. Since the definition of ESD is sufficiently abstract, there is no one manner in which to operationalise ESD education. Therefore, a careful operationalisation of indicators is important. Such operationalisation requires agreeing on the criteria used to classify education as related to ESD. Since many HEIs focus on SDGs, yet are not familiar with ESD, we expanded the operationalisation to capture ESD education as well as SDG-related education. This led to the following question: *(iv)* What criteria can be used to classify education as ESD or SDG related?

In the case of U-Multirank, the selected criteria need to be sufficiently flexible to acknowledge efforts of diverse higher education institutions and geographic locations, yet they must also be internationally comparable. This creates a tension between flexibility and comparability, where an appropriate balance needs to be found.

During the stakeholder consultations, three classification criteria were proposed, yet a consensus on the preferred approach was not reached. The first focused on the (i) content covering complex problems from three perspectives (social, environmental,

and economic), while the second emphasised the need for (ii) action-oriented teaching methods typical of the ESD approach. The last addressed (iii) SDG perspectives in a specific field. To investigate what criteria are used in practice, the U-Multirank team ran a survey, proposing the three potential definitions, as well as allowing respondents to add their own answers. Respondents could select multiple answers. As can be seen from Figure 3, in total, 227 respondents provided their answers, with many selecting multiple definitions. The most common ESD definition focused on complex problems considering three perspectives (36%), but alternative options, such as definitions linked to teaching methods (31%) and field-specific focus on SDGs (29%), were also commonly used. Amongst the 4% who mentioned other answers, the most common alternative was using learning goals that are often linked to key competencies (e.g., systems thinking, critical thinking) as a criterion for ESD or SDG-related education, while others mentioned extracurricular activities, such as learning with communities.

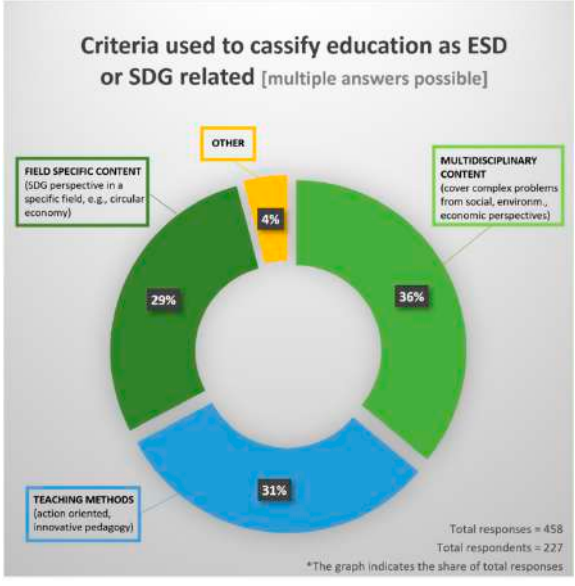

Figure 3. What criteria does your institution use to classify a program or course as ESD or SDG-related? [Multiple answers are possible].

Validity is important, and for ESD or SDG-related education, establishing consensus on how to operationalise these indicators is essential. It should provide sufficient flexibility while also ensuring transparency and contextual relevance. The survey results indicate that all three definitions are seen as helpful, while the most common one is built on the commonly used definition of sustainable development, addressing complex problems across three dimensions—social, economic, and environmental.

During the stakeholder consultation, we also received feedback on other indicators. In particular, the validity of an indicator on teacher training was criticised. Teacher qualifications differ considerably across countries. Since some might entail elements of ESD and transformational teaching methods while others may not, the starting points of the educators differ. Hence, an indicator on ESD training may not represent the quality of ESD teaching. However, it was suggested that an indicator on ESD competencies, particularly those assessed by students, could serve as a good representation of learning outcomes. Overall, consultations showed that operationalising ESD- or SDG-related indicators is challenging. However, in the long run, building international consensus on the relevant criteria may facilitate the process.

4.3.3. Feasibility

Indicator feasibility is critical in determining whether indicators are eventually used. If data are not available or the cost of collecting the required data elements is too high for an institution, even highly relevant and potentially valid indicators may not be used. In order to understand the feasibility of the proposed indicators, we ran a survey, aiming to understand (v) what indicators have the highest feasibility scores?

The survey was shared with representatives from HEIs participating in U-Multirank. The representatives were asked whether they were collecting data on proposed ESD or SDG-related education measures. In this context, 'SDG-related measures' refer to SDGs and content linked to SDGs with a more holistic approach (teaching methods, ESD competencies). As shown in Figure 4, respondents could indicate if data were already collected or would be collected in the near future (within 1–3 years). The results were ordered based on the likelihood that the data would be readily available within three years. When we refer to the likelihood, we combine values for already available data with the data that shall become available in the near future. The total number of respondents answering the question was 256. However, the answers were not forced and varied slightly for each indicator, ranging from 229 to 247.

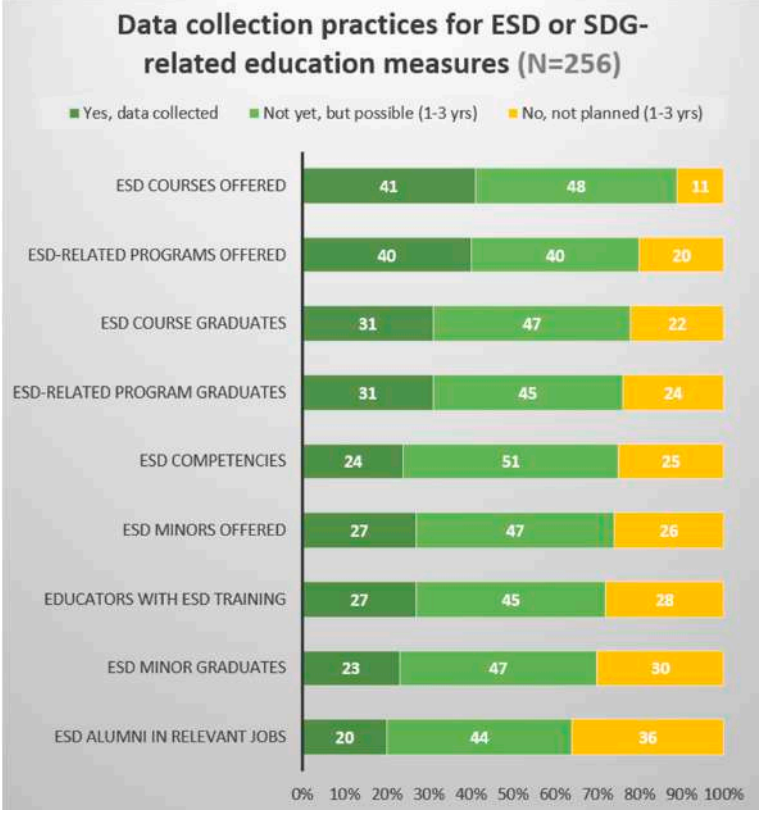

Figure 4. Data collection practices on the proposed ESD and SDG-related indicators.

As can be seen from Figure 4, the four most common indicators, judged on the current and near-future data availability, are "ESD courses offered" (89%), "ESD-related programs" (80%), ESD course graduates (78%), and ESD program graduates (76%), featuring two indicators from the learning content category and two from the learning outcome category.

For these indicators, more than 30% of the respondents indicated that the data were already available, while at least 40% reported that they would be able to provide it in the near future. For the remaining indicators, between 20 and 27% of the respondents were able to provide data right away, yet between 40 and 51% indicated that such data would be available in the future. The indicator with the lowest feasibility was ESD alumni in relevant jobs (64%), but even for this indicator, the majority of respondents expected to have data in the near future. During the consultations, stakeholders provided qualitative feedback on indicators they considered less feasible in terms of obtaining the required data. For example, it was noted that, in some national systems, minor programs are not used, and therefore, it would neither be possible to obtain data on such indicators, nor it would be relevant. On the other hand, 'alumni in relevant jobs' was seen as highly relevant, yet less feasible. The most likely data source would be existing institutional alumni surveys, with little control over response rates and often predefined job sectors. With predefined sectors, it might not be possible to identify if alumni are working on sustainability-related topics. For example, some engineers might be heavily involved in addressing sustainability challenges, while others are not. Thus, an additional question might be needed to understand whether alumni are engaged in sustainability-related jobs. Nonetheless, the feasibility survey suggests that most HEIs are proactively working on obtaining ESD-related data for even more challenging indicators.

5. Discussion

5.1. Prioritising ESD Indicators

Insights from stakeholder consultations and a feasibility survey allowed us to assess indicators on their relevance, validity, and feasibility and to prioritise them in three tiers based on the overall scores (see Table 4). More detailed feedback for each indicator is available in Table 5. The feasibility of the indicators was assessed against the possibility of obtaining the data within three years rather than immediately. In the first tier, four indicators were included: ESD courses, ESD programs, ESD course graduates, and ESD program graduates. All four indicators were assessed as highly relevant by stakeholders, had medium validity due to the need to clarify definitions, and medium to high feasibility, as indicated by the survey. By establishing a consensus around definitions for "ESD educational offering", it would be possible to increase the perceived validity of the indicators, as well as to enhance the feasibility of data collection. The insights from the feasibility survey indicate that, in the following years, the feasibility assessment is likely to move from a medium-high to a high score.

Table 4. Evaluating the new ESD indicators on their relevance, validity, and feasibility.

Category	Indicator	Relevance	Validity	Feasibility	Priority
Learning content	ESD course offering	High	Medium	High	1st tier
	ESD minor offering	Medium	Medium	Medium	2nd tier
Pedagogy	ESD program offering	High	Medium	High	1st tier
	ESD training for educators	High	Low	Medium	2nd tier
Learning Outcomes	ESD course graduates	High	Medium	High	1st tier
	ESD minor graduates	Medium	Medium	Medium	2nd tier
	ESD program graduates	High	Medium	High	1st tier
	ESD competencies	High	Medium	Medium	2nd tier
	ESD alumni in relevant jobs	High	Medium	Low	2nd tier

Table 5. Detailed feedback on indicator relevance, validity, and feasibility.

Category	Indicator	Relevance	Validity	Feasibility
Learning content	ESD course offering	High relevance, showcases availability of courses, often to a broad audience	Criteria for identifying and comparing (workload) ESD-related education are required; criteria need to be sufficiently flexible to fit various contexts and geographies; at least three definitions are commonly used: (i) multidisciplinary sustainability content, (ii) field-specific sustainability content and applications, (iii) multidisciplinary sustainability content combined with ESD teaching methods.	High feasibility, over 1/3 (41%) already collect data, 89% will be ready within 3 years
	ESD minor offering	Medium relevance, showcases availability of minor/specialisation yet 'minors' are not used in all countries	See above (row 2, column 4)	Medium feasibility, less than 1/3 (27%) already collect data, 74% will be ready within 3 years.
	ESD programs offering	High relevance, showcases availability of full programs	See above (row 2, column 4)	High feasibility, over 1/3 (40%) already collect data, 80% will be ready within 3 years
Pedagogy	ESD training for educators	High relevance, reflects educators' knowledge and competencies, impacts educational quality	See above (row 2, column 4). In addition, the validity of the indicator has been criticised for not considering national teacher training qualifications, since some systems pay more attention to ESD-related teaching methods (e.g., student-centred, transformational learning)	Medium feasibility, less than 1/3 (27%) already collect data, 72% will be ready within 3 years
Learning Outcomes	ESD course graduates	Medium relevance, showcases the number of beneficiaries from the course	See above (row 2, column 4)	High feasibility, over 1/3 (31%) already collect data, 78% will be ready within 3 years
	ESD minor graduates	Medium relevance, showcases the number of beneficiaries from the minor yet 'minors' are not used in all countries	See above (row 2, column 4)	Medium feasibility, less than 1/3 (23%) already collect data, 70% will be ready within 3 years.
	ESD program graduates	High relevance, showcases the number of beneficiaries from the program	See above (row 2, column 4)	High feasibility, over 1/3 (31%) already collect data, 76% will be ready within 3 years
	ESD competencies	High relevance, showcases to what extent students have acquired ESD competencies	Currently, 8 ESD competencies have been defined by UNESCO (e.g., systems thinking, anticipatory competency). However, criteria need to be established to assess these competencies	Medium feasibility, less than 1/3 (24%) already collect data, 75% will be ready within 3 years.
	ESD alumni in relevant jobs	High relevance, showcases to what extent students utilise their education in the labour market and create impact	Criteria for identifying jobs related to sustainable development are needed; most likely requires self-assessment due to the multi-faceted nature of jobs.	Low feasibility, less than 1/3 (20%) already collect data, less than 2/3 (64%) will be ready within 3 years.

Furthermore, in the second tier, five indicators were included—ESD minors and minor graduates, ESD competencies, ESD training for educators, and ESD alumni in relevant jobs. ESD minors and ESD minor graduates received a medium score on all three dimensions. This may be partially attributed to some educational systems not offering minors, as suggested in the stakeholder consultations. However, for institutions where such programs are offered, such indicators could still be relevant. Furthermore, ESD training for educators was considered a relevant indicator, yet its validity was criticised due to differences in national systems for teacher qualifications and the potential to signal mistrust towards educators. It received a medium feasibility score. ESD competencies were seen as a promising way to incorporate student views, but were criticised for their subjectivity. Moreover, while eight ESD competencies have been communicated [32], these competencies still need to be operationalised into measurable indicators. "ESD alumni in relevant jobs" would require thresholds to establish what constitutes ESD-relevant jobs. While highly relevant, the biggest drawback of the indicator was its feasibility score, as shown by the survey results and indicated by stakeholders. Alumni surveys might suffer from job classification methods that do not reveal whether sustainability is embedded in the job role and would likely differ across countries and even institutions.

5.2. Limitations

To identify new indicators, we used ESD as a reference framework. A different framework would most likely yield an alternative set of indicators. Moreover, as indicated by the UniSAF indicator, several additional indicators could be included, such as "educational offerings for general public (E-4)" and "sustainability focused service learning (E-6)" [82] if the education of local community members would have been included in the scope.

Moreover, throughout the stakeholder consultations, we aimed to find indicators that could be internationally comparable. For institutions that look to measure their own progress, it is not always necessary to develop internationally comparable indicators. Even though international indicators can facilitate peer-to-peer learning and provide additional reference points, at times, local contexts and needs might be stronger drives for certain indicators [16].

Furthermore, we used a snowballing method to select the stakeholders consulted, including international experts. While it is a relatively common approach given the limited availability of international experts, some selection bias can be expected. Similarly, for the feasibility survey, self-selection bias exists. While the survey was sent to all U-Multirank participants ($n > 1700$), only a relatively small share completed the survey. It is likely that these participants were already more interested and enthusiastic about sustainability topics.

5.3. Future Research

In order to establish ESD indicators, further research could be carried out on the specific guidelines that could be utilised for establishing ESD indicators. Moreover, a repeated feasibility study could be conducted in the near future to evaluate whether institutions have started collecting data on ESD indicators, as proposed by the feasibility survey in this study. In addition, this study explored indicators on three out of four ESD dimensions, eliminating the 'learning environment', since it was considered too novel and broad. However, further research could attempt to measure this dimension [38]. More broadly, another strand of future research could investigate the role of academic leaders, such as rectors, deans, and heads of departments, in implementing and supporting initiatives for monitoring ESD or SDG-related education at their institutions and academic units.

6. Conclusions

Global societal trends (e.g., Extinction Rebellion), international policy discourse [1], and large-scale initiatives [35] signal a clear priority given to sustainable development initiatives. Higher education institutions have a critical role in contributing to these priorities, particularly by preparing future leaders in a diverse set of fields. Hence, these institutions

should be transparent in communicating their efforts to existing and prospective students, as well as broader society. To identify internationally comparable ESD indicators, this paper reviewed the relevant literature and existing sustainability rankings, conducted stakeholder consultations, and ran a survey. The results of this paper are threefold. First, it compares existing higher education sustainability rankings—the Impact Ranking, UI Green Metric, Sustainabul—and highlights that these rankings pay limited attention to ESD indicators. In particular, only one out of three rankings provides measures on pedagogy and learning outcomes. Indicators on the available sustainability education (courses, minors, programs) are common across all three rankings. A holistic assessment framework, UniSAF, can provide valuable insights into the future development of ESD indicators, since it contains a much more comprehensive list of indicators, including measures on pedagogy and learning outcomes.

Second, building on the existing rankings and using ESD as a reference, the paper provides a preliminary list of indicators together with the underlying challenges. The challenges include a lack of criteria for identifying ESD-related education while recognising that such criteria need to be sufficiently flexible to fit diverse contexts and geographic locations. This challenge is not limited to educational offerings, and also includes ESD-related competencies, teacher training, and alumni job destinations. In addition, criteria for comparing workloads across different systems need to be established, which can be similar to the ECTS system used in Europe.

Third, stakeholder consultations and surveys provided insights on indicator relevance, validity, and feasibility. ESD indicators were considered highly relevant by all stakeholder groups (students, experts, and practitioners). However, assessing general relevance is not enough. The potential users of the indicators need to consider 'for what purpose are indicators relevant?' and 'for whom are these indicators relevant'? The stakeholders believed that indicators should promote institutional learning and be inclusive of all types of institutions, not only research universities. The discussions on indicator validity revealed that a consensus needs to be established on appropriate criteria for identifying ESD-related courses/programs/minors/relevant alumni jobs and educator training. At least three types of definitions are available to operationalise ESD courses and programs—(i) content-driven knowledge linked to complex interdisciplinary challenges from social, economic, and environmental perspectives, (ii) teaching methods focused on transformational learning, and (iii) field-specific content knowledge of sustainability. Lastly, the survey on indicator feasibility revealed that, while less than half of the respondents currently collect information on any of the proposed ESD indicators, more than half (64%) plan to collect such information within three years, signalling strong interest in and commitment to monitoring this area.

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Bridging Academics' Roles in Knowledge Diffusion in Sustainability-Driven Public–Private Partnerships: A Case Study of the SDGs Workshop in Central Japan

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Abstract: This article discusses the role of academics in knowledge diffusion among various stakeholders using a case study of a sustainability-oriented workshop to address issues of a local forest in central Japan. This research employs thematic analysis through interpreted data from documents, minutes of meetings, workshop interactions among stakeholders, debriefing sessions, questionnaires, and fieldwork findings of participants in a regional business school. The findings show that Bridging Academics (BAs) have effectively facilitated knowledge diffusion amongst global, national and local stakeholder clusters. The interactions among workshop stakeholders resulted in outcomes that enhanced awareness of knowledge gaps, fostered effective communication, enabled knowledge extension, and created shared values. The study contributes towards the understanding of academics' roles in collaborative settings for sustainability and suggests a multi-node knowledge link model as a collaborative mechanism for knowledge diffusion. The study suggests implications for stakeholders and provides a use case relevant to sustainability-based regional development.

Keywords: bridging academics; regional sustainability; knowledge diffusion; public–private partnership; multi-node knowledge link model; stakeholders

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1. Introduction

Sustainability is defined as fulfilling the needs of the present without compromising the ability of future generations to meet their own needs [1]. As sustainable development accounts for the needs of all members of a given society, the creation and dissemination of knowledge related to sustainability are expected to involve partnerships with the widest range of stakeholders possible. Stakeholders are drivers of organizational change when they have access to channels for participation and leadership [2]. A higher education institution is well-positioned to become a knowledge hub in a given region by providing channels through which stakeholders can engage in action-based projects on sustainability knowledge creation and dissemination, with the aim of better understanding the role of external stakeholders.

Empirical research results have indicated that isolated stakeholders cannot identify sustainable solutions to regional issues by themselves [3]. Therefore, a collaborative mechanism among universities and different stakeholders could contribute to economic development and knowledge advancement in the region. The relationship between universities and industries will especially enhance economic gains through the dissemination of knowledge and innovative solutions at the regional level [4,5].

As institutions of higher education, universities are responsible for promoting economic and social development, particularly in the region where it operates. Through joint research projects and interactions, academics as a member of the higher education institution could have a role in facilitating collaborative arrangements. The term "bridging academics" (BAs) was introduced by Trippl [6] as a scholar who linked global and regional

knowledge communities through networking. Such collaborative arrangements can be relevant in enabling sustainability-oriented projects to stakeholders' benefit in different regional settings.

This study employs the qualitative case-study approach of the Sustainable Development Goals (SDGs) Workshop. The workshop is a BAs-led multi-stakeholders collaboration, initiated by faculty members of Nagoya University of Commerce and Business (NUCB) Business School in the Chubu region of Japan. The region's economy accounts for 20% of Japan's shipment values of manufactured products and comprises approximately 10% of Japan's area, population, and gross regional production [7]. The emphasis on industrial growth that has characterized the development of this region has led to increased pressure on achieving sustainability-related goals.

The SDGs workshop took place in the Ricoh Ena Forest in the Ena City within the Tokai subregion of Chubu, Japan. The stakeholders of the workshop were invited to interact, collaborate, discuss issues, and consider future developments as well as present potential solutions pertaining to the Ricoh Ena Forest. The workshop stakeholders included Ricoh Corporation (Head Office) representatives, the Ricoh Ena Forest Management Committee, Ena City government representatives, Ena City International Exchange Association representatives (a local NPO), international students (NUCB Business School, Nagoya), and a researcher (Keio University, Tokyo).

Our study analyzed the case of the SDGs workshop that enabled collaboration among stakeholders in a sustainability-oriented project. The collaborative initiative created a unique platform for knowledge diffusion among stakeholders, including industry partners, government representatives, community members, nonprofit organizations (NPOs), and international researchers and students. The interaction among stakeholders with BAs serving as mediators provided a novel structure for exploring sustainability-oriented public–private partnerships (PPPs) to propose innovative solutions and disseminate knowledge related to sustainability issues that are relevant to the region.

Although universities represent institutional knowledge hubs at the macro level, the concept of BAs explains how the mobility of academic scientists individually contributes to knowledge transfer and socioeconomic growth [6]. Atta-Owusu [8] explored the concept of BAs and investigated their collaborative activities, specifically exploring how BAs led collaborative projects that facilitated the flow of knowledge to peripheral regions. However, Owusu's model falls short of providing real prescriptions for supporting BAs.

Our study extends on Trippl [6] and Atta-Owusu [8] studies by investigating the ways in which BAs enable partnership among stakeholders at the global and regional levels in tackling sustainability challenges. We examined the structure and process of BAs that led to collaborative arrangements to better understand knowledge diffusion among stakeholders in sustainability-oriented PPPs.

The SDGs workshop was our main subject of analysis, and we focused on stakeholder understanding of sustainability as well as any knowledge gaps that were identified. This study aims to answer the following research questions:

- How do BAs facilitate partnership among stakeholders in addressing sustainability challenges?
- What are the outcomes of knowledge diffusion with sustainability-driven public–private partnerships?

In response to the first research question, this study explored the collaborative mechanism which could be considered as the multi-node knowledge link model. The model verified the roles of BAs in facilitating partnership among global, national, and local stakeholders in addressing sustainability challenges. Each stakeholder group possesses a unique understanding of the challenges and perspectives regarding sustainability issues. We find that the BAs play an essential role as the hub of knowledge diffusion which facilitates a more cooperative and free knowledge exchange among stakeholders. The study's response to the second research question is as follows. We find that throughout the SDGs workshop, the presence of BAs ensures that every participant attains the minimum level

of required understanding through information sessions on concepts and applications. The outcomes of the workshop are manifested as focused and result-oriented discussions. The discussions enabled the knowledge flow in all directions, which resulted in every participant discovering and adapting accordingly. We find that the workshop represents an effective method in facilitating BAs-led knowledge diffusion in a multi-stakeholders sustainability project. The study contributes towards the understanding of academics' roles in collaborative settings for sustainability and suggests a multi-node knowledge link model as a collaborative mechanism for knowledge diffusion and discussion of societal impact of universities on regional/national innovation ecosystems from the academic perspectives.

The remainder of this paper is divided as follows. Section 2 examines the literature on knowledge diffusion, BAs, and sustainability-oriented PPPs. Section 3 presents the research design with the research method and introduction of the SDGs workshop's background and stakeholders. Section 4 presents the findings and discussions on how BAs collaborate with various stakeholders and the outcomes of knowledge sharing and value creation through the stakeholders' interactions. Section 5 provides conclusions to the research questions and discusses the implications and limitations of the study.

2. Literature Review

The goal of this paper is to examine the effects of Bridging Academics (BAs) on knowledge diffusion among stakeholders of a sustainability-driven public–private partnership. In the literature review section, we identified research gaps by reviewing extant literature on knowledge diffusion, role of bridging academics in knowledge diffusion, and public–private partnerships in the context of a sustainability related project.

2.1. Understanding Knowledge Diffusion

Developed economies have transitioned from economies driven by commodity and manufacturing to those driven by knowledge development, innovation, and commercialization [9]. Therefore, persistent knowledge creation and dissemination is necessary to maintain sustainable innovation among stakeholders involved in value-added processes. Cai, Ferrer, and Lastra [10] applied the concept of the innovation ecosystem to explain how actors in universities and other organizations are concerned with the diffusion of knowledge and their interdependent relations in cross-geographical contexts to generate shared values for sustainability.

Academics play an integral role in the efficient creation and dissemination of knowledge. They can leverage their capabilities to connect with different stakeholders, using their access to institutional and personal knowledge bases that are diversified in terms of geographical location and cultural background [11]. Lattu and Cai [12] identified that the diversification of academic work is one of the key tensions faced by academics amongst Finnish universities in driving sustainability. They explained that academics need sustainability-related competence and sufficient resources to fulfill the job responsibilities beyond academics from an organizational perspective. The affinity and mobility of academic scientists in various regions can enhance knowledge transfer and socioeconomic growth in respective regions, as explained by Trippl [6].

Atta-Owusu [8] extended Trippl's [6] knowledge link model to consider aspects beyond mobility. New aspects such as publications, research collaboration, social networks, cultural contexts, and global knowledge dispersion were considered. His study concluded that the development of collaborative projects and working with stakeholders can create prospects for continuous knowledge flows. The knowledge diffusion process can be enhanced by engaging external stakeholders in knowledge transfer.

However, Atta-Owusu's [8] quantitative data model did not provide applicable prescriptions for supporting BAs in other contexts. We believe that the model justified the role of BAs in knowledge diffusion but overlooked the development process and structure of collaborative arrangements. The limitation is understandable because the sample size was only large enough to focus on the peculiarities of a single collaborative project. In this

study, we employed the proposed model in a single collaborative project by considering the engagement mechanism and differences among global and regional stakeholders during knowledge dissemination. As agents of knowledge diffusion, academics can initiate a new project involving researchers, capable students, and corporate stakeholders from different regions. In addition, academics can expand their ongoing projects in different regions to engage new collaborators and increase the chances of knowledge spillover.

2.2. Role of Bridging Academics in Knowledge Diffusion

The knowledge exchange facilitated by academics has multiple dimensions, as academics can be a part of regional and global networks simultaneously. Trippl [6] defines bridging academics (BAs) as academics connecting global and regional knowledge communities through their networking and collaboration activities.

BAs act as knowledge diffuser agents through two key mechanisms: knowledge mobility and outcome-based partnership [13]. The first requires that BAs and contributors mobilize their knowledge that extends beyond the physical sense. Knowledge transfer occurs as long as participants are able to access and share their knowledge. The second criterion implies that the relationship between the stakeholders and the BAs is intended to achieve a specific goal(s) that benefit all stakeholders involved. Through these two mechanisms, BAs can tap upon the consolidated global and regional knowledge pool and efficiently dispense it to enrich stakeholders' understanding and fill knowledge gaps.

However, prior BAs literature [6,13] overlooked the distinction within the regional stakeholders. Thus, this study utilized the case study of a multi-stakeholders sustainability project to investigate the mechanism in which BAs enable collaboration among global and a subset of regional stakeholders (national and local) when tackling sustainability challenges.

2.3. Public–Private Partnerships in a Sustainability Related Project

The 2014 United Nations Educational, Scientific and Cultural Organization (UNESCO) World Conference on ESD (Education for Sustainable Development) published the 'Aichi-Nagoya Declaration'. The aim was to encourage participants to transform themselves and the society in which they live by developing knowledge, skills, attitudes, competencies, and values [14] and provide a theoretical framework for ESD in which the knowledge link among multiple stakeholders in global and regional clusters is effectively mediated by BAs. The knowledge link connectivity established among the stakeholders in the model provides a template for collaboration among stakeholders in advancing knowledge related to sustainable development.

Cheng et al. [15] proposed a model of public partnership that involves a higher level of commitment among the stakeholders by considering the issues of sustainability and environmental impact in the relationship. To achieve this goal, the partnership model involves NPOs in addition to existing corporations and government stakeholders. Under this partnership model, the PPPs projects should observe principles of good corporate governance and provide adequate disclosure on environmental impact and implications to the public [16]. The partnership requires actions to minimize adverse impacts of infrastructure projects through pollution management and reduction efforts by project members. The partnership also promotes collaborative arrangements that aim to minimize environmental damage and manage environmentally friendly resources to benefit the broader community [17].

Prior literature on strategic PPPs establishes that several strategic shortcomings are generally observed in such partnerships [18]. First, stakeholders' interests are misaligned as they prioritize their institutional interests, which are not well communicated to other stakeholders. Second, there is no intermediary organization bridging the gaps between the stakeholders. These limitations suggest the need for BAs to develop a program that connects diverse global and regional stakeholders to pursue a particular goal. Thus, our study employed the case study of a sustainability-driven public–private partnership to examine the outcomes of knowledge diffusion.

3. Research Design

3.1. Research Method

We employ a qualitative case study approach to examine a contemporary event in the context of its environment and stakeholders in depth [19]. The case study method is preferable when attempting to provide a comprehensive analysis of various processes, organizational characteristics, and/or stakeholder perspectives or experiences and offers a unique perspective when exploring stakeholder interactions in the knowledge diffusion process [20]. This method is commonly employed in the literature to explore the effectiveness of public–private partnerships projects [21,22]. Our paper analyzed and developed a conceptual understanding by empirically investigating a case study through an inductive reasoning process.

The SDGs workshop was developed to understand the scope and limitations of the sustainability-oriented Ricoh Ena Forest and designed as a field-based project to enable knowledge transfer between global and regional stakeholders. The workshop involved BAs facilitating close interactions among stakeholders including international students and researchers, Ricoh Group headquarters, Ricoh Elemex Forest Committee, Ena City government, and a nonprofit organization. Using the case study of the SDGs workshop, the BAs created a collaborative model to harness the expertise of stakeholders to enable knowledge diffusion and identify effective sustainability approaches.

The SDGs workshop has evolved into a long-term research partnership amongst the stakeholders. The SDGs workshop serves as a unique case that provides deep insights into a collaborative mechanism and outcomes of BAs-led knowledge diffusion based on the Asian context. It is a representative case for multi-stakeholders public and private partnerships that focus on knowledge diffusion and sustainability studies.

We gathered documents, meeting minutes, workshop materials, and questionnaires to record interactions with and among all participants throughout the duration of the workshop. The timeline of the workshop is presented in Table A1 in Appendix A. A code was assigned to each participant while considering their category and affiliated clusters, as shown in Table A2 in Appendix A. The collected data were analyzed using the thematic analysis approach [8,23]. Each author independently performed the thematic analysis process, and the results were consolidated to ensure the validity of the analysis. Transcribed documents were read, and relevant keywords were identified in each document. The collection of keywords was then sorted, and relevant keywords were collated and assigned to common themes that were named, defined, and reviewed. From these themes, the thematic analysis results of the case study data are summarized in the findings and discussion section.

3.2. Case Study: SDGs Workshop

3.2.1. Background of the Workshop

Academics from the NUCB Business School (based in the Tokai subregion of Japan) were tasked to develop the SDGs workshop, which aims to promote sustainability-based knowledge diffusion between the global participants and regional stakeholders involved in the Ricoh Ena Forest. The Ricoh Ena Forest is located in Ena City adjacent to Ricoh Elemex Corporation, a manufacturing subsidiary of Ricoh Corporation, which is well known for producing a variety of electronic equipment including photocopiers, optical devices, and cameras. Ena City is a small town with an estimated population of approximately 49,000 people as of January 2021. Since 2010, Ricoh has initiated forest conservation activities at the Ena forest [24] led by staff members from Ricoh Elemex Corporation with financial support from the corporate headquarters (HQ). Currently, the range of activities includes conservation of rare species in the forest by increasing environmental awareness among the young generation and the social and physical well-being of local residents.

The objective of the SDGs workshop was to help all participants improve their understanding of concepts regarding sustainability and share their knowledge based on the Ricoh Ena Forest. The workshop provided in-depth studies on the sustainability strategy

of the Ricoh Ena Forest and how it aligned the mission of the SDGs specified by the United Nations. Collaboration between academics and stakeholders was achieved by undertaking three phases of the SDGs workshop: fieldwork planning, implementing workshops, and receiving feedback from stakeholders. The workshop aimed to employ the Ricoh Ena Forest to understand the development of sustainability, its business relevance, and enable knowledge transfer among different stakeholders. The planning, execution, and reflection sessions of the first workshop lasted for nine months, as specified in Table A1 of Appendix A.

The workshop was conducted virtually involving all participants and stakeholders interacting with each other in real-time over four separate sessions from September to December 2020. Each session lasted for four hours. International students were divided into four groups to tackle different sustainability problems. Each group was put together in a balanced manner with respect to academic background, nationality, and gender. The respective stakeholders participated online to present their organizational background and practices related to SDGs. They were also interviewed by the respective groups to give personal opinions and perceptions about the theme of sustainability for about four hours per session. A final presentation was given by the student groups to all the stakeholders, who in turn, provided feedback and consideration for the adoption of the given proposals.

3.2.2. SDGs Workshop Stakeholders

The workshop stakeholders were made up of representatives and participants from academia, industry, government, and society. The academic comprises seventeen international students enrolled in the MBA program at NUCB Business School and participated in the SDGs workshop. They were divided into four teams and tasked with investigating, evaluating, and making recommendations to improve outcomes for the Ricoh Ena Forest while considering the needs of the other stakeholders. In addition, one international researcher from Keio University with research expertise in the area of sustainable development participated in the workshop as well. None of the aforementioned academics had visited Ricoh Ena Forest or had any history of interaction with other stakeholders prior to the commencement of the SDGs workshop.

From the industry, two senior managers from the Ricoh Group HQ Sustainability Department represented the Ricoh Group. They provided key information about the group's mission, corporate strategy, and nationwide practices employed in sustainability projects within different parts of Japan. They also provided macro and strategic perspectives with respect to project rationality. The company provides financial support, in addition to central government grants for forest conservation and community-oriented activities. However, management at the Ricoh Group HQ did not directly intervene with sustainability outcomes, nor did they interact with the Ena City government or local residents. There were two delegates representing Ricoh Elemex Corporation. They represented the Forest Committee and shared knowledge about how they had organized activities and managed the Ricoh Ena Forest.

Three government officials from Ena City participated in the SDGs workshop; the representatives were in charge of planning, environment, and forestry. They were also responsible for initiating and reporting sustainability activities and outcomes performed by the municipal government.

Executive Director of Ena International Exchange Association (EIEA) who was responsible for sharing and providing feedback on behalf of local residents living near the Ricoh Ena Forest. The aforementioned groups of local stakeholders did not have any formal meeting to address sustainability issues or share knowledge with other stakeholders prior to the SDGs workshop.

4. Findings and Discussions

4.1. Collaborative Mechanism: Multi-Node Knowledge Link Model

It is believed that stakeholders collaborating on a particular project may have a different understanding regarding the scope and limitations of the project due to lack of interaction. A mutual platform can reduce the knowledge gaps among the stakeholders by facilitating connectivity and collaboration. One participant explained the phenomenon:

> *It was very interesting to have the point of view of other stakeholders, the Ena city representatives, during this session. It was very necessary for us to see their side of the Ricoh Ena Forest and the actions they are developing for the city. It made us understand better on what terms they agree to collaborate. (IS-12)*

The literary paradigms are based on the stakeholder's separation into global and regional spheres. The SDGs workshop enabled us to explore the regional stakeholders in-depth while contemplating their views, understanding, and contribution towards the bigger picture. The differences in regional stakeholders were due to variations in the available information as well as interpretation expertise. Considering the geographical and knowledge-based context, we further categorized the regional stakeholders into two different clusters: national and local stakeholders. The geographical context here refers to stakeholders' factual location and the possibility of encompassing other stakeholders into their sphere of influence. Knowledge-based context refers to stakeholders' understanding, perception, and access to relevant information and their ability to evaluate its relevance in accordance with the ground realities.

National stakeholders are the individuals representing any organization with a nation-wide knowledge and responsibility to meet sustainability goals in multiple regions. On the other hand, local stakeholders are the parties with a locality-focused knowledge and responsibility to meet sustainability goals within the same geographical region.

> *It was interesting to ask about the motivation of the stakeholders and why they are taking part in this project. It helped us understand a lot their mentality and the fact that philanthropy is a big part of their motivation in this project. (IS-7)*

The above-mentioned statement uncovers the underlying assumption about the group of stakeholders collaborating in a sustainability-oriented setting. The collaboration reveals the differences in knowledge and understanding due to variations in their geographical and knowledge-based context. For global stakeholders, knowledge refers to the information, expertise and practices exercised to manage comparable projects across countries under various social and macroeconomic environments. Generally, global stakeholders include expatriate community members, global NPOs, multinational corporations, and international researchers who have the ability to offer different perspectives [25] and can explore and evaluate the project in ways that are not evident to regional stakeholders. SDGs workshop global cluster included NUCB Business School's MBA students (international students from different countries) and an international researcher from Keio University, Japan.

With a broader scope, the national stakeholders consider a particular project as a part of a bigger portfolio. Their knowledge of the project refers to a distinctive interpretation of information while considering the macro-level factors and objectives of the project to achieve certain goals within the desired timeframe. The national stakeholder cluster involves central government, national NPOs, and firms' headquarters (HQ). Representatives from Ricoh Corporation HQ were categorized as national stakeholders for the SDGs workshop. After interaction with Ricoh representatives, a student observed this:

> *. . . they are not only doing one or two projects, but it really seems like the RICOH itself uses SDG in many different areas of the company. (IS-3)*

In contrast to the national stakeholders, the local stakeholders are focused on the locality and project's implications for the local community. Local stakeholders comprise the local government, the firm's local office, community members, and local NPOs. These stakeholders are familiar with the local environment, practices, and ground realities. Their

direct exposure provides them with better local knowledge and equips this group among others in facing and resolving issues concerning the project [26]. We categorized Ricoh Ena Forest Management Committee, Ena City Government, and a nonprofit organization as local stakeholders of the SDGs workshop.

Prior to the commencement of the SDGs workshop, all stakeholders across the three clusters, global, national, and local, had no common platform to interact and exchange information regarding project objectives and wider implications for the community focusing on sustainability. Thus, the academics which we refer to as Bridging Academics (BAs) provided a formal sustainability-oriented platform for interaction and knowledge diffusion. The SDGs workshop acted as a collaborative platform for all stakeholders where the collaborative mechanism evolved into different tiers of interaction.

The distribution of stakeholders and the evolution of interaction mechanisms can be represented as a multi-node knowledge link model (Figure 1). The model explains the pivotal role of academics in linking stakeholders with each other while considering their geographical and knowledge-based context. In the multi-node knowledge link model, bridging academics plays a vital role in facilitating knowledge diffusion in a participatory and collaborative environment.

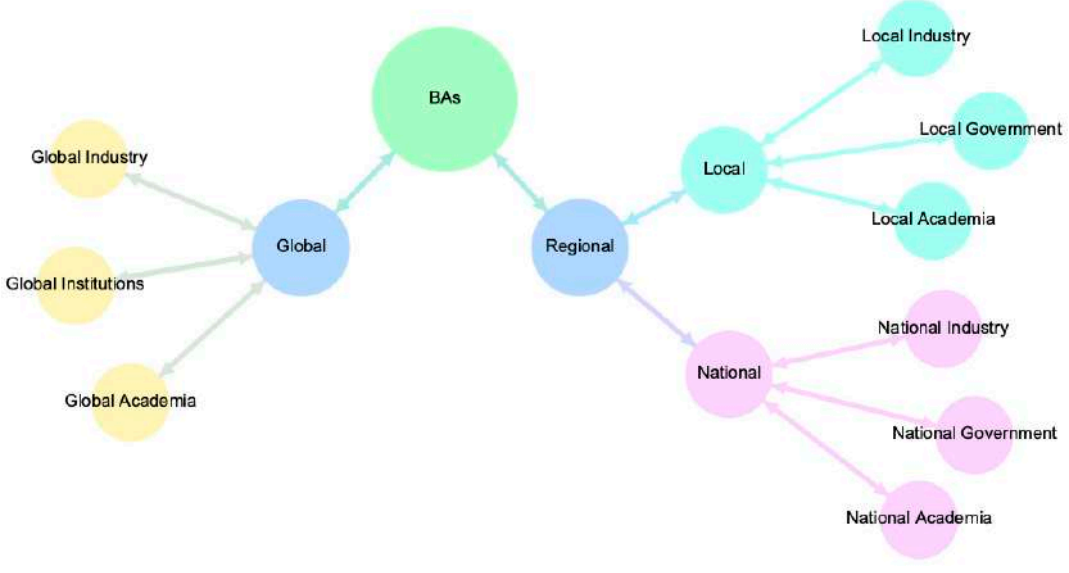

Figure 1. Multi-node knowledge link model.

> *. . . using the existing partnership as a gateway to help the various stakeholders achieve greater sustainability outcomes in their SDGs. Through new technology or new collaborations, the existing arrangement could be transformed into a valuable venture. (IS-9)*

The BAs in the multi-node knowledge link model highlight the active role universities can play in enhancing the innovative potential of regions by augmenting the capabilities of different stakeholders. The integrated approach linking institutions and corporate partners for the issues related to sustainability influences stakeholders positively in the long run [27]. The BAs-led interactions can help in fulfilling the need for social innovation to realize the goals associated with sustainable development. Social innovation in this context refers to the importance of shared knowledge to enhance the social well-being and quality of life for the community members. Improvements in the social well-being of community members will help in attaining the long-term goals concerning sustainable development.

The sustainability-oriented public–private partnership framework regulates collaborative interaction among stakeholders from the defined boundaries of sustainable solutions and development. However, the characteristic of public–private partnership in tackling sustainability-oriented issues is evolving towards a more collaborative involvement of diverse stakeholders' perspectives. The BAs in the multi-node knowledge link model plays a central role as an agent of knowledge diffusion that facilitates the knowledge flow in collaborative environments among regional (national and local) and global stakeholders.

4.2. Outcomes: Knowledge Sharing and Value Creation

Employing the sustainability-oriented partnership model, the role of BAs has evidently resulted in facilitated knowledge diffusion among stakeholders at the global, national and local levels. It has raised awareness of knowledge gaps, assisted interaction, built capacity, and created relevance for knowledge sharing to address sustainability and creative solutions.

4.2.1. Awareness of Knowledge Gaps through Inter- and Intra-Cluster Interaction

The exposure and interactions among stakeholders augmented the understanding of knowledge gaps regarding sustainability at the inter- and intracluster levels, respectively. First, within the intercluster exchange, international students gained an understanding of the differences between theoretical concepts and business and local practices from other clusters. The gap between theoretical knowledge and its application has been widely recognized in earlier studies [28]. One participant mentioned this:

> *'There were many times I found myself saying "That is what they meant in class...". It was a very hands-on, practice-based project. It tested many of the design philosophies I have studied. The practical experience was priceless.' (IS-1)*

Second, the knowledge gap among stakeholders at the intracluster level was highlighted in interviews during the reflection session. The three local stakeholders, including Ricoh Elemex members, Ena City government, and Ena International Exchange Association, were located within Ena City. The feedback shows the awareness of the differences in their respective approaches toward sustainability by the end of the project. The knowledge gap between stakeholders within the same cluster exists even in close geographical proximity [29]. However, they lack social proximity and knowledge sharing. An employee of Ricoh Elemex, who is also part of the forest management committee, explains it this way:

> *'Through the proposals, I would see what has been missing to reorganise the forest activities to be aligned with our SDGs even though we are "neighbours" in Ena City'. (ELEM-1)*

The following statement captures the sentiments of a government representative:

> *'Even though our city government has known about the Ricoh Elemex and Ricoh Ena Forest located in our city, however we have never communicated or collaborated about sustainability issues until this project. We have learnt a lot about each other.' (ENA-1)*

4.2.2. Effective Communication Outcomes through Interaction

The BA-led project structure enabled the participants to initiate a communication loop connecting every stakeholder. The process involved knowledge sharing through information sessions, interviews, proposal discussions, and feedback sessions among stakeholders. Through such interactive learning, stakeholders have reduced their cognitive distance and overcome knowledge complementarities [30]. These unique settings provide all stakeholders with essential exposure for enriched interactions.

Stakeholders can have expectations from other groups of stakeholders participating in the same project. International students and regional stakeholders have gained motivation and interest in the exchange of ideas and discussions. One participant stated this:

> *'From the direct interview with stakeholders (Ricoh HQ and Ricoh Elemex) at the breakout session, I got a clearer impression that environmental conservation and community*

engagement was the top priority. Project representatives were not too worried about financial sustainability.' (IS-3)

The group-initiated activities for research and data collection were dynamic interaction options for stakeholders to collaborate with each other. One participant recalled the following:

'Through the online interaction with stakeholders, I would feel the importance of contributing our expertise. Through the self-initiated fieldwork by our group, I appreciate the data provided during the online session, but the motivation of the forest members has given me additional perspectives to better improve the solutions.' (IS-4)

The interaction platform was surprising for industry and community stakeholders, as they recollected their thoughts in the following statement:

'I was surprised yet amazed with the intense interview with the international students during the online breakout session. Thus, we came together to guide the students for the initiated fieldwork and followed up interviews outside the workshop.' (ELEM-1 and EIEA-1)

4.2.3. Knowledge Extension through Regionally Focused Proposal

The analysis showed that after collaboration, stakeholders who represented different clusters extended their knowledge gains arising from the proposal based on Ricoh Ena Forest.

International students have completed their proposals as proof of concepts through workshops. As an extension of the knowledge gained, international students would like to implement the SDGs relevant project and directly contribute toward the development of SDGs in Ricoh Ena Forest. One of the participants mentioned the following:

'Before the course, I had a "BIG WHY" about companies who adopt SDGs in their businesses and business models. Thanks to the workshop, I have gained understanding and comments for my proposal created for Ricoh Ena Forest. If there is an opportunity, I would like to implement our plan into reality through the support of the regional stakeholders.' (IS-10)

The international researcher extended the feedback on the impact of her research to conduct a detailed case analysis of Ricoh Corporation. With the network connection, she would perform qualitative studies to better understand the dilemma and cooperation between different levels of goals and activities within the same organization in sustainability. They explained this as follows:

'After the project, I would like to explore the research to understand the effects of ESG in Ricoh from at the national level to create a used case.' (IR-1)

The collaboration has resulted in knowledge diffusion and motivation for follow-up on knowledge extension by senior managers at the Ricoh Group HQ. Even at the national level, there is a lack of exemplary cases for future learning and discussion. The Ricoh Group HQ representative shared his feedback after the workshop:

'We would continue this collaboration to find solutions for the sustainability strategy of my corporation. I would like to compare case studies between Japan and foreign countries through the international students. We would follow-up to invite the academics for a joint research presentation to share about collaboration of SDGs projects with other institutions at the national level.' (RICOH-1)

4.2.4. Creation of Shared Values through Global and Regional Knowledge Convergence

The model empowered the convergence of knowledge for the creation of shared values among all stakeholders. The insights gained from the diverse perspective's learnings can be generalized to create new shared values. This is aligned with the principle of creating shared value as advocated by Porter and Kramer [31] in partnership formation. One participant stated this:

> *'I learned a lot about sustainable development projects in companies and the overall externalities and internal issues that made those projects hard to develop. I also learned how both can create value for the companies and the society.' (IS-17)*

Ricoh Elemex was able to consider innovative methods for organizing forest activities while considering user benefits. The Ena City government was prompted to reflect on their existing SDGs policies to improve local residents' experience. The following quotation captures these sentiments:

> *'I could see how our daily activities in the forest could achieve a common goal as we have shared values about the creation of a sustainable environment for all.' (ELEM-1)*

The Ena City government expressed their gratitude towards the international students and other stakeholders for their interest and active contribution to improving sustainability by considering the Ricoh Ena Forest, the community in Ena City and beyond. The government representatives stated the following:

> *'We considered the importance of shared value to be the key towards enabling the city to achieve as a Future SDGs city. This collaboration provides precedence for other engagements beyond members in Ena City. Thanks to the faculty member for bringing us through the learning process.' (ENA-2)*

5. Conclusions

This study analyzed a case of a sustainability-driven partnership—the SDGs Workshop in Central Japan—to examine the role of academics in the knowledge diffusion process. The findings of this study are as follows.

First, the study examined the role of how BAs facilitate collaborative partnership among stakeholders in addressing sustainability challenges, which extended the existing role of BAs in knowledge diffusion discussed by Atta-Owusu's [8]. We concluded that BAs induced collaborations and facilitated interaction among different groups of stakeholders. Through the multi-node knowledge link model, BAs facilitated knowledge diffusion among global and regional (national and local) stakeholders. BAs provided a formalized sustainability-oriented platform for knowledge diffusion among global participants and regional stakeholders involved in the workshop.

The study conceptualized the diffusion of knowledge and elimination of knowledge gaps among stakeholder networks using the multi-node knowledge link model. The model incorporates the local and national stakeholders, which contributes to the existing BAs literature [6,13] that overlooked the distinctions within the regional stakeholders. The findings suggest that stakeholders of a specific project have a different understanding of the project, its scope, and objectives. Interaction among stakeholders is beneficial in eliminating such inconsistencies; however, the interaction can be sparse, and knowledge can be divergent. Collaborative activities initiated by BAs bring all stakeholders together. Such interaction helps stakeholders realize the difference in perspectives regarding projects and their potential implications. BAs are equipped with a better understanding of theoretical concepts but sometimes lack industry exposure. This interaction can be helpful in exploring the applicability of the theoretical grounds. The industry partners manage collaborative projects using standard procedures or the guidelines given by the regional stakeholders. The situation changes when a project in consideration is not a regular corporate project but a sustainability-oriented public–private partnership project. There are strong motivations for better stakeholder interactions. Primarily, sustainability-oriented projects have recently become part of corporate portfolios. Due to the emerging field and evolving nature of projects, industry partners encourage stakeholder collaboration but lack a structured mechanism. In addition, sustainability-oriented projects influence communities and have a significant personal impact on most stakeholders, and most would like to understand their scope and effects.

Second, the study derived four thematic outcomes that are generated from the BAs-driven knowledge diffusion in the sustainability-driven public–private partnerships. These

include acknowledging knowledge gaps through multi-stakeholders interactions, communicating effectively through interactive platforms, extending knowledge through regionally focused proposals, and generating shared values through the convergence of global and regional (national and local) knowledge. The thematic outcomes connect with and extend the boundaries of existing work in relation to the effectiveness of stakeholder interactions in collaborative arrangements [29–31].

The research provides a deeper understanding of the role and function of BAs, focusing on a collaborative project in a region with dynamic lenses. Through the findings, three specific roles and functions of BAs were ascertained. First, BAs may bridge the 'knowledge gap' among stakeholders. BAs induce structured interactions that facilitate bridging the gap between different groups and layers of stakeholders. Each group plays a role in a certain capacity under the prearranged guidelines or instructions of the project managers. Big projects involve a variety of stakeholders and synchronous interactions. Distinctive understanding of project objectives among partners and managers is required in gathering everyone on a single platform. Second, BAs stimulate communication by streamlining interactive spaces. The interactive space enables stakeholders to communicate with each other in a supervised and objective-driven environment. The presence of BAs ensures that every participant reaches the minimum level of required understanding through early information sessions. Subsequent discussions focused on achieving the desired targets. Third, BAs foster knowledge sharing. Another significant aspect of knowledge diffusion among partners of a single project is the potential relevance of shared knowledge. Each participant grasped different concepts as per his or her academic background, industry exposure, and cultural context. The interaction assists global participants in considering the applicability of shared knowledge in their own surroundings. This generalization will help expand the knowledge flow in all directions. Every stakeholder discovers and adapts accordingly. The possibility of imitating projects under similar conditions increases multiple times. Thus, we conclude that the research has theoretically contributed towards the understanding of bridging academic and discussion of societal impact of universities on regional/national innovation ecosystems from the academic perspectives.

This study has implications for academic institutions, industry partners, and policymakers that addresses the theme of sustainability. Academic institutions such as universities can play a critical role in developing the role of BAs to moderate stakeholder interactions. These interactions not only enhance the understanding of their students and faculty members but also improve the effectiveness of regional collaborative projects. Industrial partners should engage local and international stakeholders extensively to overcome inertia in order to develop sustainable solutions. These collaborative arrangements enable stakeholders, including local governments, to actively engage with other partners. Governments can utilize this opportunity to interact with academic and industry partners to understand their perspectives on sustainability-related issues. This is the first step in formulating and realizing shared policy goals. Thus, the study highlighted a use case of a successful public–private partnership in the context of a sustainability driven project that overcomes the strategic shortcomings commonly observed in other public–private partnerships [18] (Nieth, 2019).

This study had several limitations. First, the study applied a single case study analysis of a public–private partnership which limits research validity. Further research could adopt case comparisons to study two or more partnerships based on regional projects to improve the validity of the multi-node knowledge link model. Next, the subject of sustainability may be too broad for exploration. Thus, future research could explore specific themes in sustainability. For example, the 'reuse and sustainability of wood' is the focal point for the research. Third, there was an over-reliance on local clusters with extended stakeholders than on other clusters, which resulted in a bias in the knowledge diffusion outcomes. Thus, future studies may employ additional organizations to better represent the other clusters, such as involving the national government or sustainability association in the national cluster. In addition, future research could attempt to quantify and empirically

analyze the potential impacts of universities on regional/national innovation ecosystems. Future work would provide balanced, in-depth knowledge at every layer of the multi-node knowledge-linked model explored in this study.

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Appendix A

Table A1. Timeline for SDGs workshop activities with different stakeholders.

Stage	Date (2020–2021)	Activities
Planning	11/03/2020	SDGs workshop internal Committee Meeting
	30/03/2020	1st Fieldwork at Ricoh Ena Forest
	20/05/2020	1st SDGs workshop Committee meeting
	29/07/2020	2nd SDGs workshop Committee Meeting
	22/08/2020	2nd Fieldwork at Ricoh Ena Forest
	24/09/2020	3rd SDGs workshop Committee meeting
Intervention	14/10/2020	SDGs workshop Virtual Live Sessions
	15/10/2020	
	12/11/2020	
	10/12/2020	
Reflection	23/12/2020	SDGs debriefing session 1 (Ena City Hall and EIEA Office)
	24/12/2020	SDGs debriefing session 2 (Student groups)
	14/1/2021	SDGs debriefing session 3 (Ricoh Group HQ)

Table A2. SDGs workshop stakeholders.

No	Cluster	Country	Category	Index
1	Global	USA	International Student	IS-1
2	Global	France	International Student	IS-2
3	Global	Germany	International Student	IS-3
4	Global	Ghana	International Student	IS-4
5	Global	Germany	International Student	IS-5
6	Global	USA	International Student	IS-6
7	Global	Philippines	International Student	IS-7
8	Global	India	International Student	IS-8
9	Global	India	International Student	IS-9
10	Global	Vietnam	International Student	IS-10
11	Global	Chile	International Student	IS-11
12	Global	Vietnam	International Student	IS-12
13	Global	Indonesia	International Student	IS-13
14	Global	Gambia	International Student	IS-14
15	Global	Japan	International Student	IS-15
16	Global	South Africa	International Student	IS-16

Table A2. *Cont.*

No	Cluster	Country	Category	Index
17	Global	Japan	International Student	IS-17
18	Global	Saudi Arabia	International Researcher	IR-1
19	National	Japan	Ricoh Group HQ	RICOH-1
20	National	Japan	Ricoh Group HQ	RICOH-2
21	Local	Japan	Ricoh Elemex Employee	ELEM-1
22	Local	Japan	Ricoh Elemex Employee	ELEM-2
23	Local	Japan	Ena City Government (Planning Division)	ENA-1
24	Local	Japan	Ena City Government (Environment Division)	ENA-2
25	Local	Japan	Ena City Government (Forestry Division)	ENA-3
26	Local	Japan	Ena International Exchange Association	EIEA-1

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