

Article

Advancing Sustainable Development Goal 4 Through a Scholarship of Teaching and Learning: The Development and Validation of a Student-Centered Educational Quality Scale in Developing Countries

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Abstract: Aligned with the 2030 Agenda's call for inclusive, quality education, this study bridges Sustainable Development Goal 4 (SDG4) and the Scholarship of Teaching and Learning (SoTL)—both committed to equitable, evidence-based education. We address the challenge of SoTL practice and of implementing SDG4 targets in top-down systems prevalent in developing countries by centering student voices. By centering student perspectives as a reflective lens, we develop and validate a student-driven five-dimensional SoTL evaluation scale. Utilizing a three-phase mixed-methods approach—the initial construction of a 48-item scale (Stage 1), pilot testing with 202 students and exploratory factor analysis (Stage 2), and confirmatory factor analysis with 468 responses in the main survey (Stage 3)—we established a robust framework encompassing teaching practice, teaching effectiveness, knowledge base, the multi-relationship, and teaching interaction. This study provides a scalable tool for monitoring progress toward the SDG4 targets across diverse educational contexts, bridging global sustainability imperatives with the localized pedagogical reality.

Keywords: SDG4; the Scholarship of Teaching and Learning (SoTL); student-centered evaluations; scale validation



Academic Editors: Athanasios Mogias, George Malandrakis and Panayota Koulouri

Received: 24 March 2025

Revised: 7 May 2025

Accepted: 9 May 2025

Published: 12 May 2025

Citation: Wang, Y.; Liu, Z.; Tu, C. Advancing Sustainable Development Goal 4 Through a Scholarship of Teaching and Learning: The Development and Validation of a Student-Centered Educational Quality Scale in Developing Countries. *Sustainability* **2025**, *17*, 4369. <https://doi.org/10.3390/su17104369>

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1. Introduction

In response to the competitive nature of university rankings, the focus of university teaching has undergone significant changes since the 1990s. The emergence of the Scholarship of Teaching and Learning (SoTL) has been identified as a solution to the challenges faced by universities on a global scale. In China, there is an analogous policy orientation that emphasizes universities' involvement in creating social benefits, in line with the contemporary purpose of higher education. However, universities, as nonprofit institutions, may jeopardize their academic goals if they become overly concerned with market- or profit-based objectives [1,2].

Therefore, over the past three decades, the SoTL has received a great deal of attention worldwide [2–7]. However, the collective dilemma faced by the SoTL research and practice is that, in the process of evaluating teachers' teaching, universities are more inclined to use the unified official criteria instead of student expectations to ensure that they can achieve better results in the university ranking system or national assessments system. These tensions reflect a broader institutional paradox—while policies rhetorically endorse the SoTL principles, their operationalization remains constrained by a legacy system prioritizing

measurable outputs over transformative educational processes, especially in developing countries. In this context, student-centered assessment is critical as a complementary and reflective perspective for the understanding of the “supercomplexity” [8] concept—SoTL.

1.1. The Traditional “Research-First” Ecosystem and the Global SoTL Movement

Amidst the intensifying competition in global higher education, university ranking mechanisms and market-driven logic have profoundly reshaped institutional teaching priorities [9]. Since the 1990s, teaching has evolved from a “static process” of knowledge transmission to a “dynamic practice” of competency cultivation and intellectual inspiration. This paradigm shift catalyzed the emergence of the SoTL framework. The traditional “research-over-teaching” model prioritizes institutional prestige through research productivity, relegating teaching to a secondary role characterized by passive knowledge transmission and standardized instruction.

As a reflexive departure from the traditional “research-over-teaching” academic ecosystem, the SoTL advocates for reconceptualizing pedagogical practices as a systematized and disseminable form of scholarly inquiry. Rooted in evidence-based continuous improvement [10], the SoTL positions teaching not merely as an instructional activity but as an intellectual endeavor requiring systematic investigation, pedagogical innovation, and rigorous validation through empirical methodologies. This paradigm shift redefines faculty roles by integrating dual identities—researcher and educator—and emphasizes the institutionalization of robust evaluation frameworks that equate teaching excellence with research achievements. Concurrently, it transitions students from passive knowledge recipients to active participants in inquiry-based learning environments, fostering critical thinking and adaptability. Ultimately, the SoTL seeks to harmonize academic rigor with educational values, cultivating learners who are capable of addressing complex societal challenges.

In Table 1, we further explain the difference between the two paradigms through the five dimensions of Core Philosophy, Core Objective, Faculty Role, Student Role, Teaching Methodology, and Evaluation System.

Table 1. The difference between “research-over-teaching” and SoTL.

Dimension	“Research-Over-Teaching”	“Scholarship of Teaching and Learning”
Core Philosophy	➤ Prioritizes research output; ➤ Treats teaching as a secondary task; ➤ One-way knowledge transmission.	➤ Views teaching as scholarly work; ➤ Teaching requires research, reflection, and innovation; ➤ Capacity for lifelong learning.
Core Objective	➤ Pursues academic prestige and institutional rankings.	➤ Balances scholarly rigor with educational values.
Faculty Role	➤ Single identity as an educator in the pedagogical context; ➤ As opposed to being a researcher, the teaching roles are marginalized with limited professional development support.	➤ Dual identity as researchers and educators; ➤ Emphasizes pedagogical research, curriculum design, and sharing teaching innovations.
Student Role	➤ Passive knowledge recipients; ➤ Exam-driven learning with limited focus on innovation.	➤ Active participants in inquiry-based learning; ➤ Cultivates critical thinking and practical skills.

Table 1. Cont.

Dimension	“Research-Over-Teaching”	“Scholarship of Teaching and Learning”
Teaching Methodology	➤ Lecture-based, standardized content delivery; ➤ Prioritizes breadth of knowledge over deep understanding.	➤ Evidence-based practices (e.g., flipped classrooms); ➤ Emphasizes active learning and personalized instruction.
Evaluation System	➤ Relies on research metrics (publications, grants); ➤ Teaching evaluations are superficial and lack feedback mechanisms.	➤ Integrates teaching achievements into academic evaluation with equal weight given to research; ➤ Establishing an evaluation cycle of evaluation–feedback–improvement–evaluation.

1.2. The Characteristics of SoTL Practice in China and Student Assessment as a Reflective Perspective

The global academic movement of the SoTL aligns with China’s ongoing higher education reforms, particularly the “Double First-Class” initiative, which prioritizes universities’ societal contributions through knowledge innovation while warning against the risks of marketization eroding academic integrity [1,2]. This policy framework creates a dual tension for SoTL implementation—it demands that universities simultaneously uphold scholarly rigor and maximize societal impact through pedagogical excellence. However, as some studies have pointed out, SoTL practices in developing nations are confronted with multiple challenges. Existing studies suggest that a teaching-evaluative deficit is particularly pronounced in developing nations, where challenges such as unequal resource distribution, insufficient pedagogical innovation, and inadequate responses to diverse student needs impede substantive quality breakthroughs [11].

As a representative of developing countries, China’s SoTL practice remains in its nascent stage of development, characterized by a top–down institutional exploration primarily driven by educational administrative authorities and universities. This governance model has led to an evaluation system heavily influenced by externally imposed standards—such as policy mandates from the Ministry of Education and institutional performance metrics—rather than organic, faculty-led, pedagogical reflection and innovation. For instance, reforms like the “Guidelines for Deepening Education Evaluation Reform in the New Era” emphasize quantifying teaching achievements but often overlook the core SoTL tenets of critical self-inquiry, evidence-based iterative refinement, and disciplinary-specific pedagogical creativity.

Consequently, while administrative frameworks provide structural legitimacy to teaching scholarship, they risk reducing the SoTL to a compliance-driven exercise, diluting its transformative potential to foster authentic, localized teaching praxis. Concurrently, the pressure to align teaching with market-driven skill demands risks reducing curricula to instrumentalist training, marginalizing the SoTL’s emphasis on fostering critical thinking and lifelong learning. These tensions reflect a broader institutional paradox—while policies rhetorically endorse the SoTL principles, their operationalization remains constrained by a legacy system prioritizing measurable outputs over transformative educational processes.

It is within this contested terrain of practice that this study proposes student evaluations as a reflexive lens to interrogate China’s SoTL implementation. By foregrounding bottom–up student perspectives—such as feedback on pedagogical practices, self-reported learning experiences, and critical reflections on curriculum relevance—this approach seeks to unmask the disjuncture between policy rhetoric and classroom realities. Student voices, often marginalized in top–down policy frameworks, can reveal how administrative compliance and market-driven instrumentalism inadvertently constrain pedagogical innova-

tion. Such insights underscore the SoTL's imperative to prioritize the reflexive teaching praxis—where educators iteratively refine instruction based on the evidence of student learning—rather than merely fulfilling externally imposed benchmarks. More importantly, centering student agency aligns with the SoTL's foundational commitment to fostering life-long learning competencies, which transcend narrow skill acquisition to cultivate adaptive, ethically grounded learners capable of addressing societal challenges.

Consequently, integrating student perspectives into the SoTL evaluation frameworks not only enhances educational sustainability by bridging policy and practice but also recenters teaching scholarship on its core mission: nurturing humanistic and intellectual growth in alignment with both global scholarly ideals and localized educational contexts.

1.3. Consistency Between SDG4 and Student-Centered SoTL Assessment

Embedded within the United Nations' 2030 Agenda for Sustainable Development, Sustainable Development Goal 4 (SDG4)—Quality Education—establishes a transformative mandate for reimagining higher education systems globally. SDG4 calls for the establishment of “inclusive, equitable, and quality education systems that promote lifelong learning opportunities for all” [12], a vision that resonates intrinsically with the SoTL—a paradigm dedicated to advancing pedagogical excellence through evidence-based, reflective practices.

SDG4 emphasizes multidimensional interventions to dismantle educational inequities and elevate teaching quality, while the SoTL operationalizes this vision by reorienting pedagogy toward learner-centered methodologies and context-sensitive innovation. Together, they construct a cohesive framework that bridges global sustainability aspirations with localized pedagogical reforms, ensuring education systems are both universally equitable and adaptively responsive to diverse learner needs.

1. Equitable Access and Competency Development (SDG4.3 and SDG4.4)

The SoTL's pedagogical framework directly addresses SDG4.3 (equitable access to tertiary education) by dismantling systemic barriers through adaptive curriculum design and hybrid learning models. Simultaneously, the SoTL advances SDG4.4 (skills for employment) by prioritizing competency cultivation over content transmission. Through inquiry-based learning strategies, industry-aligned collaborative projects, and real-world problem-solving initiatives, SoTL effectively translates the aspirational framework of SDG4 into quantifiable educational outcomes in the classroom.

2. Pedagogical Innovation for Sustainability (SDG4.7)

By prioritizing metacognitive skills and self-directed learning, SoTL directly supports SDG 4.7 on fostering sustainability competencies. Through deliberate reflection on learning processes and student-led knowledge construction, learners develop the agency to apply knowledge across disciplinary boundaries. Interdisciplinary program design further strengthens this focus, cultivating interrelated competencies such as systems analysis (mapping cause-and-effect relationships in sustainability issues), value-based decision-making (weighing ethical implications of actions), and responsive innovation (adapting solutions to evolving contexts). This integrated approach links educational theory with societal needs and equips learners to address interrelated social, environmental, and economic challenges.

3. Teacher Professionalization as a Lever (SDG4.c)

The transition from instructor-led didacticism to facilitative pedagogy—central to both the SoTL and SDG4.c (teacher training)—redefines educators as co-learners and reflective practitioners. SoTL-driven professional development programs, informed by student evaluations and peer-reviewed teaching research, enhance pedagogical effectiveness while aligning faculty growth with institutional sustainability goals. For example, workshops on

inclusive assessment design or technology-enhanced instruction operationalize SDG4.c's call for qualified, adaptable educators.

4. Excluded Subgoals

Subgoals such as SDG4.1 (universal primary/secondary education) and SDG4.2 (early childhood development) primarily target foundational education stages, rendering them peripheral to higher education-focused SoTL. And, SDG4.5 (gender disparities) and SDG4.6 (literacy/numeracy) are excluded due to their stronger alignment with basic education equity and foundational skill acquisition, respectively. Infrastructure-focused targets like SDG4.a (inclusive facilities) and SDG4.b (global scholarships) are siloed in administrative or policy domains, as they address resource allocation and international partnerships rather than classroom-level pedagogical dynamics.

In summary, by institutionalizing reflexive student evaluations, the SoTL translates SDG4's aspirational targets into context-driven pedagogical reforms. This integration enables education systems to embody global sustainability commitments while fostering localized responsiveness to learner diversity, with teacher development catalyzed through student-informed reflective practices.

2. Literature Review

2.1. Definition of SoTL

When Boyer formalized the concept of the SoTL, no clear distinction was made between the SoTL and the concepts of “good teaching” and “pedagogical scholarship” [13,14]. Therefore, during the initial development of the concept of the SoTL, the term was often used as a synonym for teaching that demonstrates remarkable wisdom and deserves exemplary recognition [15,16]. As an increasingly important part of delivering quality pedagogy, the SoTL has brought a new perspective to (re)examine the purpose of being an academic [14,17,18].

However, as SoTL research and its practice continue to increase, the SoTL concept has been criticized for becoming increasingly all-encompassing. To clarify the concept of scholarly teaching, Shulman (1993) [19] expanded upon Boyer's original framework. Specifically, Shulman argues that the SoTL is elevated to the rank of scholarly pursuits because of its public nature and the opportunities for peer review and engagement with the academic community [7,19]. In subsequent studies, this viewpoint has been seen as a theoretical basis for understanding the supercomplexity of the SoTL [20]. At the same time, the all-encompassing concept of the SoTL has also faced criticism for being “diluted and muddled” by the academic function of universities [11,21,22]. Overall, the definition of the SoTL has undergone a significant change over the last three decades, primarily due to its evolution over time, as well as the changing values in higher education institutions' practices [23,24].

As pointed out by [14], three decades after Boyer's (1990) seminal work, we are no closer to consensus in our conceptualizations of academic work and knowledge in a supportive, inclusive, flexible, or dynamic way. Instead, the increasing trend toward creating academic categorizations, further fragments the notion that academic functions are overlapping and interconnected. By separating, categorizing, and defining teaching and research to solve the problem, institutions exacerbate the competitive and hierarchical nature of knowledge. Thus, for the current state of research, to better bridge the divide, it is critical to adopt a flexible, pluralistic, creative, and integrative perspective on the SoTL.

2.2. Student Evaluations as a Perspective of the SoTL

As the practice of the SoTL continues to grow globally, a growing number of researchers have emphasized the importance of evaluating SoTL practices [13,25]. They have

also called for the quality assessment of university teaching to be aligned with the core framework of the SoTL [25–30] and for the building of a comprehensive evaluation strategy for the SoTL [6,21].

Hutchings and Shulman (1999) [15] delineated the critical features of the SoTL and stated that the SoTL should be based on student evaluations. Although there were critiques of student assessments in the early stages, the refinement of the student assessment model has led to the increased acceptance of the role of student assessments in teacher evaluations. More and more researchers have advocated that teachers and researchers should promote the understanding of the SoTL through surveys of students [30]. Although peer evaluation, supervisor evaluation, and expert evaluation can be helpful, they cannot replace the valuable insights provided by student evaluations. The study conducted by [31] provides partial support for a positive correlation between student achievement and student evaluations of teachers. This is because students who perform well in class tend to achieve higher grades and subsequently assign higher ratings to their teachers. While many instructional factors can impact student learning, the primary aim of student evaluations is to identify which instructional dimensions are more likely to affect student learning both theoretically and empirically [31].

For the SoTL, which is experiencing the continuous impact of marketization in higher education, student evaluations may offer a more consistent and impartial research perspective, regardless of the national context. However, due to the differences in higher education goals of different countries, the scale of student evaluation has the problem of inapplicability when facing the transnational context. Therefore, it is necessary to create specific SoTL student evaluation scales based on the higher education contexts of different countries.

However, the existing literature is lacking on the development of evaluation systems and scales based on student perspectives. This is mainly because there are systematic issues with higher education institutional policies for the SoTL, rooted in disjointed quality assurance mechanisms that conflate teaching excellence with conventional research productivity metrics, while student perspectives remain structurally excluded from faculty development paradigms due to rigid tenure evaluation criteria [11,17,22], especially in neoliberal institutions influenced by rankings [21]. Therefore, this study attempts to use student evaluation as a new and key way of seeing and acknowledging the SoTL. And based on that, to develop and validate a student-centered assessment system.

3. Materials and Methods

This study attempts to develop and validate a student-centered SoTL assessment scale, based on two existing student assessment scales for the SoTL, and considering SoTL practices and the national assessment system in China.

3.1. Stage 1—Initial Item Generation

Based on two established scales and incorporating China's Official Teaching Evaluation Index System, this study constructed a student evaluation scale for the SoTL.

The foundational scale for this study is derived from Abrami, d'Apollonia, and Rosenfield's pioneering work, which initially developed a "student assessment scale" in 1993. Through iterative revisions over decades, this scale was formally published in the book *The Scholarship of Teaching and Learning in Higher Education: An Evidence-Based Perspective* [10]. The refined version identifies 31 instructional characteristics critical to effective teaching, independently prioritized by both students and educators.

The second scale is the "Course and Teaching Evaluation Questionnaires" (CTEQ) mentioned in the book *Evaluating Teaching and Learning* [32]. This book provides a practical

guide for colleges and universities on the SoTL and was compiled through interviews with esteemed educators, which consists of nine dimensions of teaching skills. To fully consider the higher education context in China, the scale was also constructed with reference to some of the evaluation criteria and contents in the *Undergraduate Education and Teaching Evaluation Indicator System (2021–2025)* issued by the Ministry of Education of China.

Moreover, this study conducted semi-structured interviews with five students to ensure a more comprehensive collection of information about the SoTL based on a student assessment perspective and asked 10 students to read the initial scale and asked them to present face-to-face the confusions that existed in its formulation and categorization in order to ensure that the statements in the initial questionnaire are easy to understand and free of ambiguity. As a result, the initial scale comprises 48 items that are categorized into five hypothetical constructs based on inter-item relationships.

3.2. Stage 2—Pilot Test

3.2.1. Pilot Test Procedure

Scale development includes conducting a pilot test on relevant populations to remove items that do not meet a certain threshold of reliability and validity in the initial item pool [33,34]. The pilot test was conducted on the same teaching day in a randomly selected classroom, chosen from four universities situated in Guangzhou, Guangdong Province, China. A total of 237 surveys were distributed, with 202 valid responses returned, resulting in a response rate of 85.2%.

The pilot test process is divided into two parts: Scale A asks students to answer which factors they think are more important for the SoTL, and exploratory factor analysis (EFA) is used on the scale results to confirm the factor structure; Scale B asks students to evaluate the teachers directly, and multiple regression analysis is conducted on the scale results to confirm the explanatory power of the factor.

3.2.2. Results of Exploratory Factor Analysis (EFA) of Scale A

Prior to conducting exploratory factor analysis (EFA), the suitability of the scale was assessed using Bartlett's test of sphericity and the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy. The initial KMO value (0.667) indicated suboptimal structural validity, necessitating the further refinement of the scale. To enhance structural validity, 11 items with individual KMO values below 0.5 and item reliability coefficients lower than 0.6 were sequentially removed. After these adjustments, the finalized scale retained 37 items, achieving an overall KMO value of 0.721 (Table 2), which meets the recommended threshold for factor analysis ($KMO > 0.70$). This result confirms the dataset's appropriateness for subsequent EFA.

Table 2. The KMO and Bartlett test of the adjusted scale.

Kaiser–Meyer–Olkin measure of sampling adequacy		0.721
Bartlett's test of sphericity	Approx. chi-square	1743.316
	Df	703
	Sig.	0.000

The result of the EFA indicates that the participants' evaluations of the items' significance were coherent and stable. Principal component analysis was used to extract 14 shared factors, with eigenvalues exceeding 1. The initial five common factors make up 51.345% of the total variance, demonstrating their significance in the construct, while the contribution to the explanation from the sixth common factor onwards steadily diminishes.

To determine which factors are significant, those with a sudden and steep slope are retained while those with a flat slope are removed. The gravel diagram of this scale shows an inflection point at the fifth eigenvalue, with the slope increasing from this point. Therefore, upon combining the conclusions derived from the above two techniques, the preliminary determination regarding the number of factors extracted was five (Table 3).

Table 3. Factor structure (EFA).

Items		F1	F2	F3	F4	F5	Cronbach's Alpha
A—Teaching Attitude							0.867
1	Teacher gives fast feedback on assignments or exams	0.782	−0.080	0.020	0.052	−0.016	
2	Teacher encourages students to ask more questions	0.633	0.067	0.158	0.456	−0.106	
3	Students can find teachers after class if they need	0.583	0.323	−0.086	−0.145	0.209	
4	Teacher is happy to answer if students are confusing	0.564	0.292	0.107	0.009	0.192	
5	Teacher can accept different points of view	0.562	−0.010	0.244	0.385	−0.016	
6	Teacher can recognize their mistakes if they do make	0.537	0.253	0.129	−0.049	0.200	
7	Teacher is willing to communicate with students	0.516	0.198	0.179	0.295	0.256	
8	Teacher is able to seek advice from others when they encounter problems	0.482	0.163	0.147	−0.006	−0.018	
9	Teacher is good at self-reflection	0.442	0.411	0.168	0.107	0.180	
10	Teacher encourages students to discuss with each other in class	0.723	0.022	−0.229	−0.010	0.116	
11	Teacher plans each lesson carefully	0.723	0.022	−0.229	−0.010	0.116	
B—Teaching Effectiveness							0.791
1	Enabling students to learn some basic skills	0.272	0.604	0.077	0.103	0.146	
2	Enabling students to learn some key principles	0.247	0.689	0.058	0.113	0.128	
3	Enabling students to acquire Integrated skills	−0.100	0.730	0.200	0.153	−0.041	
4	Enabling students to improve their problem-solving skills	0.103	0.665	0.183	−0.177	0.155	
5	Teacher can stimulate students' curiosity	0.229	0.628	0.011	0.217	−0.179	
6	Teacher can stimulate students' interest in the subject they teach	0.079	0.556	−0.009	0.307	0.060	
C—Multi-relationship							0.781
1	Teacher is warm and friendly	0.210	0.015	0.694	0.092	0.244	
2	Teacher cares about students	0.222	−0.050	0.692	0.244	0.233	
3	Friendly relationship exists between teachers and students	−0.067	0.161	0.516	−0.181	−0.140	
4	Teacher respects others	0.101	0.081	0.723	0.275	−0.120	
5	Teacher is a person to be honored	0.248	−0.063	0.403	0.332	0.355	
6	Teacher is passionate about education	0.330	0.307	0.431	0.286	0.093	
7	Teacher is passionate about the subject they teach	0.236	0.286	0.419	0.146	0.150	
D—Knowledge Base							0.782
1	Teacher is familiar with the subject matter they teach	0.088	0.348	0.202	0.536	0.290	
2	Teacher is familiar with the relevant subject areas	0.075	0.204	0.189	0.722	0.111	
3	Teacher is able to combine knowledge with real-life examples	−0.089	0.384	0.105	0.620	0.135	
4	Teacher has broad and deep knowledge	−0.164	−0.054	−0.031	0.717	0.149	
5	Teacher has the ability to collaborate with other teachers in the classroom	0.240	0.175	0.084	0.658	−0.168	
6	Teacher is able to handle classroom order issues appropriately	0.135	−0.014	0.388	0.403	0.158	

Table 3. Cont.

	Items	F1	F2	F3	F4	F5	Cronbach's Alpha
E—Teaching Practice							0.715
1	Teacher explains key points clearly and accurately	−0.012	0.355	−0.004	−0.058	0.559	
2	Teacher clearly explains the learning objectives of the course	0.029	0.156	−0.376	0.122	0.503	
3	Teacher's teaching is focused on the learning objectives	−0.025	0.052	0.086	0.314	0.561	
4	Teacher's teaching is easy to understand	0.025	0.072	0.364	−0.082	0.626	
5	Moderate difficulty of coursework	0.257	−0.031	0.055	0.168	0.613	
6	Moderate amount of coursework	0.212	−0.020	0.090	0.034	0.637	

3.2.3. Results of Stepwise Regression Analysis of Scale B

To validate the significance of the five mentioned dimensions, the correlation between a teacher's overall evaluation and their students' assessment of their attributes was investigated. In Scale B, we employ regression analysis to establish if an association exists between the students' ratings of interpersonal relationships, communicative reflection, knowledge base, classroom practice, teaching effectiveness, and their judgment of the teacher. Such a correlation may indicate that these five dimensions carry significant weight for students, even if they are not consciously aware of it.

In this study, stepwise regression analysis was used to avoid the interference of multicollinearity, and the results showed that all five predictor variables for the inputs effectively predict this effector variable with significant power (Table 4). The combined effect of the five independent variables on the dependent variable ($R^2 = 0.993$) was 99.3%. All five variables had considerable power in predicting students' overall satisfaction with their teachers' teaching. The amount of individual variance explained by each independent variable in the regression model reached a significance at $p < 0.05$.

Table 4. Model summary.

Models	R	R-Square	Adjustment of R-Square	Standard Error in Estimation	Changing Statistics				
					R Party Change	F Change	df1	df2	Sig. F Change
1	0.897	0.804	0.800	0.16412	0.804	184.666	1	45	0.000
2	0.945	0.892	0.887	0.12301	0.088	36.110	1	44	0.000
3	0.976	0.953	0.949	0.08243	0.060	54.983	1	43	0.000
4	0.988	0.976	0.973	0.05987	0.023	39.511	1	42	0.000
5	0.993	0.986	0.984	0.04628	0.010	29.284	1	41	0.000

The results of the two parts in the pilot test display conclusive consistency for these five factors. The multiple regression analysis reveals that the mean and total scores of the five dimensions, acquired from EFA, are all aligned with the average teacher evaluation score as the dependent variable. The pilot data analysis results of two scales display conclusive consistency, leading to the final identification of five dimensions (37 items) of the SoTL based on student perspectives in the context of Chinese higher education.

3.3. Stage 3—Main Survey

The main survey was conducted with 505 students in China. The students were asked to respond to statements using a 5-point Likert scale ranging from 1 (strongly unimportant)

to 5 (strongly important). Lastly, confirmatory factor analysis (CFA) and convergent and discriminant validity analysis were conducted.

4. Results

4.1. Descriptive Statistics

The main survey was conducted with 505 Chinese students; after excluding the 37 questionnaires that were not carefully answered, the final number of valid samples was 468, with a response rate of 92%. For a total of five factors and 37 items, the effective sample size for this analysis was ten times the number of items, which is a moderate sample size.

4.2. Confirmatory Factor Analysis (CFA)

Confirmatory factor analysis (CFA) is a type of structural equation modeling that deals specifically with measurement models, i.e., the relationships between observed measures or indicators and latent variables of factors [35,36]. Validation is achieved when the standardized λ value is 0.6 or higher, the average variance extracted (AVE) is 0.5 or higher, and the construct reliability (CR) is 0.7 or higher.

The results of the initial value of the standardized loading coefficients for all 37 items are greater than 0.6 and show significance, implying a good measurement relationship, which is acceptable in EFA. However, higher thresholds are needed in CFA to ensure that the contribution of each variable to the factor is large enough to allow for higher variance explained by the latent variables and better reliability. Therefore, we used a relatively high standardized factor loading discriminant (values ranging from 0.70 to 0.92, at a significance of $p < 0.5$) and, considering the results of the model fit indices, we successively deleted the 11 items with relatively low factor loading coefficients to ensure that the remaining 26 items truly represented the relevant constructs (Table 5).

Table 5. Confirmatory factor analysis (CFA).

Items	Loadings	AVE	CR
A—Teaching Practice		0.637	0.898
1 Teacher encourages students to discuss with each other in class	0.785		
2 Teacher gives fast feedback on assignments or exams	0.804		
3 Teacher is happy to answer if students are confusing	0.794		
4 Students can find teachers after class if they need them	0.816		
5 Teacher encourages students to ask more questions	0.791		
B—Teaching Effectiveness		0.587	0.895
1 Enabling students to learn some basic skills	0.719		
2 Teacher can stimulate students' interest in the subject they teach	0.839		
3 Teacher can stimulate students' curiosity	0.758		
4 Enabling students to improve their problem-solving skills	0.737		
5 Enabling students to acquire Integrated skills	0.718		
6 Enabling students to learn some key principles	0.817		
C—Multi-relationship		0.639	0.898
1 Teacher is warm and friendly	0.754		
2 Teacher is a person to be honored	0.715		
3 Teacher is passionate about the subject they teach	0.871		
4 Friendly relationship exists between teachers and students	0.753		
5 Teachers care about students	0.888		

Table 5. *Cont.*

	Items	Loadings	AVE	CR
D—Knowledge Base			0.575	0.870
1	Teacher is familiar with the subject matter they teach	0.715		
2	Teacher is able to handle classroom order issues appropriately	0.796		
3	Teacher is familiar with the relevant subject areas	0.693		
4	Teacher has the ability to collaborate with other teachers in the classroom	0.865		
5	Teacher is able to combine knowledge with real-life examples	0.709		
E—Teaching Interaction			0.598	0.881
1	Teacher explains key points clearly and accurately	0.844		
2	Teacher' teaching is easy to understand	0.685		
3	Teacher clearly explains the learning objectives of the course	0.732		
4	Moderate amount of coursework	0.843		
5	Teacher' teaching is focused on the learning objectives	0.749		

4.3. Convergent Validity

The statistical significance of an item's factor loading and its magnitude can indicate the extent of the convergent validity of the item to the construct [35]. To establish the convergent validity, the average variance extracted (AVE) for each factor should be greater than 0.5 and composite reliability (CR) should be above the minimum criteria ($CR > 0.70$). Moreover, the CR values should be greater than the AVE values. As shown in Table 5, the results of this study indicated that all the three recommended criteria were met to establish the convergent validity of the SoTL scale.

4.4. Discriminant Validity of Constructs

To examine the discriminate validity of the constructs, the AVE value of each construct was compared against the squared correlation coefficients between the constructs. The bold values in parentheses in Table 6 represent the AVE of the constructs, whereas the other values show squared correlation coefficients between the constructs. It is apparent that the AVE values were larger than the squared correlation coefficients between the constructs. Thus, the discriminant validity of these scales could be claimed.

Table 6. Discriminant validity.

Factors	Factor A	Factor B	Factor C	Factor D	Factor E
Factor A—Teaching Practice	0.798				
Factor B—Teaching Effectiveness	0.257	0.766			
Factor C—Knowledge Base	0.264	0.444	0.799		
Factor D—Multi-relationship	0.298	0.433	0.323	0.758	
Factor E—Teaching Interaction	0.259	0.457	0.445	0.455	0.773

Moreover, this study validated the discriminant validity of the sample data using the HTMT (heterotrait–monotrait ratio). The results in Table 7 show that all HTMT values are less than 0.85, which means that the factors are well differentiated from each other, and the study data have good discriminant validity. Hence, the measurement model of the SoTL successfully fulfilled the construct validity criteria as well as the reliability requirements.

Table 7. Heterotrait–monotrait ratio (HTMT).

Factors	Factor A	Factor B	Factor C	Factor D	Factor E
Factor A—Teaching Attitude	-				
Factor B—Teaching Effectiveness	0.285	-			
Factor C—Knowledge Base	0.295	0.495	-		
Factor D—Multi-relationship	0.332	0.487	0.363	-	
Factor E—Teaching Interaction	0.292	0.512	0.501	0.518	-

4.5. Model Fit Indicators

The confirmatory factor analysis (CFA) model fit indices (Table 8) in this study indicated that the chi-square-to-degrees-of-freedom ratio ($\chi^2/\text{df} = 2.513$) met the standard of being less than 3, suggesting a well-balanced trade-off between model complexity and fit, with satisfactory parsimony. The Root Mean Square Error of Approximation (RMSEA = 0.057, 90% CI: 0.052–0.062) was significantly below the stringent threshold of 0.08, and its confidence interval did not exceed 0.08, supporting excellent model data alignment and ideal control of overall error. The Comparative Fit Index (CFI = 0.939) and Tucker–Lewis Index (TLI = 0.932) both exceeded the conventional threshold of 0.9, demonstrating substantial improvement over the independence baseline model and appropriate adjustment for degrees of freedom. The Standardized Root Mean Square Residual (SRMR = 0.044) fell below the 0.05 threshold, further confirming minimal residuals and strong localized fit. However, although the Goodness-of-Fit Index (GFI = 0.884) slightly fell short of the conventional 0.9 threshold, this result remains acceptable given its proximity to the threshold and the model’s strong performance across other key indices.

Table 8. Model fit indicators.

Key Indicators	χ^2	df	p	χ^2/df	GFI	RMSEA	RMR	CFI	NFI	NNFI
Standard criteria	-	-	>0.05	<3	>0.9	<0.10	<0.05	>0.9	>0.9	>0.9
Value	726.245	289	0.000	2.513	0.884	0.057	0.040	0.939	0.903	0.932
Other Indicators	TLI	AGFI	IFI	PGFI	PNFI	PCFI	SRMR	RMSEA 90% CI		
Standard criteria	>0.9	>0.9	>0.9	>0.5	>0.5	>0.5	<0.1	-		
Value	0.932	0.859	0.940	0.728	0.803	0.835	0.044	0.052 ~ 0.062		
AIC = 120.896, BIC = 378.101										

5. Discussion and Conclusions

5.1. The Five Dimensions of the Student Evaluation Scale of the SoTL

Drawing on theoretical grounding and empirical validation, this study establishes a five-dimensional framework comprising 26 validated items to evaluate the SoTL from student perspectives. This framework systematically integrates teaching practice, teaching effectiveness, knowledge base, the multi-relationship dimension, and teaching interaction.

5.1.1. Teaching Practice Dimension (Five Indicators)

The teaching practice dimension embodies the SoTL principles through three interconnected processes: (1) collaborative discourse (peer discussions and question cultivation), (2) responsive feedback systems (timely assignment evaluation and in-class clarification), and (3) extended learning support (post-class teacher accessibility). This

framework redefines pedagogy as an iterative cycle where classroom interactions simultaneously advance student understanding and inform evidence-based teaching refinement. By integrating these processes, the dimension demonstrates how routine instructional acts—from fostering dialog to sustaining student–teacher engagement—systematically align with the SoTL’s core tenet of “teaching as public inquiry” [36], transforming practice into a dynamic scholarly endeavor.

5.1.2. Teaching Effectiveness Dimension (Six Indicators)

The teaching effectiveness dimension captures the SoTL’s transformative impact through three synergistic pathways: (1) foundational competency development (the mastery of basic skills and core principles), (2) intellectual engagement cultivation (stimulating subject-specific interest and curiosity), and (3) applied mastery facilitation (problem-solving and integrated skill acquisition). This dimension demonstrates how SoTL practices bridge knowledge acquisition with adaptive expertise formation. By systematically fostering intrinsic motivation through interest-driven pedagogy, it positions “Teaching Effectiveness” as a measurable catalyst for self-sustained learning. This conceptualization aligns teaching outcomes with the SoTL’s core mission of transforming instructional practices into evidence-based drivers of cognitive and motivational growth.

5.1.3. Multi-Relationship Dimension (Five Indicators)

The multi-relationship dimension redefines teaching excellence through two SoTL-anchored pillars: (1) relational pedagogy (cultivating warm, caring, and respectful student–teacher partnerships) and (2) professional modeling (demonstrating subject passion and honor-worthy conduct). These indicators collectively operationalize the SoTL’s emphasis on teaching as a socially embedded practice [16], where affective bonds and intellectual authenticity become conduits for transformative learning. By valuing emotional attunement alongside disciplinary devotion, this framework recognizes teaching as both an intellectual endeavor and a relational act of co-constructed meaning-making.

5.1.4. Knowledge Base Dimension (Five Indicators)

The knowledge base dimension redefines teaching expertise through two anchored competencies: (1) integrated pedagogical content mastery (disciplinary knowledge, cross-disciplinary connections, and real-world contextualization) and (2) collaborative classroom praxis (order management and co-teaching capabilities). This framework extends beyond static subject expertise to emphasize knowledge-in-action—the dynamic interplay between content mastery, instructional design, and adaptive classroom leadership. By positioning teachers as both disciplinary stewards and pedagogical negotiators, the dimension aligns with the SoTL’s core premise that effective teaching emerges from deliberate knowledge integration [18].

5.1.5. Teaching Interaction Dimension (Five Indicators)

The teaching interaction dimension embodies the SoTL through two defining features: (1) goal-oriented instructional coherence (the explicit articulation of learning objectives, aligned content delivery, and purposeful workload design) and (2) accessible knowledge mediation (clear explanations and conceptual scaffolding). These indicators operationalize the SoTL’s mandate for intentional teaching praxis by transforming routine classroom exchanges into deliberate acts of co-constructed understanding. Through the systematic alignment of objectives, content, and assessments, the framework achieves [16] the vision of teaching as a “community property”—a process where the clarity of communication becomes the foundation for scholarly critique, iterative refinement, and public account-

ability. This conceptualization positions teaching interaction not merely as knowledge transmission but as an evidence-based dialogic process.

By integrating these five theoretically grounded dimensions with the SoTL process, this framework captures the dynamic interplay between teaching practices, their effectiveness, the teacher's knowledge base, interpersonal relationships, and the interactive nature of the SoTL.

5.2. Implications

Based on these conclusions, this study seeks to address three critical challenges in advancing the SoTL through a student-centered assessment framework: (1) the conceptual stagnation of the SoTL under institutional "research-over-teaching" paradigms; (2) administrative-dominated assessment systems in developing countries inhibiting the teaching innovation; and (3) ranking-driven institutional logics hindering SDG4 implementation.

5.2.1. Challenge 1—Promoting Understanding of the SoTL Concept Through a Student-Centered Assessment

This study attempts to further integrate the finalized five constructs (based on students' perspectives) with the SoTL, as a process-oriented concept to advance the understanding of the SoTL and its practice, highlighting that only teaching that has undergone this whole process and all stages can be considered as the SoTL.

While it is widely recognized that the SoTL is inextricably linked to collective inquiry, in the specific classroom, the SoTL is necessarily first and foremost an individual teacher practice. From this perspective, this study suggests that, as a process-oriented concept, the SoTL should inherently involve two distinct stages—the first stage is from individual teaching practice to the teaching community, and the second stage is the collective findings of the community, which in turn improve individual teaching practice.

Although students can only evaluate teachers who teach in the classroom, a well-designed student evaluation system is crucial for teachers to reflect on their SoTL practices. Corresponding to the scales of this study, the first stage involves the personal preparation and practice for the SoTL, including teaching practice and knowledge foundation. The second stage is the reflection process based on teaching effectiveness; although this stage does not involve students directly, the teacher's teaching effectiveness is an important criterion for the SoTL team to conduct peer evaluation and prove SoTL practice. These stages are interlinked and work cyclically to facilitate a virtuous cycle. The student perspective is therefore a very important part of the whole process of the SoTL, both in terms of providing us with an understanding of what students want from individual teachers' teaching practice, and in terms of helping the teaching community to engage in more effective collective reflection.

5.2.2. Challenge 2—Advancing SoTL Practice in Developing Countries Through a Student-Driven Perspective

Student evaluations emerge as a critical reflexive lens for advancing the SoTL in developing countries, where top-down policy mandates and market-driven pressures often inhibit pedagogical innovation. In contexts like China's "Double First-Class" initiative—which emphasizes societal impact while grappling with risks of instrumentalism—student-centered assessment provides a counterbalance to compliance-oriented evaluation systems. By prioritizing "student voices" (e.g., feedback on teaching practices, self-reported learning experiences, and critical reflections on curriculum relevance), institutions can bridge the gap between policy and classroom realities. Such an approach not only exposes how administrative standardization and market-aligned curricula inadvertently constrain pedagogical creativity but also recenters the SoTL on

its foundational mission—fostering a reflexive praxis that integrates the evidence of student learning into iterative teaching refinement.

This student-driven perspective addresses systemic challenges unique to developing nations, such as unequal resource distribution and fragmented responses to diverse learner needs. For instance, student evaluations can reveal disparities in how marginalized learners experience “inclusive education” policies, guiding context-specific adjustments to teaching strategies. Moreover, embedding student agency into SoTL frameworks aligns with SDG4’s call for equitable, lifelong learning by shifting focus from narrow skill acquisition to cultivating adaptive, ethically grounded problem-solvers. To achieve its potential, institutions must reconceptualize student evaluations not as a bureaucratic metric but as a dialogic tool for co-constructing pedagogical knowledge—one that empowers educators to navigate global standards while honoring localized educational ecologies. Ultimately, centering student perspectives transforms the SoTL from a compliance exercise into a sustainable engine for systemic educational reform, ensuring teaching scholarship serves as both a mirror reflecting classroom truths and a bridge to equitable futures.

5.2.3. Challenge 3—Provide a Scalable Tool for Monitoring Progress Toward SDG4 Targets in Different Educational Contexts

This study establishes critical linkages between classroom-level SoTL practices and SDG4 by providing a scalable, context-sensitive monitoring tool that addresses systemic gaps in global education reform. Grounded in student-centered evaluation, the framework operationalizes SDG4’s equity and quality mandates through 26 actionable indicators, translating abstract targets like inclusive education and lifelong learning into observable pedagogical behaviors. The scalability of this tool means that researchers from other countries can modify specific items based on the core dimensions to adapt to diverse educational contexts, bridging the gap between standardized sustainability metrics and grassroots pedagogical realities.

1. Equitable Access (SDG4.3)

The teaching practice dimension directly combats educational inequities through adaptive pedagogical strategies. By prioritizing flexible courses and inclusive classroom management, it addresses the systemic barriers faced by rural students, working adults, and other marginalized groups. For instance, rapid feedback mechanisms (Indicator A2) and post-class accessibility (A4) ensure continuous engagement beyond traditional classroom boundaries, operationalizing SDG4.3’s call for equitable access to technical and vocational education.

2. Skills for Sustainable Futures (SDG4.4 and SDG4.7)

The teaching effectiveness and knowledge base dimensions synergistically cultivate competencies for the 21st century. Foundational skill development (B1, B6) aligns with SDG4.4’s vocational mandates by embedding industry-relevant capabilities, while higher-order thinking (B4) and contextualized knowledge integration (D5) advance SDG4.7’s sustainability goals. Problem-solving tasks tied to real-world challenges foster both technical mastery and ethical reasoning, mirroring UNESCO’s Education for Sustainable Development (ESD) framework.

3. Teacher Professionalization (SDG4.c)

The multi-relationship and teaching interaction dimensions reconceptualize teacher professionalization as an emancipatory process of relational praxis, directly addressing SDG4.c’s call for empowered educators. By institutionalizing peer collaboration (D4) and evidence-informed reflective dialog (E1–E5), the framework positions teachers as

co-designers of pedagogical innovation rather than passive policy implementers. This framework offers two possible paths:

- (1) Communities of transformative practice: warm student–teacher partnerships (C1, C4) and transparent objective-setting (E3, E5) create democratic learning ecosystems where educators simultaneously mentor students and refine their craft through reciprocal feedback, actualizing [16] the vision of teaching as a “community property”.
- (2) Contextualized policy enactment: teachers’ reflective autonomy enables the localized adaptation of SDG4 targets—for instance, translating “quality education” (SDG4.1) into culturally responsive assessment rubrics while maintaining global benchmarking capabilities.

This dual focus on relational accountability and scholarly agency directly mitigates SDG4’s chronic implementation bottlenecks—policy–practice decoupling and resistance to standardized interventions—by positioning classroom practitioners as action researchers who bridge macro-level sustainability goals with micro-level learner realities.

4. Systemic Synergy

The knowledge base dimension acts as the framework’s keystone, integrating subject expertise (D1), cultural responsiveness (D3), and pedagogical agility (D2) to align teaching with SDG4’s holistic vision. By contextualizing disciplinary knowledge and fostering teacher collaboration (D4), it ensures education remains both globally relevant and locally grounded. This framework underscores teaching as a complex adaptive system, where multidimensional evaluations drive iterative improvements that resonate with both local learner diversity and global sustainability imperatives. By embedding SDG4’s equity, quality, and lifelong learning mandates into classroom-level praxis, it redefines educational excellence as a synergy of scholarly rigor, relational accountability, and transformative societal impact.

5.3. Limitations and Prospects

Despite the current trend of the ever-expanding exploration of the meaning and practice of the SoTL, the tension between academic work and pedagogical work persists in the process [37–40], and is inextricably linked to the neoliberal dilemma faced by universities [41,42]. Within this broader context, the collective limitations of SoTL research precisely constitute the disconnect between research and practice, which is also a limitation of this study. Specifically, since it is not the students who are the subjects who ultimately present the evaluation criteria that can determine the practice of the SoTL at the university, there are limitations to the implications of this study for practice.

Nonetheless, we still believe that developing scales and providing evidence from students’ perspectives is meaningful for possible policy development, and we still need more students’ perceptions of the SoTL from different countries and regions to keep revising our understanding of the SoTL. Student-centric frameworks aligned with SDG4 target 4.7 (ensuring skills for sustainable development) and the 2030 Agenda’s emphasis on equitable, inclusive education offer pathways to bridge this gap. The SoTL’s pedagogical innovations must engage student perspectives to address systemic barriers and fulfill the global mandate to “leave no one behind”.

As endeavored by previous studies [8,11,43,44], we call for further studies on the specific experiences of academics and their SoTL work to better understand SoTL practice. Therefore, we wish to take this research a step further and hope to include students as key players in influencing the connotations and practices of the SoTL in more specific case studies in the future, as well as in improving our understanding of SoTL connotations and practices.

Author Contributions: Conceptualization, methodology, formal analysis, and writing: Y.W.; resources, review, and editing: Z.L.; supervision: C.T. All authors have read and agreed to the published version of the manuscript.

Funding: This study was funded by the 2023 National Social Science Fund Project: Research on Fostering a Strong Sense of Community for the Chinese Nation among Primary and Secondary Students in Hong Kong through Patriotic Sites of Memory (Approval Number: 23BMZ034).

Institutional Review Board Statement: This study is part of a dissertation that has been approved by the Scientific Research Ethics Review Committee of South China Normal University.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data are available and can be provided upon a reasonable written request.

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

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